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Fish Collection Methods and Standards

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ABSTRACT

This Resources Inventory Committee (RIC) document provides information for standard data collection, methods and procedures for fish inventories in lakes and streams in B.C. A sample copy of the fish collection form is provided along with associated user notes. The fish Inventory methodologies section of this guide includes procedures for fish handling, fish collection methods, length and weight measurements and determination of fish age, sex and level of maturity. Preservation techniques and requirements for collecting voucher specimens are also discussed. A glossary of common biological terms is provided.

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The Resources Inventory Committee consists of representatives from various ministries and agencies of the Canadian and the British Columbia governments as well as from First Nations peoples. RIC objectives are to develop a common set of standards and procedures for the provincial resources inventories, as recommended by the Forest Resources Commission in its report “The Future of our Forests”.

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PART 1 INTRODUCTION

This manual describes standard methods for conducting fish inventories in British Columbia.

Fish habitat data is normally collected during a fish inventory. An understanding of habitat preferences of fish expected to be encountered during an inventory is important. It ensures that the field crew is equipped with the appropriate gear to sample the habitats of the fish of interest. Detailed information on the biology of fishes in B.C. can be found in *Scott and Crossman (1973), McPhail and Lindsey (1970) and Carl et al*. (1977). Detailed procedures for conducting lake inventories are given in *Reconnaissance (1:20 000) Fish and Fish Habitat Inventory: Standards and Procedures, RIC draft, (1997)* while *Fish Stream Identification Guidebook, FPC (1995)* provides the principles involved in establishing fish presence.

This document provides standards for data collection and measurements, and gives details on a limited range of procedures. There are several text books that provide greater detail and a wider range of procedures for designing fish studies, collecting fish, and analyzing the data collected. Good, basic text books for fresh water fisheries programs include Bagenal (1978) and Nielsen and Johnson (1983).

1. FISH COLLECTION PERMITS

An important part of any field program is to obtain and carry all relevant permits for sampling activities in the study area.

Appropriate permits must be secured from the Fisheries branch of Ministry of Environment, Lands and Parks (MELP) and/or the federal Department of Fisheries and Oceans (DFO) respectively, before sampling begins. MELP (Fisheries branch) issues permits for the collection of fresh-water fish captured in British Columbia, whereas DFO is responsible for permits governing the collection of saltwater fishes and salmon in fresh-water. One should apply to the MELP and DFO regional offices responsible for the area where the inventory will be conducted. Applications usually consist of a letter stating collectors' names, sampling period, locations to be sampled, gear types to be used, and general purpose of the inventory. A small fee is charged for processing the permit. Applications must be made well in advance of the sampling dates to allow adequate time for processing. Failure to obtain permits can result in seizure of gear and penalties.

2. SPECIAL TRAINING

Special training and certification are required for electrofishing. Currently, courses are offered at Malaspina University College in Nanaimo, BC.

3. VISUAL OBSERVATIONS BY SNORKELING

Snorkeling is employed in cases where environmental conditions such as low conductivity, fast water, etc., may limit the effectiveness of other methods (Schill and Griffith, 1984). Snorkeling is efficient for covering long stretches of a stream in shorter time periods though water clarity, stream size and snorkeler's skills may limit the accuracy of the inventory. Observational, and thus analytical inaccuracies must be considered when processing the snorkeling data.

Snorkeling is generally restricted to a pre-selected number of habitat units and involves recording the species, numbers (actual), and in most instances the size classes of fish observed. These observations may be calibrated by a more accurate method such as multiple-pass depletion by electrofishing. The overall accuracy depends on the true variation in fish numbers among habitat units and on the errors in counting fish within selected units. When the true variation is large, then it is necessary to sample many habitat units. Although fish counts by divers may be less accurate than estimates based on depletion electrofishing, snorkeling is faster and more habitat units can be examined within a given time period.

Snorkeling is cost effective in remote locations because of the small amount of equipment required. Also more area can be covered in a shorter time and there is no handling of the fish. It is relatively unbiased, although not purely accurate due to difficulty in counting fish under complex habitats. One disadvantage of this technique is the variability among the snorkelers' in data collection that may lead to inconsistent or incorrect fish size estimates, failure to detect fish (especially small ones), repeated fish count and misidentified fish.

PART 2 FISH INVENTORY METHODOLOGIES

4. FISH HANDLING PROCEDURES

The most important thing to remember when handling live fish is that **fish are living, sensing animals**. Fish are extremely sensitive to handling due to their physiochemical makeup and carelessness when handling results in high mortalities.

4.1 Fish Handling

Fish are coated with a protective layer of 'slime' that protects them from infection, certain parasites and the effects of water. Any handling of the fish removes this mucilaginous layer and when the animal is returned to water it suffers "waterburn", which is similar to sunburns that humans experience. Without their protective mucilaginous layer, the fish are prone to infection and disease. Further, minor scratches and wounds as a result of the fish thrashing about when landed may take longer to heal and may be predisposed to infection. Fighting time during angling should be minimized as this results in systemic lactic acid build-up and fatigue. Cold blooded animals like fish take longer to dispose of lactic acid in their muscles, which further contributes to stress.

Fish should be handled as little as possible and processed quickly. The water quality of all holding tanks should be maintained as close as possible to the fish's natural habitat. Fish should never be pulled by their tail or head as the stretching can inflame the intercalary discs and cause dislocation of the vertebrae. Handling by the operculum can disrupt blood flow to the gills, cause gill capillaries to haemorrhage, all of which seriously affect respiration. Larger fish can be held by supporting their caudal (tail end of the body) and the ventral opercular regions (beneath the pectoral fins). Fish viscera is not well supported by mesenteries and muscle and prolonged out of water handling increases the risk of internal injuries. For the same reason, all fish must be kept in their natural horizontal position.

Finally, field crews should have proper equipment ready before starting fish sampling. Environmental conditions must be taken into account, and the crew should be adequately prepared for factors such as low water temperature, rain, etc.

4.2 Anaesthetics

Anaesthetics are primarily used to immobilize a fish so that it can be handled faster and released live, with minimal stress to the fish.

Anaesthetics are usually administered as dosage unit per the body weight of the animal. In case of fish, optimum concentrations of the anaesthetic in water are used. The intake of the anaesthetic primarily depends on the gill surface area of the fish and therefore, the same solution can be used for fish of varying size. Stages of anaesthesia range from light sedation to a stage of medullary collapse, at which opercular movements cease and cardiac arrest follows quickly. Sedation times need to be carefully monitored as over sedation may lead to death. As a rule, a small batch of fish, that can be easily processed at a time, is sedated. Once a fish slows down sufficiently and loses its equilibrium, it should be processed quickly. After this stage there is danger of over-anaesthetizing. If opercular movements become extremely feeble, the fish must be recovered immediately. (See section on **Recovery.**)

Carbon dioxide is an effective anaesthetic for fish and can be easily administered in the field. Once returned to a recovery bucket the fish usually revive in a few minutes. As with most anaesthetics the dosage is dependent on the size of fish and water temperatures. However, it must be noted that carbon dioxide will cause some degree of asphyxiation in the animal. Further information on various fish anaesthetics and their effects can be found in:

Bell, Gordon R. A Guide to the Properties, Characteristics and Uses of Some General Anaesthetics for Fish (1967). *Fisheries Board of Canada* Bulletin No. 148.

Methods for Fish Biology. Schreck, Carl B. and Peter B. Moyle, eds. (1990). *American Fisheries Society*. 684 pp.

4.3 Recovery

The fish must be fully **recovered** from the anaesthetics before being released back into the waterbody. A separate bucket of water serves as a recovery tank. It is crucial the water in the recovery tank is well oxygenated. This can be achieved by collecting fresh water and vigorously stirring it before placing the fish in it. In larger fish, holding the fish against the water flow can increase water and oxygen flow over the gills, expediting recovery. The fish must not be moved vigorously to and fro in the water as strong backflow of water over the gill elements can be damaging. Avoid placing too many fish in a recovery tank as this depletes the oxygen rapidly.

Signs of recovery must be monitored. These are usually indicated by the fish's alertness, movement of its fins, its equilibrium, etc. Water temperature of all holding tanks must be maintained as close to the water temperature of the lake or stream of origin as possible. This is more of a problem on hot summer days when the water in the recovery tank can heat up quickly and stress the fish. Prior to release, the recovery bucket is placed in the stream or lake for some time to equilibrate its water temperature, reducing the stress of a sudden temperature difference when the fish is released. Another way of ensuring consistent water temperature is to set all the holding tanks in the stream or lake.

Fish must not be dumped into the water but gently released. This usually is done by gently immersing and tilting the holding bucket in water when releasing small fish. Larger fish should be properly oriented with respect to the water flow and gently lowered down into the water. The release site should be considered. Some fish are territorial and hence release should be at different points along the length of the waterbody. Furthermore, smaller fish need cover for protection and hence the release site should be have vegetation, rocks, etc.

In the event that a fish dies during the recovery period, depending on the needs of the inventory, it can be collected and preserved as a voucher specimen. (See section on **Voucher Specimens.**)

5. FISH COLLECTION METHODS

The objective of any inventory is to identify all fish species in all habitats using all possible combinations of gear types. Individual contracts will specify in detail the equipment to be employed for the project, based on the existing information and expectations for the system. The field crew should understand general physical and biological principles that affect fish aggregation and the biology and habitat preferences of anticipated species, age groups or sizes of the fish within the sample population. This will improve the effectiveness of the field crew and the sampling within the framework of the inventory program.

5.1 Gear Bias

Gear types used for sampling can be divided into two categories: active and passive. Active gear includes those that are moved through the water either by machine or with human power. Passive gear is usually set and left stationary for a period of time. Active gear commonly used in inventory surveys include seine nets, trawl nets, dip nets, electroshockers (electric fishing), and hook and line (angling). Commonly used passive gear includes gill and enmeshing nets and minnow traps.

Although gear will be selected prior to the inventory, the inventory surveyors will exercise their judgment in using any additional gear to ensure that all habitat types are surveyed. Certain criteria assist selection of the gear type. These can be the objectives of the inventory, limitations due to waterbody type/habitat, target fish, budget, etc.

Fish mortality is an issue that must be considered. Certain gear types (*see* Table 1) result in fish (and possibly other wildlife) mortalities and, therefore, must be rigorously monitored during use.

Table 1 Lethal and non-lethal gear type

Lethal Gear	Non-lethal Gear
Angling	Gill nets
Beach/purse /pole seines	Enmeshing/Trammel
Electrofishing	nets
Gill nets or trammel nets (when run continuously)	Trawl nets
Traps (minnow, inclined plane)	
Trawl nets, Fyke nets	

Fish mortality becomes even more critical if the sampling population includes rare, threatened or endangered species. Table 2 (a, b, c) lists rare and endangered fish species of BC and their known macro-distribution and should be used for planning an inventory.

Table 2a Red-listed fish of BC and their known regional distribution

Region 1	*Gasterosteus sp* 2	Enos lake limnetic stickleback
Region 1	*Gasterosteus sp* 3	Enos lake benthic stickleback
Region 1	*Lamptera macrostoma*	Lake lamprey
Region 1,6	*Gasterosteus sp* 1	Giant black stickleback
Region 2	*Spirinchus sp* 1	Pygmy longfin smelt
Region 2	*Cottus sp* 2	Cultus lake sculpin

Region 2	*Catostomus sp* 4	Salish sucker
Region 2	*Gasterosteus sp* 10	Emily lake limnetic stickleback
Region 2	*Gasterosteus sp* 11	Emily lake benthic stickleback
Region 2	*Gasterosteus sp* 4	Paxton lake limnetic stickleback
Region 2	*Gasterosteus sp* 5	Paxton lake benthic stickleback
Region 2	*Gasterosteus sp* 6	Priest lake limnetic stickleback
Region 2	*Gasterosteus sp* 7	Priest lake benthic stickleback
Region 2	*Gasterosteus sp* 8	Balkwill lake limnetic stickleback
Region 2	*Gasterosteus sp* 9	Balkwill lake benthic stickleback
Region 2	*Rhinichthys sp* 4	Nooksack dace
Region 2, 3, 4, 5, 7 zone A	*Acipencer transmontanus*	White sturgeon
Region 2, 7, Zone B	*Pungitius pungitius*	Ninespine stickleback
Region 4, 8	*Rhinichthys umatilla*	Umatilla dace
Region 5,6	*Prosopium sp* 2	Giant pygmy whitefish
Region 6	*Coregonus nasus*	Broad whitefish
Region 6	*Coregonus sardinella*	Least cisco
Region 7 zone A	*Thymallus arcticus* POP 1	Arctic grayling (Williston watershed population)
Region 7 zone B	*Phoxinus eos* X *P. neogaeus*	Northern redbelly dace X Finescale dace
Region 8	*Rhinichthys osculus*	Speckled dace
Sub-region 7	*Coregonus artedi*	Cisco
Sub-region 7	*Notropis atherinoides*	Emerald shiner
Sub-region 7	*Notropis hudsonius*	Spottail shiner

Table 2b Blue-listed fish of BC and their known regional distribution

Region 2, 3, 4, 5, 6, 7, 8	*Salvelinus confluentus*	Bull trout
Region 2, 5, 7	*Hybognathus hankinsoni*	Brassy minnow
Region 2, 5, 7 sub-region 3	*Catostomus platyrhynchus*	Mountain sucker
Region 4, 8	*Cottus bairdi*	Mottled sculpin
Region 4, 8	*Cottus confusus*	Shorthead sculpin
Sub-region 3, Region 4, 5, 8	*Acrocheilus alutaceus*	Chiselmouth
Region 7	*Margariscus margarita*	Pearl dace

Table 2c Extinct fish of BC and their last known regional distribution

Region 1	*Gasterosteus sp* 12	Hadley lake limnetic stickleback
Region 1	*Gasterosteus sp* 13	Hadley lake benthic stickleback
Region 5	*Coregonus sp* 1	Dragonlake whitefish

Certain limitations may restrict the use of a particular gear type to a lake, stream or a particular habitat. For example, electrofishing is effective in shallow areas of high water velocity but cannot be used efficiently in deep open waters. Site accessibility, substrate, vegetation, time constraints, size and accessibility of the habitat or of the lake or stream may further affect deployment of each gear type. Often the best results are obtained by using a variety of gear types to sample as many habitat types as possible, thus ensuring the widest possible range of fish species and sizes are collected.

Many factors affect fish sampling. These include water depth, conductivity, water clarity, water temperature, water velocity, fish size and behavior. The effects these factors have on sampling efficiency vary, and as many of the factors are interrelated, it is difficult to determine their individual effects.

The **depth of the water** influences sampling efficiency of the various gear types. For example during electrofishing, fish have more room to avoid the electrical field in deeper waters.

Conductivity of the water is primarily a function of the concentration of ions in the water. Water with low concentrations of ions will have a high resistivity and thus low conductance and *vice versa*. During summer months when water flows decrease, BC streams typically experience an increase in ionic concentrations. This is necessary when determining the optimum voltage used during electrofishing.

Water clarity plays a big role in the effectiveness of snorkel surveys and can work with or against the crew when it comes to catching particular species of fish. Clear water may help the crew see benthic fishes that do not normally flee their territory when threatened. However, open water species may be able to detect the crew and stay out of range. In less clear conditions, although the fish are more difficult to see, the fish may also have difficulty detecting the crew as they approach close enough to capture individual fish.

High water velocities can make retrieving fish difficult and reduce overall sampling efficiency. Usually fish would not have territorial areas in swiftly flowing streams or rivers. Seining with small mesh nets is difficult under these conditions; mesh size of the nets must be considered.

Water temperature affects fish activity and behaviour. Very low temperatures may limit fish to over-winter refugia and reduce movement.

The **size of the fish** and the complexity of the **habitat** they occupy relates to how easily the fish can be caught. Larger fish tend to inhabit open water spaces. Small fish typically hide under cover or in shallow water habitats where the avenues for escape are limited, making them more vulnerable to capture. On the other hand, small fish hidden in root wads are often difficult to draw out for collection. Fish size will determine the mesh size of nets, the use of minnow traps and the voltage/frequency of electrical current during electrofishing.

Fish behaviour and **activity** will too affect sampling. For example, spawning fish tend to move to the shoal areas of the lake, juvenile fish and fry may exhibit schooling behaviour and occupy different diurnal and nocturnal sites within the lake.

5.2 Gear Selectivity

Selectivity can be defined as any factor that limits the catch to a specific range of the fish population. The quality and quantity of the catch are therefore dependent on such conditions as gear specifications and operation, time of fishing, seasonal variation in fish behaviour, fish size, etc. Comparing catches from various gear types would illustrate the selectivity of fishing gear. However, the topic of gear selectivity falls outside the scope of this field guide.

Suggested readings that may list further references:

- Manual of Methods for Fish Stock Assessment Part III - Selectivity of Fishing Gear (1975). *Food and Agriculture organization of the United Nations (FAO) Fisheries Technical Paper No. 41 revision 1. 65pp.*
- Methods for Assessment of Fish production in Fresh Waters (1978). Bagenal, Timothy ed. *third edition. Blackwell Scientific publications. pages 9 - 12.*

5.3 Fish Collection Methods in Lakes

Certain gear types may require auxiliary equipment such as dip nets, stop nets, buckets for anaesthetizing and recovering fish, anaesthetics, measuring boards, etc.

5.3.1 Active Gear

Beach Seine Nets
Beach seine nets are easily deployed from a boat or by hand, and are used to enclose a specific area of the littoral zone. This technique requires minimal instruction to be used effectively.

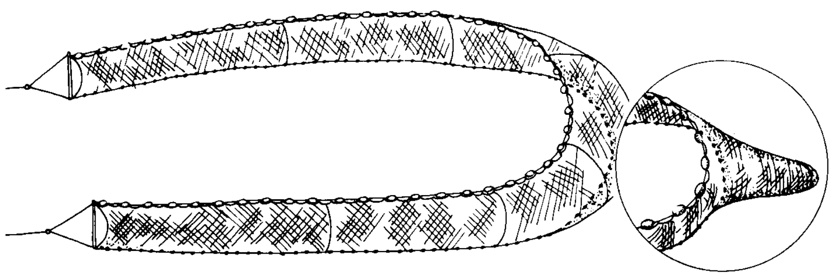


Figure 1 Typical beach seine net. Inset illustrates the bunt

Specifications – The configuration of beach seine nets can vary greatly depending on the application of the net and the target species. Beach seines 10 to 30 m long and 1.8 to 2.4 m deep are designed to capture small fish or fry but the nets can be up to 100 m long. Seine nets come in a variety of sizes and the appropriate net depends on the area to be sampled and the equipment available to deploy the net (Conlin and Tutty, 1979). The generalized beach seine includes relatively small mesh size of 0.3 - 0.6 cm in the middle section called the **bunt**. The bunt is quite loose and balloons out during the set to form a pocket in which the fish become concentrated. Extending from either side of the bunt are the wings of the net that consist of larger meshes of 1.2 to 2.5 cm. The wings serve to intercept fish and direct them towards the bunt. The larger meshes help to reduce drag as the net is hauled through water. The bottom of the net is weighted with a braided leadline or rolled lead weights while the top of the net is supported by a floating corkline. Figure 1 illustrates the parts of a generic beach seine net.

Application – Beach seines can be deployed from many types of boats or simply by wading into the water. When using a power boat to set the net, the net should be loaded into the bow of the boat and the boat should be operated in reverse gear. This allows the net to be fed out over the bow of the boat thus preventing fouling of the propeller and subsequent damage to the net. In power boats that have a modified platform on the transom to facilitate deploying of seine nets, the boat may be operated in forward gear. It should also be noted that small row boats work well for setting seine nets and have the added advantage of being very quiet, limiting the possibility of scaring fish from the sampling area.

The net should be loaded into the boat in an organized manner with the leadline piled on one side of the boat and the corkline on the other. This will allow the net to feed out smoothly and not tangle. Any corners or objects on the boat that may snag the net should be covered or taped.

To set the beach seine, one end of the net should be held by a crew member on shore or be tied off to a nearby object such as a tree or rock. The boat should pull away from the shore allowing the net to feed out over the bow of the boat, away from the motor or oars. The boat operator should attempt to set the net in a smooth arc that ends near the shore. When finished, all of the net should be in the water, enclosing a semi-circular section of the beach.

To retrieve the sample, pull the net to shore with one person on each end of the net. The cork and leadlines should be pulled in together at a slow, even pace, with the corkline slightly trailing the leadline. This will allow the flow of water up through the bunt. Do not pull too quickly, as this could cause the corkline to become submerged and possibly allow fish to escape over the net. If the corkline is pulled in ahead of the leadline, the flow of water will be downward causing the leadline to lift off the bottom, allowing fish to escape underneath the net. As the net approaches shore, the leadline should be kept on the bottom and the corkline should be lifted slightly to stop fish from jumping out of the net. The entire net should be pulled onto the shore and the catch quickly recovered and processed. If many fish have been captured in a set, a small pocket of net may be made to hold the fish in the water while they are being processed.

The efficiency of the seine net is reduced in areas with submerged debris, large boulders, irregular bottom features, or steep drop-offs. These features will cause the leadline to lift off the bottom allowing fish to escape or snag the net requiring the set to be aborted. Pole seining is an alternative is such areas. A brief reconnaissance of the sampling site should be done to determine its suitability for seining and the area may have to be cleared of snags and jagged boulders. In lakes, night seining is more effective than during the day because fish typically move on to shoals in the evening. Dark coloured nets increase the effectiveness of fishing as they are less visible. Also, depending on fish behaviour, different subsets of fish population may be captured at various times of day and night.

Purse Seine Nets

Purse seines are used to sample the surface of open water habitats. Purse seine used for lake sampling varies in size (Backiel and Welcomme 1980). Nets designed to catch fry and other small fish can be 30 to 100 m long and 3 to 5 m deep with a mesh size of 0.5 cm. Nets for larger fish can be larger, up to 100 to 200 m long with increased mesh sizes and are generally limited by the equipment available to handle the net. Backiel and Welcomme (1980) recommend that purse seines have a length of about 200 m to avoid escape reactions by the target fish. The net is deployed in a circle with the net forming a cylinder in the water column (Figure 2). When all the net is in the water, lines are pulled which close the bottom of the net trapping the fish inside.

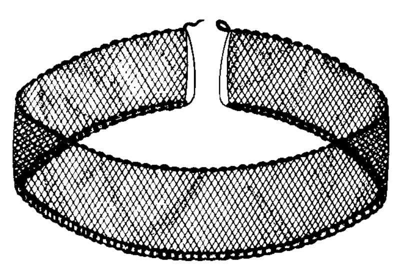


Figure 2 Typical purse seine

Once closed, the net is hauled into the boat and the catch is processed. Using two boats will maximize the speed and efficiency of setting a purse seine. To efficiently and quickly deploy a purse seine two boats are required.

Trawl nets

A trawl net is a long bag or sock-shaped net that is pulled through the water to capture fish. Many trawl systems are available for conducting inventories of lake communities. These systems vary in size, the depths they sample, and the boats required to tow them. The type of system used will depend on the lake being sampled. Large systems usually require large powerful boats and winches, which may only be useful for lakes that are easily accessible. Medium to small trawl nets can usually be deployed with smaller equipment and tend to be more portable but are generally less efficient at capturing fish. In BC, trawling is most commonly used for sampling juvenile sockeye and kokanee populations rearing in lakes and are used in conjunction with hydroacoustic gear.

Trawl nets are most useful for allowing active open water sampling at many depths. Nets can be weighted to operate at or near the surface, in mid-depths, or close to the bottom. As well, very specific depths can be targeted in an effort to capture specific groupings of fish, often located by echosounding. Unfortunately, the actual fishing motion and depth of the trawl can be erratic. Acoustic devices can either be affixed to the trawl or operated from the surface to attempt to pinpoint the fishing depth of the net. Acoustic techniques such as this can also be used to calibrate a particular trawl net configuration so that for specific set of warp angles and lengths, the depth of the trawl can be estimated. Accurately and consistently positioning the net at the desired depth is important since inaccuracies of 1 or 2 m depth may result in the net missing bands of closely aggregated fish. Small, portable mid-water trawl systems are often used in conjunction with a hydroacoustic system to provide physical verification of the fish species being recorded on the echogram. In this application, the portability and specificity of the trawl make it a useful tool to support hydroacoustic data.

The generic setup of a trawl net would include a net, a codend (the section where the fish become trapped), a trawl frame or spreader bars for the net opening, and bridles. The net and codend are attached to the trawl frame or spreader bars. One end of the bridles is also attached to the frame, and the other end of the bridles is attached to the winch cable. The boat used to tow the trawl net is usually outfitted with a winch, cable, and a tow frame. The tow frame guides the cable from the winch over the back of the boat and usually has a pulley mechanism to facilitate winch in the net. Specific trawl systems currently in use are described in Reiman (1992), which provides a discussion of a trawling procedure for sampling kokanee populations.

To deploy the net, the end of the winch cable is threaded through the tow frame and attached to the loose ends of the bridle. The net is lowered into the water, and the boat is powered forward at a slow speed to open the net. This allows the crew to check the fishing orientation of the net while it is near the boat. To begin the set, the trawl net is lowered to depth and the boat is accelerated to the appropriate trawling speed. After a predetermined time, the net is hauled to the surface, where the net and codend are checked for fish. The area sampled can be calculated using the area of the opening of the front of the trawl net and the distance the net was towed or a device for measuring the speed of the boat can be used. These values can be used to calculate the volume of water the net passed through. The time the net was fishing must also be recorded for comparing catch per unit effort.

The use of trawling in conjunction with echo sounders is commonly used in BC for assessing populations of pelagic, lake rearing fish. However, this type of inventory requires specialized boats, expensive electronic equipment and experienced personnel. Prior to undertaking a hydroacoustic/trawl inventory contact researchers at either DFO's Pacific Biological Station in Nanaimo or the provincial Fisheries Research Section at the University of B.C.

Electrofishing
Electrofishing is the technique of passing electric current through the water to attract and stun fish, thus facilitating their capture. It is most useful in streams and rivers, but can also be used to sample shallow littoral areas of lakes. The deeper and more open a sampling area the more likely fish will be able to avoid capture by electro-fishing. Electro-fishing is commonly done on foot using a backpack shocking device or from a boat with a powerful boat-shocker. Experiments have been done using electrified fences, seine nets, and trawl nets, but the use of these devices is not common in north temperate areas such as British Columbia. More details on electrofishing are contained in **section 5.4.1**.

Angling
Angling provides most value when used as a method for estimating angling quality but it can, of course, be used to sample fish presence. Angling can be labor and time intensive and tends to provide data of limited use since the technique is highly biased for size and species. Angling is best used as an alternate method if other more effective means of sampling are not available. Angling can also be used in conjunction with other methods particularly if information is required on the presence and size of adult fish.

Basic angling equipment includes, a fishing rod and reel, fish hooks, monofilament line, weights, bait, lures, and patience. Angling is most effective when the angler has specific knowledge of the habitat and food preferences of the target species.

5.3.2 Passive Gear

Gill nets
Gill nets are passive devices that are suspended in the water column and capture fish swimming into the meshes of the net. The capture process is called **gilling** and occurs when the maxillary or opercular area is caught in a single mesh when the fish encounters the net. Fish may also be entangled by their teeth, spines, girth, or scales as they try to pass through or free themselves from the mesh (Figure 3).

Gill nets are probably one of the most commonly used methods for sampling fish in lakes in BC. However, they can be very selective for the size and type of fish they will catch depending on the size of mesh and whether the net is designed to float or sink. The type of materials used for the net can also influence the effectiveness. For example, water clarity and weather conditions can make a net more or less visible to fish. Therefore, a clear understanding of the purpose of the sampling program will help define the type of net that is needed.

In B.C. a standard procedure has been developed for the use of gill nets in lakes for reconnaissance level inventories. The net consists of six nets or panels, 15.2 m long and of different mesh sizes, that are strung together in a "gang" to form a net 91.2 m long and 2.4 m deep. The mesh size is measured from knot to knot of a single, diagonally stretched mesh. Each mesh size is selective for a certain size fish (Table 3), therefore, the individual panels used in the net have been chosen so the net is capable of catching a wide range of fish. The following is the standard order of the panels based on mesh size, the corresponding filament size used in the construction of the net and the mean fork length of the fish caught by each of the mesh sizes:

Table 3 Order, mesh size and filament size standard in relation to the mean fork length of fish caught

Order	Mesh size	Filament size	Fish fork length
1	25 mm	0.20 mm	114 mm
2	76 mm	0.25 mm	345 mm
3	51 mm	0.20 mm	228 mm
4	89 mm	0.30 mm	380 mm
5	38 mm	0.20 mm	178 mm
6	64 mm	0.25 mm	280 mm

Research by Hamley (1972) determined the average size of fish caught in each mesh size. While these studies are based on whitefish, their shape is sufficiently similar to trout and salmon that the size selectivity would be similar. Therefore, the nets used in BC will effectively sample fish populations that range in size from 100 to 400 mm, fork length.

Other specifications for gill nets used in BC include:

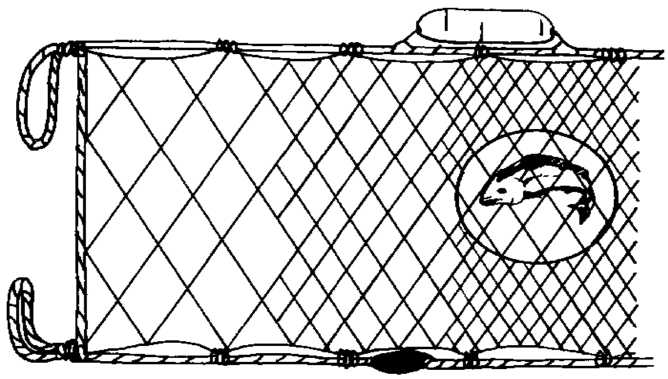
- nets to be double knotted and hung on a 2:1 basis (twice as much web as lead/cork line).
- braided lead line of 75 g/m.
- corks braided into corkline (with corks 15 - 20 cm apart).
- corks should vary in size, not in number to allow the net to either float or sink.
- nets to be constructed of light green, multi or monofilament nylon (Miracle R-13 L).
- nets must have nylon gables of approximately 18 kg test.
- mending lines must be monofilament nylon.

Gill net gangs can be set can be set in a variety of ways depending on the lake and the purpose of the set. Floating nets will sample fish in the upper 2.4 m of the lake while sinking nets will sample benthic species. Nets can be near shore or offshore, and perpendicular or parallel to shore. Rationale can be provided for any combination of configurations mentioned above. Floating nets in the littoral zone perpendicular to shore will focus on species migrating through the littoral zones. Sinking nets, slightly offshore, and parallel to shore may concentrate on species migrating on and offshore. In areas where it is necessary to minimize the number of fish killed in the gill net, short sets of one hour or less can be used. The crew must also monitor the net for any movement of the cork line that indicates fish have been caught. A variety of different sets may be the best way to comprehensively sample an area. To obtain a representative sample of fish populations in the lake the gill net sets should be chosen to cover as many of the habitat types in the lake as possible.

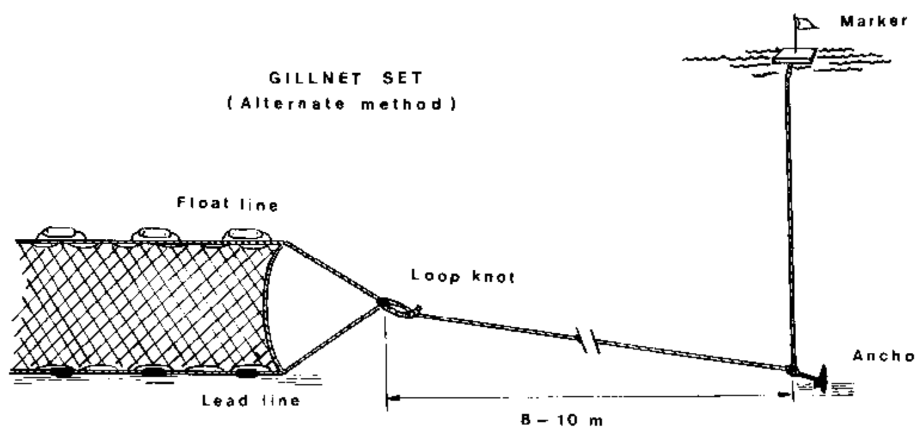
Generally, gill nets are set at dusk, left to fish overnight and are retrieved the following morning to process the catch. In some cases it may be appropriate to set a net during the day to gauge the amount of fishing effort that would be required to sufficiently sample the fish population. Nets should not be set down steep slopes and drop-offs that may compress and close the meshes reducing their efficiency. Nets are best set over even, regular substrate. However, areas with cover, such as snags or underwater debris, are good places to catch fish but there is a high risk of tangling or snagging the net and great care should be used when setting the net. Fish also concentrate along the intersection of the thermocline and the shoreline making this a good area for setting nets.

Gill nets are easily set with the use of a boat. One end of the net is either tied off on shore or anchored with a marked buoy. The boat is then reversed and the net is let out over the bow.

To avoid tangles it is best to carefully load the net into a tub or bag trying to keep cork and leadline separated. This will allow the net to be set with a minimum of tangles and snags. When all of the net has been let out, pull the net taut by holding onto the bridle ropes and reversing the boat. When the net is taut, set the second anchor and mark it with a buoy. If sinking sets are being used, ensure that there is sufficient buoy line to let the marker reach the surface when the net is deployed.



Gill net mesh sizes



Gill net set

Figure 3 Typical sinking gill or enmeshing net

A standardized net design and procedure has been developed for the fish inventory of BC lakes so that the data from different lakes, different sampling periods, or locations on the same lake can be compared. The standard procedure in BC requires that two gangs of gill nets, as described above, be set overnight. Usually one net is floating and the other is sinking. The floating net is set directly off shore and perpendicular to the beach. The sinking net is set further off shore by connecting the near-shore end of the net to 15 to 30 m of rope that is tied off on shore and then setting the net from the end of the rope. The distance offshore will depend on the profile of the lake as the objective of the deeper set is to sample benthic fish and those that inhabit deepwater areas of the lake. There should be some judgment used in setting the net in order to avoid over-sampling a lake. For example, if a lake appears to be very productive setting a net directly off the mouth of a major tributary may catch more fish than required to develop preliminary details on species composition and length, weight, and age profiles. As a rule the length, weight, and age data from 30 fish of each species are required to develop statistically useful relationships.

Enmeshing Nets/Trammel Nets

Enmeshing or Trammel nets capture fish by tangling them in the meshes or loose folds in the net. Enmeshing nets can be used in areas and habitats similar to where a gill net would be set. These nets are not as size selective as gill nets so that a wider range of fish sizes can be caught by a single net. Trammel nets are often used for fish, such as flatfish or sturgeon, that are not easily caught in gillnets (Backiel and Welcomme 1980).

Enmeshing nets can be constructed either in single or multi-panel designs. Single panel nets are normally very loose or baggy and capture fish that swim into the net simply by becoming tangled in the net (Figure 3). Double panel nets use 2 different sizes of mesh. Whereas gill nets attach gangs of nets end to end, enmeshing nets layer the panels of different mesh sizes beside each other like the layers of a sandwich. Fish swimming from the small side to the large side will push a pocket of small mesh net through the large mesh net and be captured. If swimming in the other direction, fish will go through the large meshes and become caught up in the baggy small mesh net. A triple panel of nets has a large mesh net sandwiched between two baggy small mesh nets. Fish entering the net from either direction are captured by pocketing themselves.

No standardized design specifications exist for enmeshing nets in British Columbia.

Minnow traps

Minnow traps or Gee-minnow traps are net or wire enclosures used to trap live fish. Small fish and animals swim or climb inside through funnel shaped openings that guide them from a large opening near the outside of the trap to the narrow opening close to the centre of the trap. Once inside it is difficult for the animal to locate the opening and escape. The trap dimensions are approximately 40 cm in length, 23 cm in diameter at the middle, and 19 cm in diameter at the ends. An illustration of a typical minnow trap is given in Figure 4.

Minnow traps are also size selective and are best suited for sampling juvenile fish or adults of small species. They are most commonly used in littoral habitat that may be difficult to sample with nets or electric fishing techniques, such as deep areas or habitats with many snags. However, some researchers in the United States have experimented with large traps for sampling deeper water (J.D. McPhail, pers. comm. 1993, University of BC)

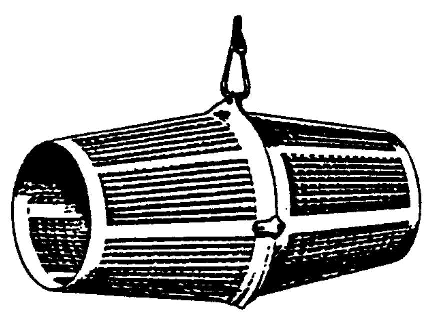


Figure 4 Typical minnow trap

Minnow traps usually consist of two wire baskets held together by a clip and attached to a marker float. The baskets are interlocked and the clip is inserted to hold the two halves together. The float line is attached and the trap is positioned either on the bottom or suspended at a particular depth. The position of the trap is marked by the float attached to the line. Traps can be set with or without bait. Conlin and Tutty (1979) suggest that the most effective use of a minnow trap includes using fresh roe as bait and soak time of 24 hours. Other baits include preserved fish roe, catfood, sardines, canned fish, corn, shrimp and cheese. Traps are set in a variety of habitats such as weeds, beach areas, under overhanging vegetation or amongst submerged logs.

All traps **must** be recovered as they continue to fish indefinitely. Furthermore, predation among the captured fish is common and hence the traps should be monitored regularly. Small rocks can be put into the trap to provide some refuge for the smaller fish.

Trap Nets and Fyke Nets
Trap nets and Fyke nets usually used in near-shore or shallow areas of a lake. There are sinking versions of the trap net that can be used in deepwater sections of a lake but they are normally designed to fish the surface. They are designed to be light, portable, and relatively simple to assemble.

A typical net consists of an internal framework that supports the netting material: a trap box and heart with funnel. Trap nets have a central lead that extends from shore and the fish are captured by being directed through a series of funnels leading to collection chamber at the offshore end of the net. A typical lake trap has a leader of up to 50 m long and 2.5 m deep, however the length is flexible and more appropriately determined by the specific location of the trap. Wing leads, present on either side of the opening and leading to the capture area, are 2.5 m deep and 4 m long. The trap box at the end of the leader is 2m X 2m X 2m.

Fyke nets consist of an internal cone that directs the fish into the trap and when set in lakes wings are often employed to direct fish into the net (Figure 5). The opening diameter of a Fyke net can be up to 2 m. Fykes and traps are also size selective and because they are fixed, will only catch fish that use the area of the lake where the trap is set.

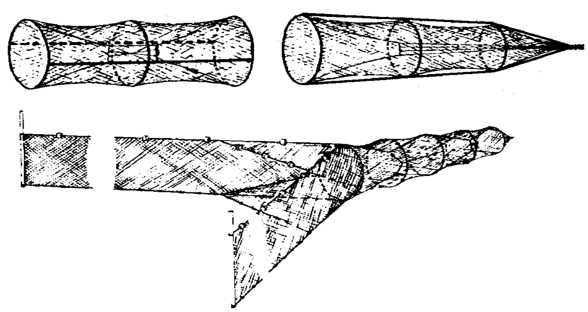


Figure 5 Typical Fyke net designs with and without wings

5.4 Fish Collection Methods in Rivers and Streams

Sampling in rivers and streams can be challenging. Prior knowledge of the potential target species, especially with respect to spawning and migratory behavior and the habitats used by each age group is very important to successfully sample an area. Also, a basic understanding of the conditions under which sampling will take place such as stream size, water depth, conductivity, and temperature will also help focus the sampling program. The purpose of the inventory will dictate the appropriate time to sample the species and life history stage of interest. However, several of BC's habitat and fish inventories, in particular at the reconnaissance level, are conducted during the period of lowest stream flow that the juvenile fish will encounter during the main growing season. This period, referred to as ***the critical stream flow period*** (CSFP), occurs throughout most of BC between August and October. This period represents the stream conditions most likely to limit fish production. Reconnaissance level inventories should be timed to coincide with the CSFP. Intensive studies are timed according to their specific objectives. Other manuals in RIC series discuss habitat capability, habitat suitability, and stock status and will detail the data requirements for these analyses.

Note: Certain gear types may require auxiliary equipment such as dip nets, stop nets, buckets for anaesthetizing and recovering fish, anaesthetics, measuring boards, etc.

5.4.1 Active Gear

Electrofishing

Electrofishing is the technique of passing electric current through the water to attract and immobilize fish for capture. It is most efficiently used in contained areas of small rivers and streams that are difficult to sample using nets or traps. Most electrofishing is done on foot using a backpack or portable shocking device or from a specially modified boat. Although the concept of electrofishing sounds simple, there are many physical, chemical, biological, and technical factors that govern the efficiency and success of the technique. As well, the combination of electricity and water presents a serious potential safety hazard. The following section will describe how electrofishing is used to sample river and stream habitats, the basic gear configuration, the main factors affecting sampling efficiency, and the primary safety concerns. However, the section is not intended to be a training guide on the implementation of electrofishing sampling programs or on electrofishing techniques. Crew members must receive certification and first aid training from qualified persons before working with electrofishing equipment.

The *behaviour* of fish will affect the sampling efficiency of electric fishing. Cowx and Lamarque (1990) note that the differences in catchability of species can most notably be seen when comparing benthic (e.g., sculpins) versus nectonic (e.g., trout) species, and between territorial and schooling behaviors. Benthic fish tend to be more difficult to capture with electrofishing gear since they tend to swim only in short bursts and then sink when stunned, often becoming lost in the substrate. Nectonic species can be forced to swim for longer periods and may be brought into open water where collecting is easily done. When comparing territorial species with schooling species, the former are generally easier to capture since they hold their ground and do not swim away from the crew. The fright response of schooling fish tends to allow them to swim out of the electric field, avoiding capture.

Fish caught in an electrical current can respond in three ways: forced swimming or *taxis*, muscle contraction or *tetanus* and muscle relaxation or *narcosis*. Application of alternating current (AC) is the most damaging to fish and usually results in a high mortality rate either from direct exposure to the current or from injury caused when exposed to the current. Only direct current (DC) electroshockers are used in BC as it is less harmful and has the advantage of causing galvanotaxis (forced swimming) towards the anode. As a fish gets closer to the anode they go into narcosis and can be easily captured. Practiced use of an electoshocker can employ this response to draw fish out of complex habitats.

Specifications – Portable backpack shocking systems are used extensively to sample small streams, side-channels, and the shallow margins of rivers. The basic unit consists of a power supply, a voltage and current regulator, a cathode, and an anode. The power supply is generally a small gas powered generator or a 12 V storage battery either acid or lightweight gel-cel. The voltage/current regulator can be used to adjust the voltage and current discharged to the water and usually includes a timing circuit to keep track of the amount of time the current has been applied to the water. Both the power supply and regulator are mounted to a backpack frame to be carried by the operator, and should be weather resistant. The cathode is normally a braided wire cable approximately 3 m long that trails down from the shocking unit into the water behind the operator. The cable should be insulated near the shocker unit to protect the operator, while the section in the water should be bare. The operator carries the probe, which consists of the anode, a metal ring at the end of a fiberglass pole or wand. The anode ring fitted with netting or a basket as many fish can be scooped up by the operator. The operator will also control the waterproof power switch mounted on the probe. The power switch, should be "fail safe" meaning if it is released, the current flow will stop. As well, the backpack unit should have a "balance" switch that cuts the current flow from the unit if the backpack is not vertical. This will help to protect the crew if the operator was to fall.

Shocking units are capable of delivering several types of current that are useful for different fishing situations. The basic current types used are: AC, modified AC, DC, and pulsed DC. DC and pulsed DC are normally used because they cause galvanotaxis or forced swimming of the fish towards the anode.

Sampling Technique – The overall experience and organization of the electrofishing crew will have a profound impact on sampling efficiency. Proper training, understanding of the principles involved, and practice of the appropriate techniques will improve fishing results. Also, limiting the number of crew members to 2 or 3 improves communication and efficiency, makes organization easier, and will help to maintain safety standards.

Sampling with a portable electroshocker must include at least two individuals. One operates the shocker while the second (and third) works next to the operator with a dip net and a holding bucket. The crew should work from downstream to upstream so that disturbed debris and sediment does not interfere with catching fish as the material drifts downstream. However, downstream sweeps can be effective when stop nets are used. Each crew member should wear Polaroid glasses as this will increase the ability to see fish in the water and, from a safety perspective, persons will have a better view of underwater obstacles. During the fishing operation the shocker can be secured upright on the stream bank (if the cable for the anode is long enough) or the operator can carry the unit on his or her back. The operator walks slowly through the water, making sure both the cathode and anode are in the water. The anode is slowly swept from side to side, with a general motion of drawing the anode towards the operator. This motion will help to attract fish to the anode (if the unit is set to DC) before they are stunned by the electric field. The power switch should be turned on and off since continued application of electrical current to the water will cause herding behavior of the fish and reduce catch efficiency. The effective use of an electroshocker takes practice and individuals learning to use one should work with an experienced operator. The accompanying field crew assist in the capture of the stunned fish.

While fishing, the operator should note the behaviour of the fish so that adjustments can be made to the output of the shocker. If the output is too low the capture efficiency will be poor but if the output is too high fish caught in the electrical field will be injured or killed. In most situations pulsed DC current is used with the shocker set to a higher pulse frequency and higher voltage for small fish such as juvenile salmonids and a lower pulse frequency and lower voltage for larger fish however, the conductivity of the water is a significant factor in determining the voltage required. Once the electroshocking is complete the operator should record the number of seconds spent shocking and the area, in square meters, that was covered. New models of electroshocking units include a counter that records the number of seconds of shocker operation. The accumulated seconds of shocking can be used as a measure of the fishing effort, expressed as the number of fish caught per unit time.

A downstream net must be used in areas where the fish are hard to see or the water velocities are high. Fish can be washed downstream, become impinged on the stop net and collected. For sampling for total removal population studies the sampling site should be approximately 100 m^2 in size and blocked off with stop nets. Lightweight nylon nets 15 m long with a 1 cm mesh make effective stop nets as they are easy to handle. For total removal sampling two of these nets are required to fully enclose the sampling site.

Boat Shocking – Boat shocking systems are normally used in shallow wide streams. Electrofishing from boats in deep water is not very effective and should not be used for sampling these areas. Two types of boats are used, drift (passive) or jet boats, the former used on small rivers and the latter on larger systems.
Boat shocking systems require special modifications to the boat and are normally installed on metal hulled craft to facilitate grounding. Consequently, the use of a boat shocker is limited to areas that can be accessed by water or road, or have areas suitable for boat launching.

There are many potential installations of shocking systems on boats. The basic components of the shocking system include a power supply, voltage and current regulator, cathode, anode, and safety circuits. The boat itself, should be large enough to hold all the equipment and provide safe and adequate work space for the crew. Generally, flat bottomed aluminum hull boats are preferred, since metal hulled boats are easy to ground. The power supply is normally a gas powered generator. The cathodes are suspended from the sides of the boats and the anodes are normally one or two booms protruding from the front of the boat. A boat shocking crew should consist of one boat operator, possibly a generator operator, and one or two net handlers. Each crew member will have access to a safety switch that will stop current flow in the event of an emergency. Special training is required to operate this system.

Angling
Section **5.3.1** provides basic information about angling. The use of this technique for sampling fish in rivers and streams requires individuals with angling experience. As with lakes, angling is a biased collection method and will normally result in the capture of fish that are greater than 20 cm long. However, the most effective fishing method in rivers is to sequentially use bait (e.g., roe, worms, etc.) followed by lures, followed by flies.

Beach or Pole Seine Nets
Beach seines are described in section **5.3.1**. The operation method is same for streams.. A pole seine consists of a seine net with poles on either end. The pole seine is usually fairly short and can be easily maneuvered in streams and small back channels. Pole seines and beach seines are operated in similar manners and are suited to streams with small substrate and limited obstructions. With one person on each pole the net is worked through the sample area, usually downstream. A bag is kept in the net to collect the fish. The lead line must be kept on the bottom to prevent the fish from escaping from under the net. The crew must work quickly to keep the bag in the net as they work downstream. With a beach seine, one end of the net is held in place on the shore. The net is pulled quickly out into the current and then downstream and back to the shore forming a circle back to the end of the net on the beach. In large, faster moving rivers a properly equipped motor boat will be required to set a seine. The field crew should measure and record the area sampled by the seine in order to express the number of fish captured per unit area.

5.4.2 Passive Gear

Minnow traps
See: section **5.3.2**.

Gill net
Refer to section **5.3.2**. Gill nets are not normally used in rivers and streams for fish inventory projects unless the water is very slow moving, usually associated with large rivers. It is often difficult and sometimes dangerous to set a gill net in fast flowing water. Debris can foul or damage the net so the net must be constantly monitored during the set.

Enmeshing Nets
Refer to section **5.3.2**. This type of collection gear is not well suited for use on rivers and streams unless the water velocity is very low. High velocities make it difficult and sometimes dangerous to set the net and debris can foul or damage the net and reduce the catch success.

Fyke nets
– described in section **5.3.2**, are also used in river and stream environments. The standardized Fyke net is has a square opening of 1.4 m^2 and is 3.6 m long. A live box can be attached to the end of the net to hold fish without killing them. The net is normally set with the opening facing upstream and panels or wings can be used to deflect fish into the net. The main drawback of a Fyke net is that debris can collect in the net or damage the net, reducing catch efficiency. Usually Fyke nets in flowing water require regular monitoring to remove debris. Further details of Fyke net design and operation are presented in Conlin and Tutty (1979). Rocks are placed in the trap box to provide refuge for little fish and reduce predation.

6. FISH SAMPLING PROCEDURES

Collecting length and age measurements is an important component of fish inventories. These measurements are useful for estimating growth, size range, age structure, standing crop, and production of fish stocks. Once fish have been captured they are measured for length, their stage of maturity assessed and scales or some other structure is removed for aging. In many cases fish can be collected, identified, counted, measured, and returned to the water alive. If fish are to be released alive then field crew should be well organized to take all the required measurements as quickly as possible and minimize the holding and handling time of the fish. The shorter the processing time, the higher the chance of survival once the fish are returned to the water. An example of a data sheet for recording individual fish data is provided in Section 2: Fish Collection Forms.

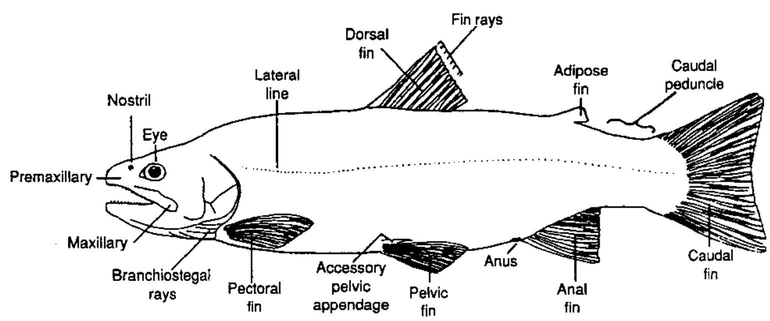


Figure 6 External Characteristics of a Typical Salmonid

6.1 Length

When collecting information on the size of fish in a population the most important measurement is length. Grouping fish by length categories can also be used to determine age classes and growth rates.

Length measurements made on fish can be categorized as whole body measurements or body part measurements. Measurements of body parts tend to be used in specialized studies, or in cases where the specimens have been badly damaged. Whole body measurements are most commonly used in fisheries studies. Before beginning an inventory, it should be clearly noted what types of measurements are required. Three of the most common whole body measurements are fork length, total length, and standard length (Anderson and Gutreuter, 1983). Length measurements should be reported in millimeters (mm) but other units can be used if appropriate to the size of fish. Table 4 lists species for which fork length or total length is recorded.

Fork length is measured from the most anterior part of the head to the median caudal fin rays (fork of tail, Figure 7). This method is commonly used in Canada (Anderson and Gutreuter, 1983) and is only appropriate for fork tailed fish such as salmon, trout, and char. Another measurement sometimes used for salmon that have undergone morphological changes associated with breeding, is the post-orbital hypural length (MacLellan, 1987). Post-orbital hypural length is the distance from the posterior margin of the eye orbit to the posterior end of the hypural bone (last vertebrate).

Table 4 Species measured for fork length or total length

Fork Length		Total Length
Goldeyes	Smelts	Catfish
Grayling	Sturgeon	Cod
Herrings/shad	Suckers	Flounders
Minnows	Sunfish/Bass	Lampreys
Perches	Troutperch	Mosquitofish
Pike	Whitefish	Sculpins
Salmonids		Sticklebacks

Total length is the distance from the most anterior part of the head to the tip of the longest caudal fin ray when the fin lobes of the tail are pressed together. In BC, total length is the measurement used on fish without forked tails such as burbot and sculpins (Figure 7).

Standard length is the distance from the most anterior part of the upper jaw to the posterior end of the hypural bone. In applying this measurement, some other external landmark is often used instead of the hypural bone. This is normally the end of the caudal peduncle or the last scale of the lateral line (Anderson and Gutreuter, 1983). As well, measurements will often be made from the most anterior tip of the head as opposed to the upper jaw. Due to the variety of ways different observers define this measurement, standard length can often be confusing and inconvenient to use.

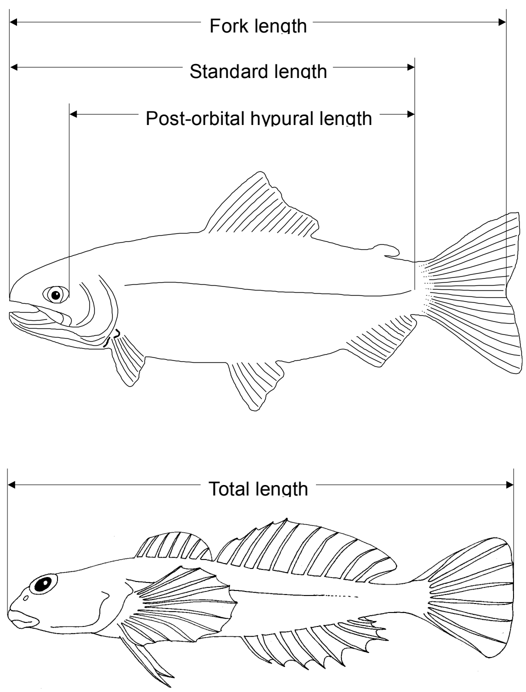


Figure 7 Diagram illustrating common length measurements for BC freshwater fishes

Table 4 lists species for which fork length or total length is measured. All length measurements are recorded in millimeters (mm). Many rulers, tapes, calipers, or boards are available for measuring fish. The device used should be water-proof, light-weight, durable, easy to use, and offer adequate accuracy and precision. The units and type of length measurement should be clearly recorded on the data sheets and should be consistent for all the data collected during a sampling program. This will help to avoid confusion when the data is analyzed.

6.2 Weight

Weight measurements are normally made in grams (g) on whole fish that have been recently captured (whole wet weight). Excess water is drained or blotted from the animal with paper towel before measurement. As with the length measurements it is important to remain consistent in the techniques used and to carefully record units and methods in the field notes.

Several different types of weigh scales can be used to make weight measurements in the field. Commonly used scales include toploading electronic balances, beam balances, and spring scales. One should attempt to match the accuracy of the scale to the size of the fish. For example, fry should not be weighed on a spring scale designed for adult fish.

Toploading electronic balances are available in a variety of sizes and capacities suitable for field applications. Single scale models generally measure up to approximately 700 g, with accuracy greater than 0.01 g. Multiple scale balances can measure up to many kilograms, with accuracy of 0.1 g. Although flexible in their capacities, electronic balances require a power source and may not be useful for long, remote field trips. Also, their components may be sensitive to rough handling and inclement weather, conditions often experienced in the field.

Beam balances can measure up to approximately 3000 g and are normally accurate to at least 0.1 g. Although they do not require electricity, they can be bulky, sensitive to rough treatment, and very difficult to use in bad weather. Pull type spring scales can measure weights up to 2000 g although the level of accuracy is not as high as beam or electronic balances. There are several spring balances available that have a range of 0 - 10 g with an accuracy of ± 1 g. While they may not be as accurate as electronic or balance beam balances, spring scales are small, durable, and do not require electricity. These attributes make them useful for field work and as a backup to other weighing systems.

6.3 Determination of Fish Age

The effective management of fish populations requires knowledge of the growth rate of the fish. This requires determination of the age of fish to develop a relationship between the size and age of fish. For an inventory, this information provides insights to evaluate the potential effect of harvesting on the population and to monitor the health of a population that may be affected by developments that affect fish habitat. Age can be determined directly or indirectly from the population of interest. Age and associated length or weight can be measured empirically from individuals reared in captivity or from fish specially marked at a known age and size, and recaptured at some later date. However, the cost and space required to rear fish often precludes the use of this as a practical method. As well, it can be argued that captive or marked individuals do not demonstrate growth typical of unmolested animals in the natural environment.

For many species a direct measure of age can be made by analyzing hard body structures collected in the field. As fish grow, they deposit minerals in their skeletal tissues, producing characteristic growth patterns. In bones, these patterns are called annuli and in scales they are called circuli. Different periods of growth can be determined by counting the light and dark bands typical of annuli or by observing the differences in spacing of the circuli. By assessing these patterns the age of the fish can be determined.

Otoliths, scales, fin rays, cleithrum, or the operculum are some of the typical structures collected for age information. The structure that is collected should depend on the needs of the inventory and the characteristics of the species collected. For example, scales can not be used to age fish that are very long lived, such as lake trout, because the circuli near the center of the scale become very compressed and difficult to read accurately. Also, an ageing method that requires sacrificing the animal may not be desirable when studying sensitive populations.

Regardless of the structures used, individuals experienced at ageing fish should be used as ageing is as much an art as it is a science. More detailed discussions on studies of fish growth can be found in Nielsen and Johnson (1983) and Bagenal (1978). Detailed descriptions of taking, preserving, and reading samples are provided in Mackay et al. (1990).

6.3.1 Scales

Scales are one of the most common and convenient methods for determining the age of a fish. Scale removal is relatively quick and easy, requires only simple dissecting tools, and has minimal impact on live fish when properly done. However, aging fish with scales does have disadvantages. Many fish have the ability to re-absorb scales or produce new scales to replace lost ones resulting in growth patterns that do not accurately reflect the age of the fish. As well, scales from older fish, such as lake trout, Dolly Varden and bull trout are very difficult to read and interpret, and thus fin rays and otoliths (in special cases) are the preferred structures for aging these fish.

Depending on the species, scale samples are taken from different locations on the body. Figures 8 & 9 illustrates several typical areas where scales can be removed. For salmonids and trout, scales are usually removed from area between posterior edge of dorsal fin and the lateral line, approximately two scale rows above the lateral line on the left side of the fish.

Before sampling scales, clear away dirt and excess mucilage from the area to be sampled. Scales are removed by gently scraping against the grain of the scales with the blade of a clean scalpel or knife. If the scales are large they may also be removed with small forceps. Since any one scale may not accurately represent the true age of the fish, several scales (~5) should be collected from the fish. Removed scales are deposited onto a glass microscope slide, into a scale book, or envelope. The slide or envelope is then clearly labeled.

No special solutions are used to preserve the scales as air drying is sufficient for preservation, especially if the scales will be analyzed soon after collection. However, if left too long, scales can turn cloudy, obscuring circuli. For long term preservation, scales can be frozen.

Traditionally, scale books or envelopes have been used as the main medium for storing scales. Books or envelopes offer the advantage of being small and light. However, the drying scales may start to curl and risk being broken if they are forced flat once dry.

If scale books or envelopes are used, they should be pressed flat while the scales are drying to avoid curling. Alternately, scales can be mounted on gum labels then pressed under a standard weight (scale press) and temperature into an acetate plastic slide from which

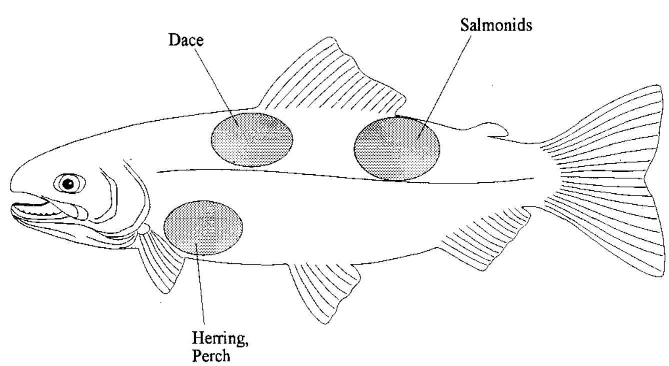


Figure 8 Diagram indicating preferred locations on body for collecting scales for different species

photomerographs are made. Appendix B contains DFO's instructions for generally collecting aging structures and specifically how to use a scale booklet.

Glass microscope slides are an excellent alternative to the paper medium. Scales are deposited directly onto a slide that has been labeled, covered with a second slide, and taped together. Typically the bottom slide will have frosted glass at one end and a pencil can be used to write collecting location, date, and scale number(s) directly onto the slide. Scales stored on slides will not curl, and if placed correctly, do not require much handling or

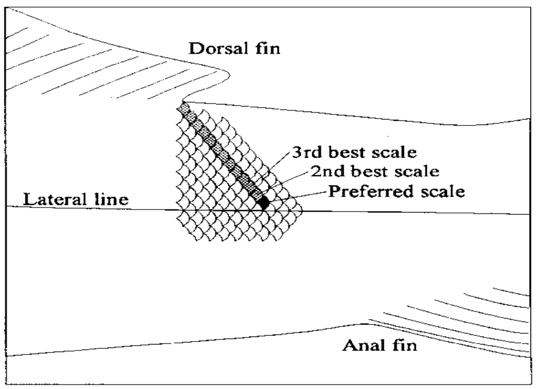


Figure 9 Diagram indicating preferred scales to be taken from salmonids for aging

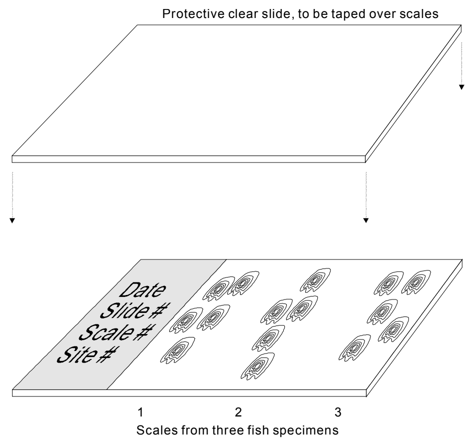


Figure 10 The use of microscope slides for collecting fish scales

manipulation before reading. As well, scales from several fish can be placed on one slide (Figure 10). However, there is a risk that glass slides can break and care must be used when handling and transporting.

6.3.2 Fin Rays

Rays or spines of pelvic, anal, dorsal or pectoral fins offer an aging structure for species where scales may not available or reliable, and the animal cannot be killed for otolith analysis. Pectoral fin ray. Pectoral fin rays are the preferred aging structure for sturgeon. As with scales, fin rays sampling is easily performed with basic dissecting tools and does not involve sacrificing the fish. Different fin rays or spines may be taken depending on the species thus a protocol for sampling should be established before going into the field. Generally fin rays are taken from the left pelvic fin.

To remove fin rays, use scissors to cut perpendicular to the length of the ray or spine. Cut close to the body (except for sturgeon where the cut must be made approximately 5 mm from the fin articulation to avoid cutting the fin artery) to ensure that all annuli will be present in the removed fin ray. Using a scalpel or scissors, separate the ray from the remainder of the fin by carefully cutting through the skin between the rays. For some species, several spines/rays may be taken or only small sections of rays may be taken, to allow the cut to heal over and reduce any disability the clipping may cause.

Fin rays and spines are cleaned in distilled water and allowed to air dry. They are stored in small, clearly labeled envelopes. They may be frozen for long term storage.

6.3.3 Otolith

The sagittal otolith bones (*sagittae*) from the head of the fish are another structure used for ageing fish. 'Otolith' is a generic term used for small calcareous particles that are present in fluid filled sacs in the fish's middle ear. The paired middle ears are located latero-posteriorly (*behind and to the sides*) to the brain. Otoliths possess a white centre surrounded by alternating concentric opaque and clear (hyaline deposits) rings. These structures assist in giving the animal its position with respect to gravity and allowing it to balance. Collecting otoliths require killing the fish and, hence, should only be performed when other, non-lethal methods cannot be employed.

The removal procedure is easily learned, relatively quick, and requires only basic dissecting tools. Otolith bones collection is the preferred method for determining age in species that do not produce reliable scale readings, or grow to great ages.

To remove the sagittal otolith bones, hold the killed fish upside down and cut through the gill arches and isthmus to expose the roof of the mouth. Cut 3/4 through the roof of the mouth (parashenoid bone) where the first gill arches join the roof of the mouth. Holding the head of the fish, break the backbone downwards where the cut was made in the roof of the mouth. This will expose the otolith bones within membranous sacs on either side of the mid-line at the posterior ventral portion of the brain cavity. The otoliths should be extracted unbroken and as clean as possible, using small forceps. Both bones should be removed (Mackay et al., 1990). Once removed from fish, any residual tissue, gelatinous membrane or blood should be rinsed from the otolith with fresh water. Other methods that can be used to remove otoliths and the procedures can be found in Jearld (1983) and MacLellan (1987).

Generally otoliths can be preserved by air drying or by freezing. If stored dry, otoliths may become brittle and easily damaged by rough handling. A solution of glycerin, glycerin/water, or glycerin/alcohol can be used to preserve otoliths and prevent them from becoming dry and fragile. Glycerin has also been known to have a mild clearing effect on the otoliths making them easier to read. Formalin should not be used to preserve otoliths or fish from which otoliths may later be taken. The formalin tends to de-calcify bone resulting in chalky otoliths where the annuli are obscured.

Otoliths are generally stored in small, labeled envelopes. If preserved with a liquid, the bones should be kept in a small, sealed container with a label placed inside the container with the bones.

6.3.4 Cleithrum and Operculum

Cleithra or opercular bones are structures that can be useful for ageing pike, walleye, or perch. However, this procedure requires killing the fish and thus should be justifiable. The operculum is easily removed with dissecting scissors and cutting along the anterior boarder of the gill cover. The cleithrum is a bony structure that supports the posterior border of the gill cavity and is usually covered by the posterior portion of the gill cover. Mackay et al. (1990) describe the removal of the cleithrum:

Expose the cleithrum by lifting the gill cover. Push the thumb between the posterior edge of the cleithrum and the muscle and connective tissue. Separate the inner surface of the cleithrum from the underlying soft tissue. Move the thumb along the inner surface of the cleithrum dorsally toward the posterior end of the cleithrum to loosen the bone. Push the thumb or index finger through the connective tissues at the anterior end of the cleithrum. Pull the cleithrum away from its dorsal joining point. When the dorsal tip of the cleithrum has been released, grasp it between the thumb and index finger. Pull the cleithrum out from the body towards the front. The anterior tip will now be exposed. It is important during this procedure to pull the cleithrum strongly away from the body to avoid tearing or breaking the tip and growing edge. Push the cleithrum over the index finger of the same hand, or over the thumb or index finger of the other hand. This peels away the muscle and connective tissue from the outer surface of the cleithrum.

Freshly removed structures can be frozen for up to 2 months before they are analyzed. Prior to analysis they should be cleaned, soaked in hot water to remove excess tissue and oils and allowed to air dry for several days. After drying the cleithra should be read within 2 weeks. If left too long, cleithra turn opaque making it difficult to discern the annuli markings.

6.4 Sexing and Maturity

6.4.1 Determination of Sex

The most accurate way to determine the sex of most species of fish is through an examination of internal sex organs. In adults, eggs are usually obvious in the ovaries and in males the testes are typically smooth, whitish organs along the dorsal surface of the body cavity. The sex organs of immature fish can be hard to find but generally they will appear as long, thin organs along the dorsal surface of the body cavity; females will be a pinkish colour while males will be translucent to whitish.

Some species of trout/salmon develop specific secondary sex characteristics during the spawning phase and the larger the fish the more obvious the distinction. External observations of trout in spawning colour would include body shape and jaw shape. Females will tend to have a rounder girth while larger males may develop a slight hook in the jaw. However, these changes may be difficult to distinguish. For reconnaissance level inventory it is not necessary to sacrifice fish for determining its sex, unless the animal is collected as a voucher specimen.

6.4.2 Determination of Maturity

Recording the maturity of specimens is important information as the onset of sexual maturity has an effect on weight-length relationships and condition factors. The Nielsen and Johnson (1983) present detailed classification schemes for categorizing the maturity of fish. Accurate determination of maturity is best accomplished through direct observation of the gonads. However, classification can also be done based on external observations. The following provides basic descriptions for 6 stages of sexual maturity (brackets include abbreviations for coding).

Immature (IM):	Young individuals that have not yet reproduced; fish with underdeveloped gonads.
Maturing (MT):	Ovaries and testes begin to fill out and take up a large part of the body cavity; eggs distinguishable to the naked eye.
Mature (M):	Fish in full spawning colours; gonads at maximum size; body cavity feels full, especially females; roe or milt is not produced if the body cavity is lightly squeezed.
Spawning (SP):	Fish in full spawning colours; eggs and milt are expelled when body cavity is lightly squeezed (also referred to as gravid).
Spent (ST):	Still have spawning colours; eggs and sperm totally discharged; body cavity feels empty and genital opening is inflamed; gonads empty except for a few remaining eggs or residual sperm.
Resting (R):	Adult sized fish; spawning colours not as apparent; gonads are very small and eggs may

not be visible to the naked eye.

7. FISH PRESERVATION TECHNIQUES

Careful and correct preservation procedures in both the field and laboratory are important for ensuring the quality of the collected specimens or tissues. Fixatives of the correct concentration, appropriate containers, clean and sharp dissecting tools, waterproof data form/labels, and complete observations will all affect the quality and value of the sampling. Preservation techniques vary depending on how the samples will be used. All voucher specimens must be submitted in 50% isopropyl alcohol in the prescribed jars. The following sections outline some of the most common techniques, and describes the Ministry's requirement regarding the submission of samples.

Reconnaissance (1:20 000) Fish and Fish Habitat Inventory: Standards and Procedures

7.1 Voucher Specimens

Voucher specimens are representative samples of species identified in the field, collected and preserved to verify the field identification. **Only one representative sample of each red/blue listed species should be collected** (*see* Table 2). For species that are neither rare nor endangered, two to three specimens can be collected. (*Also see: Reconnaissance (1:20 000) Fish and Fish Habitat Inventory: Standards and Procedures, RIC draft (1997*). These specimens should represent the size variability encountered at the sampling site. Any mortalities that occur during fish capture for sampling can be submitted as voucher specimens. Samples should be sent to the following by prior arrangement:

Fish Museum, Department of Zoology
University of British Columbia,
6270 University Blvd.,
Vancouver, BC V6T 1Z4

Natural History Section, Vertebrate Zoology
Royal British Columbia Museum,
675 Belleville St.,
Victoria, BC V8V 1X4

7.1.1 Preservation

Anaesthetizing to kill
All fish must be killed prior to fixation. This is can be achieved by leaving the fish in high doses of the anaesthetizing solution. This is an ethical treatment of a live animal and also serves a scientific purpose: anaesthetized fish relax and can be preserved in a more natural state.

Fixatives

- **Formalin** is commonly used to preserve collected specimens and it is available in liquid or powder forms *(Full strength liquid formalin is actually 37% formaldehyde dissolved in water)*. It is recommended that a solution of 10% formalin be used for the preservation of fish specimens. To make a 10% solution of **buffered formalin**, combine 1 part full strength formalin with 9 parts distilled water and add approximately 3 ml of borax (buffering agent) per litre of solution (McAllister, 1965).
- **Paraformaldehyde** powder can also be used to make a formalin solution. The powder has the advantage of being relatively light-weight and easily transportable. A mixture of 1 part paraformaldehyde, 4 parts anhydrous sodium carbonate, and a small amount of

Alconox (wetting agent) can be added in proportions of 20 g powder mixture to 400 ml of distilled water to produce a 10% buffered formalin solution (McAllister, 1965).

- Formalin is slightly acidic and will de-calcify and soften bony structures. The addition of a buffering agent helps to slow down this process. Fish preserved in formalin will change in weight and length over time.
- **Alcohols**, such as ethanol and iso-propanol, are also commonly used to fix and preserve fish specimens, especially if skeletal structures such as otoliths are to be examined. Alcohol is a poor fixative and is not recommended for fixation.
- An alternative for preserving specimens is to quickly **freeze** them in dry ice or liquid nitrogen. This is one of the best methods to preserve the colours and tissues of the specimen. Samples must remain frozen until they arrive at the laboratory and can be permanently preserved. Fish which have been frozen without initial preservation tend to fall apart when thawed. Partly thawing the specimen in 10% formalin solution is an option though freezing is not recommended as a technique of choice for specimen preservation. However, frozen tissue can be used for genetic sampling. Logistically, freezing specimens may be hard to accomplish and maintain, especially on long field surveys.
- Disposal of Formalin

  Formalin must be oxidized to formic acid prior to disposal in the sanitary sewer as an aqueous waste. Protective gloves, clothes and eye protection are mandatory when working with formalin. Slowly add while stirring, diluted formalin (1 ml of formalin to 10 mls of water) to an excess of household bleach (25 mls of household bleach for each ml of formalin). Stir for 20 minutes and then wash the solution into the drain with at least 50 times its volume of water. (This procedure is from Armour, Browne and Weir in "Hazardous Chemical Information and Disposal Guide," Dept. of Chemistry, University of Alberta.)

Fixation Procedures

Specimens should be fixed soon after collection to limit deterioration of the tissues. All specimen must be **killed (**see **7.1.1)** prior to fixation. To fix the specimen, place it in a wide-mouthed glass, and fill the jar with the fixative solution. Polypropylene lids with polyfoam liners must be used. (One suggested distributor is Ryco Packing (206) 872-0858 in Kent, Washington.) Specimens should be inserted into jars head first to make them easier to remove from the jars in the laboratory. Different species captured in the same set can be fixed and stored together. Though more than one animal can be fixed in the same jar, care must be taken not to pack too many fish in one jar.

Fish Voucher Specimen Data Label	
Gazetted name: ____________	Alias: ____________
Watershed code: ____________	
Watershed/waterbody identifier: ____________	
Reach no.: ____ - ____ Site no: ____	Date: ____ - ____ - ____
Species: ____________	No.: ____________
Crew: ____________	Phone #: ____________
Comments: ____________	

Specimen label

Fish ID no.:	
Species name:	
Collection Mt.:	

Figure 11 Example of data and specimen label to be included in the jar with preserved specimens

The fish must be preserved in as natural a state as possible. Where possible, the specimen should float freely in the jar to avoid curling or bending. Before immersing large specimens, fixative should be injected directly into the body cavity to facilitate penetration and preservation of the internal organs. If syringes are not available an incision can be made to the right of the ventral line to allow penetration of the fixative into the body cavity. The stomach should also be incised for internal fixation in order to prevent rotting due to digestive juices. Care should be taken when making the incision to avoid damaging the internal organs.

Two labels are needed for the specimen: a waterproof specimen attached to the jaw or inserted into the mouth or opercular area of each specimen and a waterproof data label on the outside of each jar. All labels must be written in pencil (Figure 11). The **specimen label** contains the **fish identification number, species name** of the fish and the **collection method code**. **Data labels** describe: **Gazetted name, alias, watershed code** and the **watershed/waterbody identifier** (if applicable), **reach number, Site number**, **No. (number of specimen submitted**), **collection date**, and the **crew's name**(s) and a **contact phone number** (*For details on data label fields, see Section 2, Fish Collection Forms*). A brief description of the habitat and catch may also be included. The data label for a sample should be referenced to the field notes or data forms. The notes or forms will include the information recorded on the label but will also contain detailed information on habitat, size of sampling site, weather, sampling methods, etc.

Once the fixative has been added, the jar is sealed with Parafilm® (American National Can™), secured with plastic screw-type lids and placed on its side. This prevents curling of the specimen's body and abduction of the fins. For proper fixation, the animal should be immersed in the fixative for several days. Optimum fixation times for fish under six inches in length is one to two weeks. For fish over six inches in length preservation time ranges from two to four weeks. The longest possible fixation time should be allowed as inadequately preserved specimen deteriorate rapidly.

Following fixation, the specimens are thoroughly rinsed and put into 50 % isopropyl alcohol. The decanted formalin can be reused. Formalin must be denatured before it is disposed, as described in section **7.1.1**. The specimen can be rinsed by putting the jar under running water.

Alternately, the jar is filled with water. After several hours, the water is decanted and fresh water is added. This is repeated for several days until no formalin odour can be detected. If during rinsing, the specimen shows signs of deterioration, it is transferred directly to 50% isopropyl alcohol.

7.1.2 Precaution

Formalin has a powerful and irritating smell, is carcinogenic, promotes allergic reaction after prolonged and repeated exposure, and is extremely painful on cuts and open wounds. Alcohols used for preservation are poisonous and highly flammable. Field crews should be informed of the dangers of working with these substances and receive instructions for safe handling (gloves, safety glasses, good ventilation). As well, effort should be made to keep preservation grade alcohols from being stolen and ingested as they can pose a serious health risk.

Specimens stored in formalin and alcohol, which are classified as toxic and dangerous substances, must be identified and labeled with Workplace Hazardous Materials Information System (WHMIS) labels. An up-to-date Material Safety Data Sheet (MSDS) for each substance used should accompany field crews. The MSDS sheet contains important information regarding emergency medical treatment, environmental spill treatment, and transportation restrictions. Federal and provincial transportation guidelines governing the movement of dangerous substances must also be observed. Failure to comply with guidelines may result in costly fines or penalties.

7.2 Genetic Sampling: Protein Electrophoresis and DNA Analyses

Increasingly more work is being done which utilizes genetic markers and /or genetic parameters for populations. These techniques are useful in fisheries management to identify populations of fish, select brood stock, assess purity of hatchery stock, determine genetic population structure and assess biodiversity at the genetic level (Whitmore, 1990). The methods commonly used to determine genetic differences between stocks include protein electrophoresis and DNA analyses, and are project specific. As the procedures for sample collection and preservation are dependent on the project-specific genetic techniques, the Fish Geneticist in the Conservation Section (MELP) must be contacted to obtain the necessary details prior to collecting material for genetic analysis.

Ideally, one would wish to collect the appropriate tissues without sacrificing the donor. Tissue samples required can vary from organ tissue, to fin clips, scales and epithelial tissue. Many tissue preparation techniques are available and laboratories vary in techniques. Before sampling begins, sampling protocol should be confirmed with the lab conducting the analyses to ensure that appropriate samples are taken. This section describes basic field collection and storage techniques for genetic samples.

The type and amount of tissue required will depend on the analyses to be conducted. There are three basic categories:

1. protein electrophoresis: requires organ tissue including heart, muscle, eye and kidney either fresh or fresh frozen, stringent quality requirements
2. DNA analyses with no PCR amplification: requires relatively large amounts of tissue often fresh and in buffer solution, stringent quality requirements
3. DNA analyses with PCR amplification: requires very little tissue (e.g., fin clip, scale) and can be preserved in ethanol or dried; fairly lax quality requirements where some tissue degradation is often not a problem

The third category is becoming increasingly popular as conservation and non-lethal sampling requirements become more of an issue. In addition, this sampling for this category is far less arduous in the field and requires very little equipment.

Dissections should be done with clean and sharp dissecting tools. Between sampling of different specimens, all tools should be cleaned and rinsed with distilled water. If possible, disposable scalpel blades should be changed to avoid contaminating the samples.

Double labeling should be done to ensure that samples can be identified. All labels must be filled out using pencil, as preservatives, etc., can dissolve ink. Waterproof should be stored with the samples. Samples with data label containing sampling information should be sealed individually in labeled plastic containers or bags.

7.3 Collection and Preservation of Parasites and Other Health Related Specimens

Fish can be infected with a variety of internal and external parasites. Sampling specifically for parasites can take a great deal of time and is not within the scope of a reconnaissance inventory. Given the number and types of parasites that may infect fish, no single sampling procedure can be recommended. Much of the thorough examination for parasites requires a full necropsy and use of stereo or compound microscopes to examine the tissues. It is best that this work be done back at the lab or some permanent station where a parasitologist can be consulted to verify observations.

Parasites infect almost any tissue group. If sampling for parasites is a priority, the entire fish should be retained and preserved for laboratory analysis. Ideally, live fish offer the best information as some parasites will leave as the fish dies. Preserving the entire fish in a fixative should only be done if the previous alternative is not possible.

Labeling of the specimens would follow the protocol outlined in previous sections of this manual. Other observations on the health of the fish should also be recorded. These include swimming behaviour of the fish, its colouration, respiration, presence of obvious lesions or parasites on the external surface of the animal (especially around the head and gills), and the appearance of the fins. Researchers at the Pacific Biological Station can direct samples of parasites and other specimens for pathological review to the correct individuals for analysis. Additional information on fish parasites can be found in:

Nothcote T.G.(*no date given*). Common Diseases and Parasites of Fresh-water Fishes in British Columbia. *British Columbia Game Commission Management Publication No. 6: 25 pp.*

Specimens should be submitted to:

Sally Goldes (PIAF building, Room 100)
Science & Technology Dept.,
Malaspina College, 900 5th Street,
Nanaimo B.C. V9R 5S5

GLOSSARY

Active gear: Active gear is moved through the water either by machinery or human power and includes: beach seine nets, pole seine nets, purse seine nets, trawl nets, electrofishing (shocking), boat shocking and all types of angling.

Adipose fin: Modified rayless posterior dorsal fin in some fishes.

Alevin: Newly hatched salmon when still attached to the yolk sac.

Anal fin: The median ventral line fin of fishes located near the anus.

Anus: The posterior external opening of the alimentary canal: the vent.

Aquatic organism: Organism that spends a critical part or all of its life cycle; in water, and relies on a particular aquatic habitat for its survival.

Benthic organisms: Aquatic organisms that live on or in the bottom of any aquatic habitat. They include sessile, creeping and burrowing forms. *See:* **Benthos.**

Benthos: The organisms, collectively, that live on or in the bottom of a particular water body or aquatic habitat.

Blue listed species: Any species considered sensitive or vulnerable (in BC). These are indigenous (native) species that are not immediately threatened but are particularly at risk for reasons including low declining numbers, a restricted distribution or occurrence at the fringe of their global range.

Branchiostegal ray: One group of dermal bones/rays that close the branchial or gill cavity under the head.

Caudal fin: The fin located at the tail end of fishes.

Caudal peduncle: The fleshy end of the body behind the anal fin and before the caudal or tail fin.

Circuli: Ring - like arrangement of markings of fish scales.

Cleithrum: The clavicular element of some fishes.

Critical stream flow period (CSFP): The period of lowest stream flow that the juvenile fish will encounter during the main growing season (occurs throughout most of BC between August and October). This period represents the stream conditions most likely to limit fish production.

Dorsal fin: The median fin located on the back (mid-dorsal line) of fishes.

Extinct species: All indigenous (native) BC species that are no longer found in BC.

Fin-rays: Stiff rods of connective tissues, generally cartilage, which supports the fins.

Fork length: Fork length is measured from the most anterior part of the head to the median caudal fin rays. This method is only appropriate for fork tailed fish such as salmon, trout, and char.

Fry: Recently hatched fish

Galvanotaxis: Response or reaction to electrical stimulus.

Gear Type: *See* (1) **Active Gear** *and* (2) **Passive Gear.**

Gill: Respiratory organ of many aquatic animals (e.g., crustaceans, fishes, amphibians). A plate-like or filamentous outgrowth richly supplied with blood vessels at which gas exchange between water and blood occurs.

Gill cover: *See* **Operculum.**

Gilling: The capture process using gill nets. Fish are caught when their maxillary or opercular area is caught in the mesh of the net. Fish may also be entangled by their teeth, spines, girth, or scales as they try to pass through or free themselves from the mesh.

Gill rakers: A series of bony projections along the anterior edge of the gill arch. Gill-raker counts are usually made on the left anterior arch. Every raker is counted, including the bony rudiments at the ends of the series that may be difficult to see expect under magnification.

Juvenile: A young individual resembling an adult of its kind except in size and reproductive activity.

Larva: Independently living post-embryonic stage of an animal that is markedly different in form from the adult and which undergoes metamorphosis into the adult form. The larval form may also exhibit difference in behavior and sensitivity to environmental effects than the adult form (singular- larva, plural-larvae).

Lateral line: Longitudinal line on each side of the body of fishes that marks the position of cutaneous sensory cells of the acoustico-lateralis system concerned with the perception of movement and sound waves in water, the cells on the lateral line being collectively known as the lateral line system.

Littoral Zone: The shallow shoreward region of a water body. It usually has light penetration to the bottom and is often occupied by rooted macrophytes; that region of a lake in which the water is less than 6 metres deep.

Mandible: Lower jaw.

Maxillary: The posterior and lateral element of the upper jaw.

Narcosis: *In this context* A state of arrested activity induced by the use of electrical stimulation.

Nectonic: Describes organisms that are capable of swimming independent of waterturbulence.

Operculum: The bony (opercular bones) covering of the gill cavity of fishes.

Otoliths: Calcareous particle or plate-like structure found in the auditory organ of many animals including fish.

Passive gear: Passive gear is usually set and left stationary for a period of time. Passive gear includes: gill nets, enmeshing (trammel) nets, gee minnow traps, trap nets, Fyke nets, set lines, inclined plane traps and rotary screw traps.

Pectoral fin: The most anterior or uppermost paired fins, located on the side of body of fish.

Pelagic: Of or pertaining to the open waters of a **lake** or **ocean**, especially where the water is greater than 20 metres deep; term applied to organisms that occupy the open waters of a lake or ocean.

Pelvic fin: Ventral, paired fins on the underside of body in fish, representing the hind limbs of land vertebrates.

Post-orbital hypural length: Another measurement often used for salmon that have undergone morphological changes associated with breeding (MacLellan, 1987). It is the distance from the posterior margin of the eye orbit to the posterior end of the hypural bone (last vertebrate).

Presence/Absence sampling: A method of sampling whereby organisms are noted as present or absent without enumeration.

Ray: An articulated or jointed rod that supports the membrane of a fin.

Reconnaissance: (1) Exploration or survey of an area. (2) Forestry definition: The field examination of proposed road location to determine its feasibility and possible impact on other resources, and to lay out the proposed centerline.

Red listed species: Any species that is designated as being threatened or endangered (in BC). Endangered species are indigenous (native) species facing imminent extirpation or extinction. Threatened species are likely to become endangered if limiting factors are not reversed.

Regenerate scale: A scale that has been regrown after the original one was lost.

Sessile: Refers to aquatic organisms that are fixed to a substrate and are immobile during part or all of their life cycle.

Smolt: A young salmon or sea trout that is about two years old and that is at the stage of development when it assumes the silvery colour of an adult.

Standard length: Standard length is the distance from the most anterior part of the upper jaw to the posterior end of the hypural bone.

Taxis: Directional movement of a whole organism or cell in response to an external stimulus.

Tetanus: State of a muscle undergoing a continuous fused series of contractions due to electrical stimulation.

Thermocline: A well-defined vertical temperature change or boundary often associated with stratification in lakes.

Total length: Total length is the distance from the most anterior part of the head to the tip of the longest caudal fin ray when the fin lobes of the tail are pressed . In BC, total length is the measurement most commonly used on fish without forked tails such as burbot and sculpins.

Ventral: On the lower surface; pertaining to the abdomen or belly.

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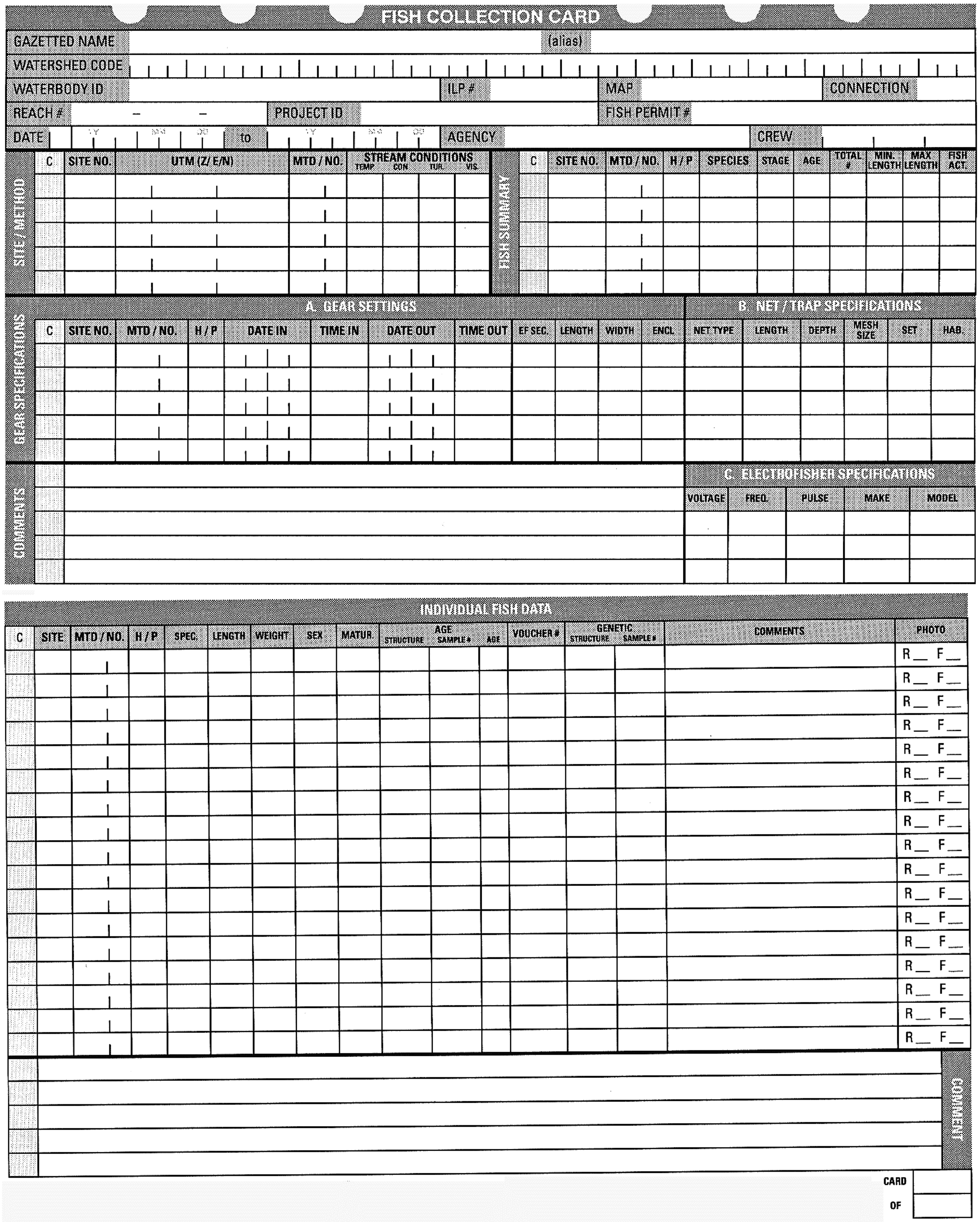
APPENDIX A – FISH COLLECTION DATA FORMS

The Fish Collection Forms are designed to collect all pertinent field information regarding the fish sampled during the process of a lake or stream inventory. A sample form, associated user notes and a complete fish species code list is provided in this chapter.



FISH COLLECTION CARD

GAZETTED NAME		(alias)	
WATERSHED CODE			
WATERBODY ID	ILP #	MAP	CONNECTION
REACH # – –	PROJECT ID	FISH PERMIT #	
DATE Y M D to Y M D	AGENCY	CREW	

SITE / METHOD

C	SITE NO.	UTM (Z/ E/N)	MTD / NO.	STREAM CONDITIONS TEMP	CON	TUR.	VIS.

FISH SUMMARY

C	SITE NO.	MTD / NO.	H / P	SPECIES	STAGE	AGE	TOTAL #	MIN. LENGTH	MAX LENGTH	FISH ACT.

GEAR SPECIFICATIONS

A. GEAR SETTINGS

C	SITE NO.	MTD / NO.	H / P	DATE IN	TIME IN	DATE OUT	TIME OUT	EF SEC.	LENGTH	WIDTH	ENCL.

B. NET / TRAP SPECIFICATIONS

NET TYPE	LENGTH	DEPTH	MESH SIZE	SET	HAB.

COMMENTS

C. ELECTROFISHER SPECIFICATIONS

VOLTAGE	FREQ.	PULSE	MAKE	MODEL

INDIVIDUAL FISH DATA

C	SITE	MTD / NO.	H / P	SPEC.	LENGTH	WEIGHT	SEX	MATUR.	AGE STRUCTURE	AGE SAMPLE #	AGE	VOUCHER #	GENETIC STRUCTURE	GENETIC SAMPLE #	COMMENTS	PHOTO
																R__ F__
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COMMENT

CARD

OF

NOTES FOR THE FISH COLLECTION DATA FORM

Gazetted Name:

Definition: The official name of the lake or stream being surveyed as listed in the Gazetteer of Canada for British Columbia.
Method: Determine from the Gazetteer of Canada for British Columbia.
Recording Procedure: Record gazetted name. If not gazetted, enter "unnamed."

Alias (local):

Definition: An unofficial or locally used lake or stream name.
Method: Can be obtained from old lake summary reports, regional MELP offices, etc.
Recording Procedure: Record the local/alias name.

Watershed Code:

Definition: A unique, 45 digit number assigned to the watersheds in British Columbia.
Method: WWW, GIS Watershed Atlas group. *See: User's Guide to the British Columbia's Watershed/waterbody Identifier System, RIC (1997).*
Recording Procedure: Record the complete code to the first set of zeros.

Waterbody identifier:

Definition: The waterbody identifier is an alpha-numeric, 9 string of characters that uniquely identifies a waterbody within the province of British Columbia. It is composed of 5 numeric digits followed by a 4 letter acronym of the parent watershed group.
Method: At present only available through the GIS Watershed Atlas group. *See: User's Guide to the British Columbia's Watershed/waterbody Identifier System, RIC (1997).*
Recording Procedure: Record the complete 9 character alpha-numeric Watershed identifier.

Note: The following information is filled when no waterbody identifier is available.

Interim Locational Point (ILP) Map number:

Definition: The number of the mapsheet used to assign the interim locator.
Method: Read from the map. *See: User's Guide to the British Columbia's Watershed/waterbody Identifier System, RIC (1997).*
Recording Procedure: Record the mapsheet number, e.g., 92L.005.

Interim Locational Point (ILP) Number:

Definition: A number unique to any particular point on the map sheet. It is used to identify waterbodies lacking referencing codes and is assigned at the outlet.
Method: *See: User's Guide to the British Columbia's Watershed/waterbody Identifier System, RIC (1997).*
Recording Procedure: Record the Interim Locational Point Number.

Project ID:

Definition: A user defined identification code for the project.
Method: *See: User's Guide to the British Columbia's Watershed/waterbody Identifier System, RIC (1997).*
Recording Procedure: Record a unique project ID code.

Reach Number:

Definition: A **reach** is a stream segment with relatively repetitious and homogenous sequence of physical processes and habitat types (e.g., homogenous slope, discharge, habitat, channel type and riparian features); lakes and wetlands are also considered reaches. **Reach number** is the unique number given to individual reaches.
Method: The reach number is given to the reaches in a sequential, up-stream, ascending order.
Recording Procedure: Record the reach number in the following order: (reach no. - subreach no.). For 1997, only reach number will be recorded, e.g., (1 -).

Fish Collection Permit number:

Definition: Permit issued by Ministry of Environment, Lands and Parks for the collection of fish for scientific purposes from non-tidal waters.
Method: N/A
Recording Procedure: Record the Fish Collection Permit Number.

SURVEY INFORMATION

Survey Date (*yyyy/mm/dd*):

Definition: The date of survey was started and the date it was completed, both dates inclusive.
Method: N/A
Recording Procedure: Must be filled in the following sequence: year(YYYY)/month/date (e.g., 1996/06/23 **to** 1996/06/24).

Agency:

Definition*:* Name of the agency contracting the inventory.
Method*:* Agency codes are listed below, and in the in the data entry tool. For the current list consult the Inventory WebPage @ http://www.env.gov.bc.ca:80/fsh/ids/. For agencies not listed, please contact the Data Management Group at Fisheries Inventory.
Recording Procedure*:* Record the code of the organization contracting out the inventory (e.g., C55).

Agency	Code
Acres Consulting	C61
Adland Environmental	C62
Agra Earth and Environmental Ltd.	C63
Applied Ecosystem Management	C64
Appropriate Forestry Services Ltd.	C65
Aquafor Consulting Ltd.	C66
Aquametrix Research ltd.	C67
Aquaterra Consultants	C68
Aquatic Environment Ltd.	C53
ARC Environmental Ltd.	C69
Archipelago Marine Research ltd.	C70
Aresco Ltd.	C54
Artech Consulting Ltd.	C71
BC Research (Vancouver)	C20
Beak Consultants	C52
Bella Coola Grizzly Holdings Ltd.	C73
Bio-Systems	C03
BioLith Scientific Consultants Inc.	C74
Canadian Salvage Environmental Corp.	C75
Cariboo Envirotech	C76
Carmanah Research Ltd.	C77
Castor Consultants Ltd.	C78
Coast Forest Management	C79
Coast River Environmental Services Ltd.	C80
Columbia Environmental Services	C81
CRL and Associates	C82
Burt and Associates	C83
Tripp Biological Consultants Ltd.	C84
Bernard Contracting	C85
Clough Consulting	C86
David Bustard and Associates	C87
Diversified Ova Tech Ltd.	C88
Don Sinclair	C89
Tobe Enterprises	C90
ECL Envirowest Consultants Ltd.	C91
Ecofocus	C92
Ecologistics Ltd.	C93
ENKON Environmental Ltd.	C94
Entech Environmental Consultants Ltd.	C95
Envirocon	C40
Environment Research Consultants	C45
Environment Sciences	C55
EnviroResource Consulting Ltd.	C96
EVS Consultants	C30
Fishfor Contracting	C98
G3 Consulting Ltd.	C99
Gartner Lee Ltd.	C100

Agency	Code
Kokanee Forests Consulting Ltd.	C111
Ktunaxa/Kinbasket Tribal Council	C112
Larkspur Biological Consultants	C113
LGL Sidney	C10
Longstaff Land Surveying Ltd.	C114
Whelen and Associates Ltd.	C115
Lough and Associates	C116
Dillon Ltd.	C117
MacLaren Plansearch	C15
Madrone Consultants Ltd.	C118
Marlin Ecological Consulting Ltd.	C119
McCart Biological Consultants	C51
Mirkwood Ecological Consultants Ltd.	C120
Natural Resources Serv.	C02
Nelson Environmental Services	C121
New East Consulting Ltd.	C122
Nicola Valley Tribal	C123
Norecol Env. Cons. Ltd.	C35
Norecol, Dames and Moore, Inc.	C124
North/South Consultants Inc.	C125
Northern Van Island Salmonid Enhancement Assoc.	C126
Northwest Ecosystem Institute	C127
Pacific Cascade Consultants	C128
Pottinger Gaherty Environmental Consultants Ltd.	C129
RL & L. Environmental Services Ltd. (Prince George)	C131
RL & L. Environmental Services Ltd. (Castlegar)	C130
Raven River Habitat Services	C132
Renewable Resource (Edmonton)	C25
RL & L Environmental Service Ltd.	C50
Ron Tschirhart	C133
Scott Resource Services Inc.	C134
Shawn Hamilton and Associates	C135
Ship Environmental Consultants	C136
SIGMA Engineering Ltd.	C137
Silvatech Consulting Ltd.	C138
Silvicon Services Inc.	C139
Simons Reid Collins	C140
SKR Consultants	C141
SNC Lavalin Inc.	C142
Strathinnes Forestry Consultants Ltd.	C143
Summit Environmental Consultants Ltd.	C144
Systems Forestry Consulting	C145
T and E Consultants Inc.	C146
Taiga-Pacific	C147
Techman (Calgary)	C01
Terra Lotic Resources Ltd.	C148
Terrasol Environmental Industries	C149

Agency	Code
Geoalpine Environmental Consulting	C101
Geomatics International Inc.	C102
Global Fisheries Consultants Ltd.	C103
Golder Associates Ltd.	C104
Hallam Knight Plesold Ltd.	C105
Hatfield Consulting Ltd.	C60
IEC (International Env. Cons.)	C59
Independent Consultant	C58
Industrial Forestry Service Ltd.	C106
Interior Reforestation Co. Ltd.	C107
Kallahin Surveying	C108
Kerr Wood Leidal Associates Ltd.	C109
Klohn-Crippen Consultants Ltd.	C110

Agency	Code
Timberland Consultants Ltd.	C150
Triton Environmental Consultants (Nanaimo)	C151
Triton Environmental Consultants (Richmond)	C152
UMA Engineering Ltd.	C153
Underwood Mclelland Ass. Ltd.	C57
Urban Prog. Plan. (R.E. Mann)	C56
Poulin and Associates Ltd.	C154
Ward and Associates Ltd.	C155
Westerra Resources Ltd.	C156
Westroad Resource Consultants Ltd.	C157
Westworth, Brusnyk and Associates Ltd.	C158
Wild Stone Resources Ltd.	C159

Crew:

Definition: Initials of crew conducting inventory.
Method: N/A
Recording Procedure: Record 2-3 letter initials of the principal individual(s) who conducted the survey (e.g., CPL/ MOP).

SITE/METHOD

NOTE: The site refers to an area of a stream reach, wetland or lake where the sampling is done while method/number relates to the actual gear type deployed within the site. Method number is a sequential number assigned to various gears of one type.

Site Number:

Definition: A number associated with a unique sampling area/location of a stream reach, wetland or lake.
Method: N/A
Recording Procedure: Record the site number.

Note: NID numbers: Assigning NIDs is a method of identifying features on a mapsheet. Each feature identified on a mapsheet is assigned a five digit number, unique to that mapsheet, such as 00001, 00002, etc. The mapsheet number followed by this feature identifier number forms a complete NID reference code (e.g., 92L00500012) that is unique to the project. Only the unique, five digit feature identifier is marked on the mapsheet, adjacent to each feature. On the data forms, however, both the mapsheet number and the feature identifier are recorded in their respective, corresponding columns, as explained below.

NID Map No:

Definition: The number of the mapsheet on which the specific NID number occurs.
Method: Read from map.
Recording Procedure: Record the mapsheet number, e.g., 92L.005.

NID number:

Definition: The unique five digit number that identifies the feature on a mapsheet.
Method: N/A
Recording Procedure: Record the five digit NID number unique to mapsheet recorded in the corresponding NID Map No. column, e.g., 00012.

Method/Number:

Definition: The code for the method used to capture fish, i.e., the gear type followed by a number that identifies the number of the same gear type used. For example, if one gill net and three minnow traps are used at a site, then these will be entered as GN1, MT1, MT2 and MT3 respectively.
Recording Procedure: Record the appropriate fish capture method code followed by the appropriate sequential number. If the Method is EF (electrofishing), then section C, Electrofisher Specifications, is applicable.

Method	Code
Angler report	AR
Angling	AG
Creel census	CR
Dead capture	DC
Dip netting	DN
Electrofishing	EF
Gill netting	GN

Method	Code
Minnow trapping	MT
Seining	SN
Swimming/Snorkeling	SW
Trap net	TN
Visual observation above water	VO
Method unknown	UN

Note: The following three fields (i.e., temperature, conductivity and visibility) are applicable to streams only.

Temperature (°C):

Definition: The temperature of the water in degrees Celsius (°C).
Method: Thermometer (hand-held or electronic).
Recording Procedure: Record the water temperature to the nearest 0.1 °C.

Conductivity (µmhos/cm):

Definition: A measure of the ability of a solution to carry an electrical current, dependent on the total concentration of ionized substances dissolved in water.
Method: YSI or Hydrolab.
Recording Procedure: Record the conductivity to the nearest 1 µmhos/cm, standardized to 25 °C as calculated from a nomograph or as given by instrument employing automatic temperature compensation.

Visibility (*snorkeling only*):

Definition*:* The range of underwater visibility during snorkeling.
Method*:* Determine using tape measure with one snorkeler sighting on the other.
Recording Procedure*:* Record the approximate range of visibility in metres.

FISH SUMMARY

Note: This section is to be completed only if the Individual Fish Data section cannot be completed or if some data collected was from snorkel surveys.

Site and Method (gear) Number:

Definition*: See Site/Method section.*
Method*:* N/A
Recording Procedure*:* Record the **corresponding numbers** from *Site/Method section*.

Haul (*Trap/Net*)/Pass Number:

Definition*:* A unique number assigned to identify repeated deployment of each gear type (i.e., trap or net) or electrofishing. This number will be used to discern the fish caught from each haul/pass if the gear is deployed more than once
Method*:* N/A
Recording Procedure*:* Record the appropriate haul/pass number.

Species:

Definition*:* Codes for the fish species of BC.
Method*: Refer to Appendix 1*
Recording Procedure*:* Record the appropriate species code from the Species Code List (Appendix 1).

(Life) Stage:

Definition: The life stage of the fish.
Method*:* Visual observation.
Recording Procedure*:* Record the appropriate code.

Code	Description
F	fry
J	juvenile
A	adult

Age: (Primarily for intensive surveys and age of juveniles is obvious from length frequency tally form.)

Definition: The determined age of the fish.
Method: Visual approximation***.***
Recording Procedure: Record the determined age of the fish as 0+, 1+, etc.

Total Number:

Definition*:* The total number of a fish observed.
Method*:* Visual observation.
Recording Procedure*:* Record the estimated number of fish.

Minimum length:

Definition*:* The average minimum length of the fish sampled/observed.
Method*:* Visual observation

Recording Procedure: Record the estimated minimum length in millimetres (mm).

Maximum Length:

Definition: The average maximum length of the fish sampled/observed.
Method: Visual observation
Recording Procedure: Record the estimated maximum length in millimetres (mm).

Fish Activity:

Definition: The activity exhibited by the fish at the time of capture.
Method: Visual observation
Recording Procedure: Record the determined activity code.

Code	Description
M	migration
I	incubation
S	spawning
R	rearing (feeding or resting)

GEAR SPECIFICATIONS

Note: Only applicable fields are to be entered.

A. Gear Settings

Site and Method (gear) Number:

Definition: *See Site/Method section.*
Method: N/A
Recording Procedure: Record the **corresponding numbers** from *Site/Method section*.

Haul (*Trap/Net*) Number:

Definition: A unique number assigned to identify repeated deployment of each gear type (i.e., trap or net). This number will be used to discern the fish caught from each haul if the trap/net is deployed more than once.
Method: N/A
Recording Procedure: Record the appropriate haul number.

Pass Number:

Definition: A unique number assigned to each electrofishing pass at a fish collection site. This number will be used to discern which fish were caught from the electrofishing passes over the same area.
Method: N/A
Recording Procedure: Record the appropriate pass or number.

Date in (MM/DD)

Definition: The date when a particular capture method was employed (e.g., gill net gang set into a lake).
Method: N/A
Recording Procedure: Record the date as (MM/DD), e.g., 06/22.

Time in (24 hr clock):

Definition: The time (using a 24 hr clock system) when a particular capture method was employed (e.g., gill net gang set into the lake).
Method: N/A
Recording Procedure: Record the time, e.g., 1300 (hours).

Date out (MM/DD):

Definition: The date when use of a particular capture method ended (e.g., gill net gang pulled out of the lake).
Method: N/A
Recording Procedure: Record the date (MM/DD), e.g., 06/23.

Time out (24 hr clock):

Definition: The time (using a 24 hr clock system) when use of a particular capture method ended (e.g., gill net gang pulled out of the lake).
Method: N/A
Recording Procedure: Record the time, e.g., 0700 (hours).

Electrofishing Time (EF sec):

***Definition**:* The total electrofishing time in seconds for one pass, as read directly from the electrofishing equipment.
***Method**:* N/A
***Recording Procedure**:* Record the time in seconds.

(Gear) Length:

***Definition**:* Length of the electrofishing area. For electrofishing, this is the linear measure of stream length for electrofishing.
***Method**:* Measured length using hip chain, tape, range finder or visual estimate.
***Recording Procedure**:* Record the length of the electrofishing area in metres.

(Gear) Width:

***Definition**:* Width of the stream used for electrofishing.
***Method**:* Measured width using hip chain, tape, range finder or visual estimate.
***Recording Procedure**:* Record the width of the electrofishing area in metres.

(Gear) Enclosure:

***Definition**:* The degree of enclosure of the fish capture area. The site is considered '**Open**' if no natural or installed enclosures surround the capture area, **'Closed**' for total enclosure of a site either by the installation of stop nets or use of natural barriers at both the upstream and downstream locations of the site, or '**Partially Enclosed**' if a downstream stop net is used. In lakes, all enclosures will generally be open type.
***Method**:* N/A
***Recording Procedure**:* Record the appropriate code for the type of enclosure.

Code	Description
O	open
C	closed
PE	partial enclosure

B. Net/Trap Specifications

Net Type:

***Definition**:* Define if the net was of floating or sinking type.
***Method**:* N/A
***Recording Procedure**:* Record the appropriate code for the type of net used/set.

Code	Description
FL	floating
SK	sinking

(Gear) Length:

***Definition**:* Length of the gear's fishing area. For example, this will be length of gill net gang or linear measure of stream length for electrofishing. This is not applicable for minnow traps.
***Method**:* N/A
***Recording Procedure**:* Record the gear length in metres.

(Gear) Depth:

***Definition**:* The **maximum** measured fishing depth of the gear in the lake or stream.
***Method**:* Weighted/measured line.
***Recording Procedure**:* Record the maximum depth in metres.

Mesh Size:

***Definition**:* Specify if nets were standard gill net gangs or individual mesh panels were used. Seine nets will be considered as individual meshes.
***Method**:* N/A
***Recording Procedure**:* Record the appropriate code for the type of mesh used.

Code	Description
ST	standard gill net gangs
IN	individual mesh panel

If IN enter mesh size in Comment section.

Setting:

***Definition**:* The zone in which the gear was set in the lake or stream.

***Method**:* N/A
***Recording Procedure**:* Record the appropriate code.

Code	Description
BT	bottom
MD	mid-water
SU	surface
VR	variable

Habitat:

***Definition**:* The general habitat in which the trap was set in, i.e., pelagic or littoral.
***Method**:* N/A
***Recording Procedure**:* Record the appropriate habitat code.

Code	Description
P	pelagic
L	littoral
PL	both

C. Electrofisher Specifications

Voltage:

***Definition**:* Electric potential or the potential difference expressed in volts
***Method**:* N/A
***Recording Procedure**:* Record the voltage used.

Frequency:

***Definition**:*N/A
***Method**:* N/A
***Recording Procedure**:* Record the Frequency setting, if available on the model used.

Pulse:

***Definition**:* N/A
***Method**:* N/A
***Recording Procedure**:* Record the Pulse setting, if available on the model used.

Make:

***Definition**:* The manufacturing company name of the electrofishing equipment.
***Method**:* N/A
***Recording Procedure**:* Record the name (i.e., Coffelt).

Model:

***Definition**:* The model number of the electrofishing equipment.
***Method**:* N/A
***Recording Procedure**:* Record the appropriate model number.

INDIVIDUAL FISH DATA

Site and Gear (Method) Number:

***Definition**: See Site/Method section.*
***Method**:* N/A
***Recording Procedure**:* Record the **corresponding numbers** from *Site/Method section*.

Haul/Pass Number:

***Definition**: See Section B or C.*
***Method**:* N/A
***Recording Procedure**:* Record the corresponding haul or pass number.

Species:

***Definition**:* Codes for the fish species of BC.
***Method**:* Refer to Appendix 1.
***Recording Procedure**:* Record the appropriate species code from the Species Code List (Appendix 1).

Length (mm):

***Definition**:*

- **Fork length (FL)**: The length of a fish (in mm) from nose tip to fork of tail (median caudal fin rays).
- **Total length (TL):** Total length is the distance from the most anterior part of the head to the tip of the longest caudal fin ray. Only measured in fish without a forked tail.

Method: Measure the required type of length of the fish in mm as suggested in Appendix 1; defined species specifically.
Recording Procedure: Record the length of the fish in mm as follows (45).

Weight (g):

Definition: The weight of the fish after excessive water has been gently blotted away.
Method: Weighing scale.
Recording Procedure: Record the weight of the fish in grams (to the nearest 0.0 g).

Sex (Code):

Definition: The gender of the fish.
Method: If the fish is ripe and ready to spawn sex may be easily determined by secondary (phenotypic) sexual characteristics. If the sex cannot easily be determined by external examination, internal examination will be required only of those specimens already sacrificed for other reasons (i.e., voucher specimens).
Recording Procedure: Record the appropriate sex code for the fish.

Code	Description
M	male
F	female
U	undetermined

Maturity (Code):

Definition: **Maturity:** The life stage of the fish coded as the level of maturity.
Method: Visual observation.
Recording Procedure: Record the appropriate code.

Code	Description
IM	immature
MT	maturing
M	mature

Code	Description
SP	spawning
ST	spent

Age Structure:

Definition: The body structure collected to estimate the age of the fish.
Method: N/A
Recording Procedure: Record the aging structure code.

Code	Description
CL	cleithrum
FR	fin ray
OP	operculum

Code	Description
OT	otolith
SC	scale

Age Sample number:

Definition: The identification number attached to each aging sample submitted to MELP.
Method: N/A
Recording Procedure: Record the aging sample number.

Age:

Definition: The determined age of the fish.
Method: Determined post-field, from aging structure samples.
Recording Procedure: Record the determined age of the fish.

Voucher number:

Definition: A unique number attached to a fish specimen collected for preservation and submission.
Method: N/A
Recording Procedure: Record a unique number.

Genetic Structure:

Definition: The body structure of the fish collected for genetic sampling.
Method: *See Fish Collection Standards and Methods, RIC (1997).*
Recording Procedure: Record one of the following codes.

Code	Description
TP	tissue plug

FR	fin rays

Genetic Sample number:

***Definition**:* The identification number attached to each genetic sample submitted to MELP.
***Method**:* N/A
***Recording Procedure**:* Record the genetic sample number.

Comments:

***Definition**:*

- Record comments such as mark numbers, fish identification characteristics, if unique, fish health or any other comments of interest.
- **Photo Inf.:** Record the roll number and frame number of the corresponding photograph, if taken.

***Method**:* :N/A
***Recording Procedure**:* Record comments about the fish. Record the roll and frame number, if a photograph was taken.

GENERAL COMMENTS SECTION

Comments:

Definition: Any additional information. Comment identifiers are used to flag any additional comments that may be recorded in the general comments section.
Method: N/A
Recording Procedure: Record any relevant, flagged comments.

Fish Species Codes for BC

Standardized two and three character codes for fish species have been established and used in British Columbia for several years. The abbreviations currently in use are presented below. Consistent use of these codes is necessary to eliminate confusion and errors often associated with trying to decipher personal abbreviations for fish species. This list of species includes those found in British Columbia or known to have been introduced at some period.

	COMMON NAMES	LATIN NAMES	Length
	Salmonids (Salmon, Trout, Char)		Type
AGB	Anadromous Brown Trout, Anadromous German Brown Trout	*Salmo trutta*	FL
ACT	Anadromous Cutthroat Trout	*Oncorhynchus clarki* (formerly *Salmo clarki*)	FL
ADV	Anadromous Dolly Varden, Anadromous Dolly Varden Char	*Salvelinus malma*	FL
AEB	Anadromous Eastern Brook Trout	*Salvelinus fontinalis*	FL
AC	Arctic Char	*Salvelinus alpinus*	FL
AS	Atlantic Salmon	*Salmo salar*	FL
EB	Brook Trout, Eastern Brook Trout	*Salvelinus fontinalis*	FL
GB	Brown Trout, German Brown Trout	*Salmo trutta*	FL
BT	Bull Trout	*Salvelinus confluentus*	FL
CH	Chinook Salmon, Spring Salmon, King Salmon, Tyee	*Oncorhynchus tshawytscha*	FL
CM	Chum Salmon, Dog Salmon	*Oncorhynchus keta*	FL
CCT	Coastal Cutthroat Trout	*Oncorhynchus clarki clarki* (formerly *Salmo clarki clarki*)	FL
CO	Coho Salmon	*Oncorhynchus kisutch*	FL
CT	Cutthroat Trout (General)	*Oncorhynchus clarki* (formerly *Salmo clarki*)	FL
DV	Dolly Varden, Dolly Varden Char	*Salvelinus malma*	FL
KO	Kokanee	*Oncorhynchus nerka*	FL
LT	Lake Trout, Lake Char	*Salvelinus namaycush*	FL
PK	Pink Salmon, Humpback Salmon	*Oncorhynchus gorbuscha*	FL
RB	Rainbow Trout, Kamloops Trout	*Oncorhynchus mykiss* (formerly *Salmo gairdneri*)	FL
SK	Sockeye Salmon	*Oncorhynchus nerka*	FL
SPK	Splake	*Salvelinus fontinalis x S. namaycush*	FL
ST	Steelhead	*Oncorhynchus mykiss* (formerly *Salmo gairdneri*)	FL

	COMMON NAMES	LATIN NAMES	Length
SST	Steelhead (Summer-run)	*Oncorhynchus mykiss* (formerly *Salmo gairdneri*)	FL
WST	Steelhead (Winter-run)	*Oncorhynchus mykiss* (formerly *Salmo gairdneri*)	FL
WCT	Westslope Cutthroat Trout (preferred) Yellowstone Cutthroat Trout	*Oncorhynchus clarki lewisi* (formerly *Salmo clarki lewisi*)	FL
	Sturgeon		
GSG	Green Sturgeon	*Acipenser medirostris*	FL
WSG	White Sturgeon	*Acipenser transmontanus*	FL
WSG	White Sturgeon (Kootney River Pop)	*Acipenser transmontanus* Pop 1	FL
	Cod		
BB	Burbot, Freshwater Ling Cod, Ling, Loche, Lawyer	*Lota lota*	TL
	Whitefish		
BW	Broad Whitefish, Round-nosed Whitefish, Sheep-nose Whitefish	*Coregonus nasus*	FL
DLW	Dragon Lake Whitefish	*Coregonus* Sp 1	FL
GPW	Giant Pygmy Whitefish	*Prosopium* sp., poss. subspecies of *Prosopium coulteri*	FL
HW	Humpbacked Whitefish	*Coregonus pidschian*	FL
LW	Lake Whitefish, Common Whitefish, Humpback Whitefish	*Coregonus clupeaformis*	FL
MW	Mountain Whitefish, Rocky Mountain Whitefish	*Prosopium williamsoni*	FL
PW	Pygmy Whitefish, Coulter's Whitefish	*Prosopium coulteri*	FL
RW	Round Whitefish	*Prosopium cylindraceum*	FL
SQ	Squanga	*Coregonus* sp.	FL
CA	Arctic Cisco	*Coregonus autumnalis*	FL
CB	Bering Cisco	*Coregonus laurettae*	FL
CL	Lake Cisco	*Coregonus artedii*	FL
CS	Least Cisco	*Coregonus sardinella*	FL
IN	Inconnu, Sheefish, "Conny"	*Stenodus leucichthys*	FL
	Lampreys		
AL	Arctic Lamprey	*Lampetrajaponica*	TL
PL	Pacific Lamprey, Sea Lamprey	*Lampetra tridentata*	TL
BL	Western Brook Lamprey	*Lampetra richardsoni*	TL
RL	River Lamprey, Western Lamprey	*Lampetra ayresi*	TL
MCL	Morrison Creek Lamprey	*Lampetra richardsoni marifaga*	TL
LL	Lake Lamprey, Cowichan Lamprey	*Lampetra macrostoma*	TL

	COMMON NAMES	LATIN NAMES	Length
	Grayling		
GR	Arctic Grayling	*Thymallus arcticus*	FL
	Goldeyes		
GE	Goldeye	*Hiodon alosoides*	FL
	Herrings		
SH	American Shad	*Alosa sapidissima*	FL
	Minnows		
CP	Carp	*Cyprinus carpio*	FL
GC	Goldfish	*Carassius auratus*	FL
TC	Tench	*Tinca tinca*	FL
ESC	Emerald Shiner	*Notropis atherinoides*	FL
RSC	Redside Shiner	*Richardsonius balteatus*	FL
STC	Spottail Shiner	*Notropis hudsonius*	FL
FHC	Flathead Chub	*Platygobio gracilis*	FL
LKC	Lake Chub	*Couesius plumbeus*	FL
PCC	Peamouth Chub, Peamouth	*Mylocheilus caurinus*	FL
NSC	Northern Squawfish	*Ptycheilus oregonensis*	FL
CMC	Chiselmouth	*Acrocheilus alutaceus*	FL
BMC	Brassy Minnow	*Hybognathus hankinsoni*	FL
FM	Fathead Minnow	*Pimephales promelas*	FL
FDC	Finescale Dace	*Phoxinus neogaeus* (formerly *Pfrille neogaea* and *Chrosomus neogaeus*)	FL
LDC	Leopard Dace	*Rhinichthys falcatus*	FL
LNC	Longnose Dace	*Rhinichthys cataractae*	FL
NDC	Nooksack Dace, Nooky Dace	*Rhinichthys* sp.	FL
RDC	Northern Redbelly Dace	*Phoxinus eos* (formerly *Chrosomus eos*)	FL
XDC	Northern Redbelly Dace X Finescale Dace	*Phoxinus eos (Cope)* X *Phoxinus neogaeus*	FL
PDC	Pearl Dace, Northern Pearl Dace	*Margariscus margarita* (formerly *Semotilus margarita*)	FL
SDC	Speckled Dace	*Rhinichthys osculus*	FL
UDC	Umatilla Dace	*Rhinichthys umatilla*	FL
	Suckers		
BSU	Bridgelip Sucker, Columbia Small-scaled Sucker	*Catostomus columbianus*	FL
CSU	Largescale Sucker, Coarsescale Sucker	*Catostomus macrocheilus*	FL

	COMMON NAMES	LATIN NAMES	Length
LSU	Longnose Sucker, Fine-scaled Sucker, Northern Sucker	*Catostomus catostomus*	FL
MSU	Mountain Sucker, Northern/Plains Mountain Sucker	*Catostomus platyrhyncus* (formerly *Pantosteus jordani*)	FL
SSU	Salish Sucker	*Catostomus* sp.	FL
WSU	White Sucker	*Catostomus commersoni*	FL
	Catfish		
BKH	Black Bullhead, Black Catfish	*Ameiurus melas* (formerly *Ictalurus melas*)	TL
BNH	Brown Bullhead, Brown Catfish	*Ameiurus nebulosus* (formerly *Ictalurus nebulosus*)	TL
	Pike		
NP	Northern Pike, Jackfish, Jack	*Esox lucius*	FL
	Smelts		
ASM	Arctic Smelt	*?*	FL
EU	Eulachon, Candlefish	*Thaleichthys pacificus*	FL
LSM	Longfin Smelt	*Spirinchus thaleichthys*	FL
PLS	Pygmy Longfin Smelt	*Spirinchus* spp.	FL
RSM	Rainbow Smelt	*Osmerus dentex*	FL
SSM	Surf Smelt	*Hypomesus pretiosus*	FL
	Sticklebacks		
SB1	Balkwill Lake Benthic Stickleback	*Gasterosteus* sp.	TL
SB2	Balkwill Lake Limnetic Stickleback	*Gasterosteus* sp.	TL
BSB	Brook Stickleback	*Culea inconstans*	TL
SB3	Charlotte Unarmoured Stickleback, Unarmoured Stickleback	*Gasterosteus* sp.	TL
SB4	Emily Lake Benthic Stickleback	*Gasterosteus* sp.	TL
SB5	Emily Lake Limnetic Stickleback	*Gasterosteus* sp.	TL
SB6	Enos Lake Benthic Stickleback	*Gasterosteus* sp.	TL
SB7	Enos Lake Limnetic Stickleback	*Gasterosteus* sp.	TL
SB8	Giant Stickleback, Giant Black	*Gasterosteus* sp.	TL
SB9	Hadley Lake Benthic Stickleback	*Gasterosteus* sp.	TL
SB10	Hadley Lake Limnetic Stickleback	*Gasterosteus* sp.	TL
SB11	Lake Stickleback	*Gasterosteus* sp.	TL
NSB	Ninespine Stickleback	*Pungitius pungitius*	TL
SB12	Paxton Lake Benthic Stickleback	*Gasterosteus* sp.	TL
SB13	Paxton Lake Limnetic Stickleback	*Gasterosteus* sp.	TL
SBB	Priest Lake Benthic Stickleback	*Gasterosteus* sp.	TL

	COMMON NAMES	LATIN NAMES	Length
SBP	Priest Lake Limnetic Stickleback	*Gasterosteus* sp.	TL
TSB	Threespine Stickleback	*Gasterosteus aculeatus*	TL
	Sculpins		
CAL	Coastrange Sculpin, Aleutian Sculpin	*Cottus aleuticus*	TL
CCL	Cultus Lake Sculpin	*Cottus* sp.	TL
CMT	Deepwater Sculpin	*Myoxocephalus thompsoni (quadricornis ?)*	TL
CBA	Mottled Sculpin	*Cottus bairdi*	TL
CLA	Pacific Staghorn Sculpin, Staghorn Sculpin	*Leptocottus armatus*	TL
CAS	Prickly Sculpin	*Cottus asper*	TL
CCA	Sharpnose Sculpin	*Clinocottus acuticeps*	TL
CCN	Shorthead Sculpin	*Cottus confusus*	TL
CCG	Slimy Sculpin	*Cottus cognatus*	TL
CRI	Spoonhead Sculpin, Spoonhead Muddler	*Cottus ricei*	TL
COM	Tidepool Sculpin	*Oligocottus maculosus*	TL
CRH	Torrent Sculpin	*Cottus rhotheus*	TL
	Sunfish/Bass		
PMB	Pumpkinseed, Sunfish, Pumpkinseed Sunfish	*Lepomis gibbosus*	FL
BCB	Black Crappie, Calico Bass	*Pomoxis nigromaculatus*	FL
LMB	Largemouth Bass, Largemouth Black Bass	*Micropterus salmoides*	FL
SMB	Smallmouth Bass, Smallmouth Black Bass	*Micropterus dolomieui*	FL
	Perches		
WP	Walleye, Pike-perch, Pickerel, Dore, many others	*Stizostedion vitreum*	FL
YP	Yellow Perch, American Yellow Perch, many others	*Perca flavescens*	FL
	Flounders		
SFL	Starry Flounder	*Platichthys stellatus*	TL
	Troutperch		
TP	Troutperch	*Percopis omiscomaycus*	FL
	Mosquitofish		
GAM	Mosquitofish, Gambusia	*Gambusia* sp.	TL