SECTION 9.0. RESTORING THE WATERCOURSE

THIS SECTION CONTAINS:

- Steps to a successful program
- Stream enhancement methods and devices
- How to clean up a watercourse
- A quiz to test your knowledge

9.1. How a Professional Can Help You

Contact a NSSA Adopt-A-Stream habitat professional to discuss your ideas for your watercourse. By this time you should have a written report that includes:

- A map of the area as it once looked
- A map of what it looks like now
- A survey of the watercourse
- A list of what you think the problems are in the watercourse
- A list of proposed solutions
- A tentative plan of action
- A group organized and ready to work

The goal of joint planning is to weigh all available options in order to enhance the habitat of the watercourse you have adopted.

Most likely you have had preliminary discussions with a habitat professional while completing the steps above. Now the professional will evaluate your report and help you develop a more detailed action plan. While doing this he/she will balance the needs of the watercourse against the time and resources your group has to offer. You should consider this stage as "joint planning". The professional, although an expert in fish and water ecosystems, is not an expert in your community or even the particular watercourse you have chosen. You can contribute ideas based on your experience and the information you have gathered. Your input is important, as there are limited resources available to study watercourses in our province. Observations, surveys, and interviews you have collected are invaluable to the habitat professional in assessing the individual situation of your watercourse.

Please remember that every watercourse is different and must be evaluated separately.

What works on one watercourse may be totally inappropriate on your watercourse.

If you haven't completed a plan for your watercourse, go back and re-read previous sections of this manual.

9.2 Steps to Successful Enhancement

- **Know the physical conditions** that are limiting the productivity of the habitat and the future land use plans for the area.

- **Know the different options for improving** fish habitat in your watercourse. This section of the manual will outline some basic choices. Although you will rely on a NSSA professional to guide you, it is important for you to understand different methods.

- **Pick the right "tools" and treatment** for your stream. Each stream is a unique ecosystem. Its best condition is determined largely by the soils and vegetation in the surrounding area. Each stream, therefore, must be viewed as unique, with individual problems and solutions. Enhancement measures used successfully on one stream may not work for another.

- **Make sure you have completed a watercourse plan** and have read about legal and safety considerations outlined later in this section.

Here are some typical devices:

• Digger logs – hardwood logs set across the stream bottom at various angles depending on the stability of the bank and where the pool is needed. Logs are held in place by re bar pins and rocks.

• Vegetation – planting native vegetation like willows along streams with low eroding banks will collect sand and silt and re-build the channel.

• Deflectors made out of rock or wood – In wood deflectors, mature trees are dropped parallel to the bank and tied to their stump. Deflectors are used in areas where silt and sand needs to be collected.

- **Make sure you have obtained all the necessary permits** to work in the watercourse (see the previous section).

- **Be certain your plan does not help one species of fish or one area of the ecosystem at the expense of another**. Poorly planned work may result in watercourse damage rather than improvement.

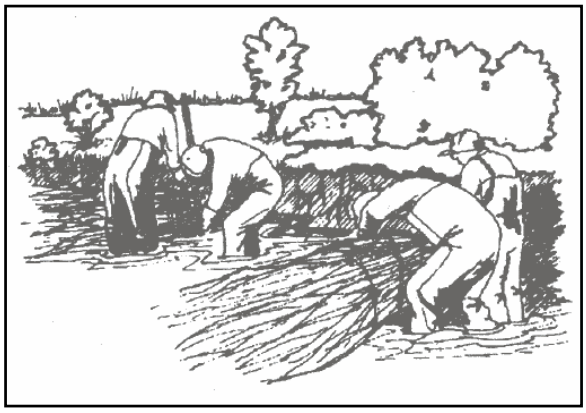
9.3. Stream Enhancement Methods

Some enhancement can be very simple:

- **Removing debris and garbage** that has blocked a watercourse obstructing access to spawning and nursery areas.

- **Cleaning up garbage and minor pollution** sources. Later in this section there are tips and rules for performing clean-ups on watercourses.

- **Planting trees and shrubs**. Planting helps stabilize banks, increases the amount of leaf fall into the stream, and provides cover for fish. In some cases volunteers can strap bundles of willow or other vegetation to help eroding banks as shown.



- **Placing fencing along the watercourse** to keep grazing animals out of the water and from over-grazing grasses and shrubs along the water's edge.

- **Repairing culverts** so they do not obstruct migrating fish.

Other enhancement activities may be more complex such as restoring the stream channel, putting in stream enhancement devices, fishways, or fish screens.

- **Restoring the stream channel** includes using a combination of stream enhancement techniques to work with or help the natural flows. Structures are designed and put into the stream to help clear sand and silt out of the bottom and develop a narrower, deeper channel with well-formed pools and riffle areas. Stream flows can be very powerful and do extensive damage if not properly used. The design of instream restoration work must be done by trained professionals but be sure to accompany them when they lay out the work so you can understand what has to be done. If the work is not designed properly all of your work might be fruitless. For example, if the device is not placed in the correct place it might be washed out in the spring. Once the needs of your stream are established and a pattern developed, your group can often continue to layout the work to the next major tributary.

9.4. Stream Enhancement Devices

All devices must be carefully placed and securely fastened to make allowance for drifting debris and changing flow patterns. These techniques can take 2-3 years to complete and need to be checked every year to make sure they have not been damaged. Working with nature gives the stream a natural look and the work can usually be done with materials available on the site. In severe cases where damage such as extensive gravel removal, channel straightening, or stream-relocation has been done, detailed engineering plans will be required.

In these cases large rocks and heavy machinery are usually involved. How these devices work is illustrated in the DFO NSDEL fact sheets on the next few pages.
You may find that your stream can be restored to provide more rearing habitat than can be used by the available fish. In these cases, **incubation boxes** can provide substitute spawning areas and additional young fry. Perhaps the population of one species has been eliminated from your stream and after restoration you would like to stock it with fish from a hatchery. All of these options can be discussed with a trained professional

HOW TO UNDERTAKE A STREAM BANK STABILIZATION PROJECT

Introduction

Riparian zones are areas close to streams, rivers, ponds, and lakes. They serve as important habitat for fish and wildlife. Species such as muskrats, beaver, bobcats, moose, and deer use riparian zones as travel corridors, feeding areas, and shelter. Tremendous numbers of insects living in riparian areas become food for complex food webs that include songbirds, fish, turtles, mink, and many other wildlife species. Harmful land clearing practices associated with forestry, agriculture, and related activities have resulted in the removal of riparian vegetation. Many of the large hardwood and softwood trees that used to anchor stream banks are now gone. Their large root systems formerly served to protect banks from ice scour and erosion. Increasing soil loss from stream banks impacts a stream by making it wider and shallower, with fewer deep holding areas for larger fish. Soil that enters the stream settles to the bottom and covers valuable trout and salmon spawning areas by filling in the spaces between gravel and rocks. Many aquatic insects live in these spaces thus, sedimentation can greatly reduce the availability of these species as food for wildlife. Wide streams with shallow water depths, along with a reduction in the amount of shade provided by overhanging trees, can also result in water temperatures that become too warm for trout and salmon in summer. Bank stabilization can be used as a stream enhancement technique to protect and maintain the variety of stream habitats that are beneficial to trout, salmon, and other wildlife species.

Know Your Watercourse

The understanding of different stream processes is complicated, and considerable experience is required to layout a proper enhancement design. Every stream is unique, and some problems, therefore, may or may not be solved with the design tools that are explained below. Consultation with individuals experienced in stream enhancement technology is strongly recommended. When planning any stream improvement project, an assessment of the present habitat conditions will determine if bank stabilization is needed. An experienced person can do this by walking along a portion of a watercourse and investigating the habitat quality. The lack of vegetation on banks, the presence of exposed soil along the banks, and the amount of fine sediment on the stream bottom are important features when considering bank stabilization.

Besides the fairly obvious physical considerations, understanding the chemical characteristics and temperature changes of a watercourse will help to prepare for an enhancement project. For instance, if acidity levels are high, then bank stabilization will not be the answer to improving a low trout population. In many streams and rivers in Nova Scotia, summer water temperatures

may rise above 20°C. When this occurs, trout may swim upstream to reach cooler sections of a watercourse. In this situation, it may be beneficial to the trout if enhancement measures are undertaken in cooler tributaries that serve as summer refuges. In this way, more fish could survive through warm periods. Habitat information on local watercourses can be obtained from:

- The Nova Scotia Adopt-A-Stream Program, or related government agencies.
- Recording water temperatures in the summer or taking pH (water acidity) measurements in the spring and fall.
- Talking to landowners, community members, and anglers. Conducting a stream habitat survey.

Landowner Support

About 70% of the land in Nova Scotia is privately owned, and although watercourses are public property, developing and maintaining a good relationship with community members is important. Therefore, permission should be obtained from landowners before starting any enhancement project on or near their property.

Work Team

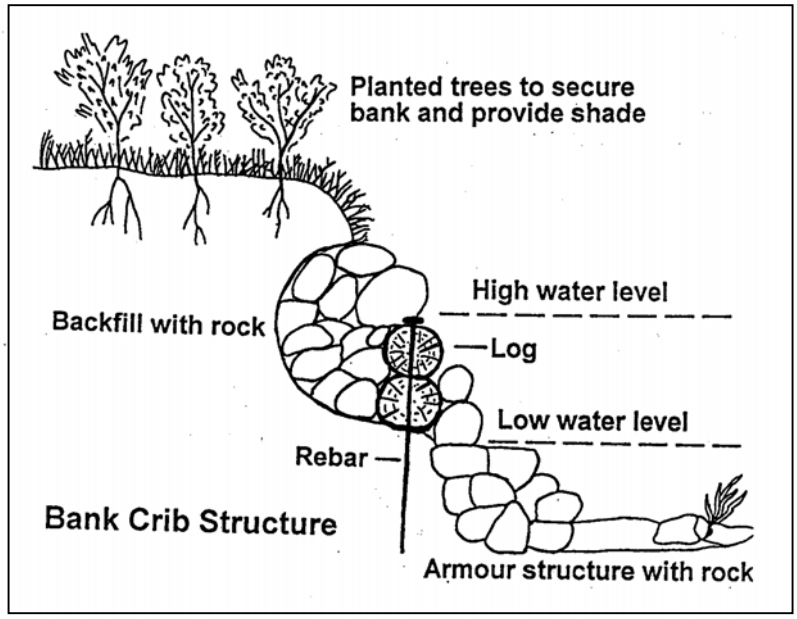
For smaller streams, a team of two or three able-bodied workers, properly equipped and trained, makes for an efficient crew. They must know how to move heavy objects safely, lifting with bars and their legs, rather than straining their backs.

Fencing Livestock From Streams

Livestock access is one of the major problems affecting numerous watercourses in Nova Scotia. Limiting livestock access is a challenge, and landowners with access problems must be approached in a reasonable manner. Site plans will depend on the wants and needs of the farmer, as well as the type of stream section to be fenced. In many cases, an alternative watering source for livestock may be required. A variety of methods have been used, including the following: nose pumps, gravity feed systems, and barnyard watering. If the area of access is located on a floodplain, then fencing off the fields from the stream and digging a hole in the floodplain could be a simple solution. Water from areas of higher elevation will seep into the ground and cross underneath the floodplain before entering the river. The hole will fill with water and function as an alternative watering site for livestock. Another option is to reduce the access to a small area of the stream and place rock (hard ball size and smaller) over the stream bottom and approach slopes. This will, serve to reduce disturbance. A number of agencies have a vested interest in reducing livestock access and might be willing to help with these projects. The Nova Scotia Department of Agriculture and the Eastern Habitat Joint Venture Project (currently a part of the Wildlife Division, Nova Scotia Department of Natural Resources) have experience dealing with landowners and providing financial support toward the reduction of livestock access to watercourses.

Tree planting along banks in the spring will be a long-term method of bank stabilization. In many situations, tree planting in newly fenced areas hastens the re-establishment of vegetation to secure banks and provide shade trees. The trees selected should be long lived and have deep roots, such as ash, maples, hemlocks, oaks, white pine, and willows. Make sure the habitat is suitable for the types of trees selected. Transplanting from other nearby areas to watercourse banks has been successful. Willow shoots and branches can be cut and transplanted to damp areas along stream banks. Willows grow very quickly and are often used to secure banks from erosion. Willow cuttings should be taller than the grass or other competing summer vegetation at the planting site. When planting seedlings and saplings, wood chips (shavings) should be piled around the base of each tree. Wood chips will reduce the growth of surrounding vegetation and increase the survival of newly planted trees. In the past, forestry corporations have donated trees to community groups undertaking enhancement projects. Information on the types of trees suited for riparian zones can be obtained from the Nova Scotia Department of Natural Resources. Funding to purchase trees from nurseries can be obtained from the Tree Plan Canada Program, which is administered through Canada Forestry.

Bank Cribs

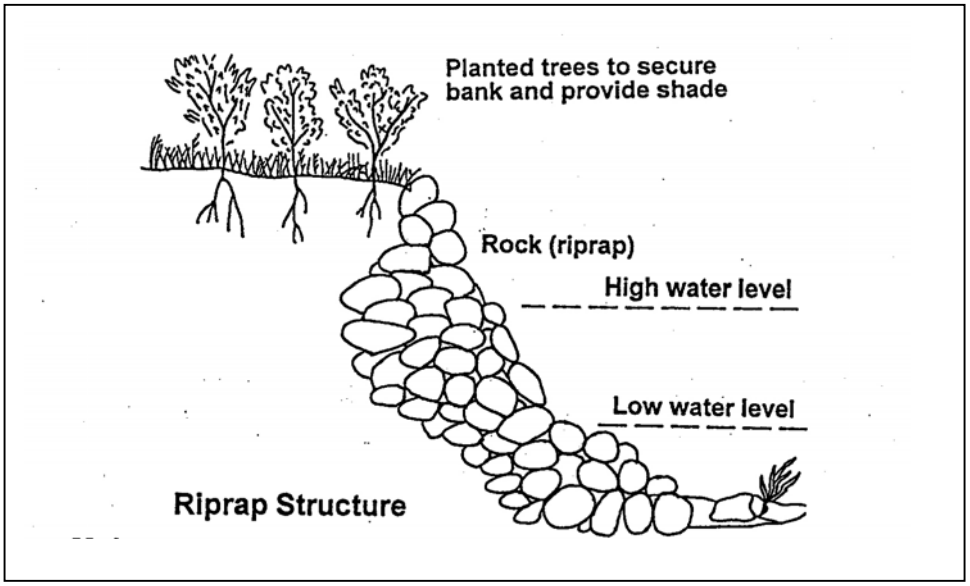


Bank cribs are used to armour and protect eroding banks, and can be made from slabs or logs, wooden stakes or t-bars, rock, and rebar. The structures are of two main types. On large projects, wooden stakes or t-bars can be used depending on substrate type. Wooden stakes will only work if the stream bottom is relatively soft, whereas t-bars will work best if they are hammered into hard substrate. Logs and slabs can be attached with spikes or rebar to wooden stakes, and with heavy gauge wire to t-bars. On smaller projects, rebar can be used to secure logs directly to the stream bottom (cover of brochure). The area between the eroding bank and the wooden structure can be backfilled with rock or large wood debris.

- Lateral supports can be used on t-bar and wooden stake structures to help prevent washout in high flows periods (large drainage area upstream from site).
- Logs, stakes, and/or slabs used to build bank cribs should be large enough to resist undercutting and washout.
- When rebar is used, logs should be pre-drilled, and rebar hammered through the drilled

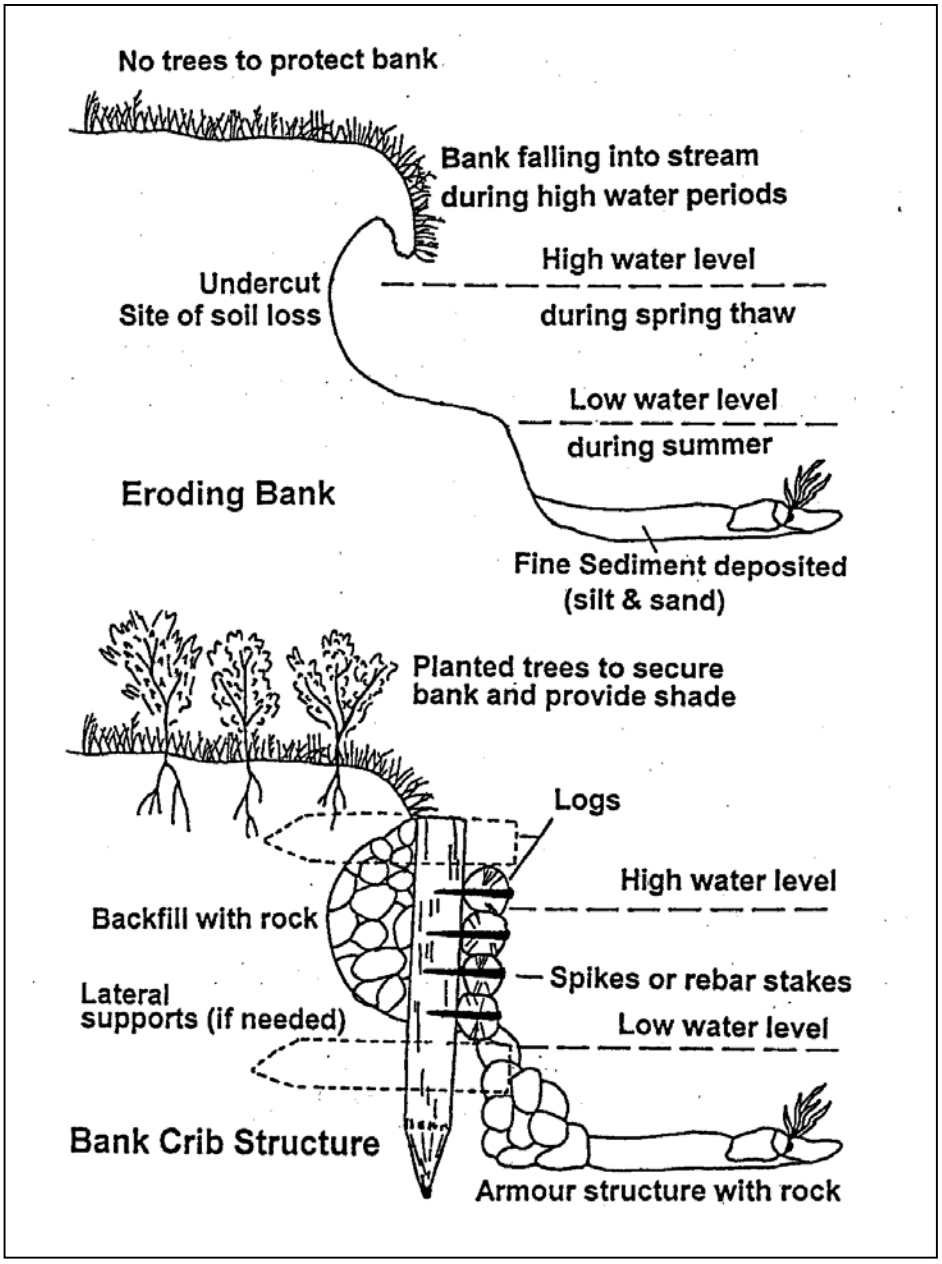
holes at regular intervals along their length. Bank cribs can be single or double (stacked), depending on the size of the stream.

- The rebar, stakes, and t-bars should be driven into the streambed as far as is reasonably possible. The depth of penetration should be 1 m; however, depending on the substrate, it may go down only 0.5 m, or to bedrock.
- One must be able to anchor the log to, or into, the banks and the stream bottom. Logs can be lodged against in-stream boulders, and/or rocked in at the banks.



Rocking the banks (Riprap)

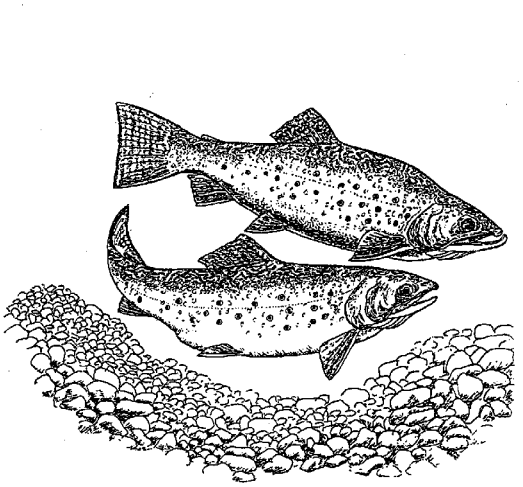
Large rock can be used effectively to prevent erosion. The rock must be of suitable size to reduce the susceptibility of washout. Planting trees and grass behind rock structures can be a good way of further stabilizing the bank and providing shade to a watercourse. Bank stabilization projects should be done no later than mid-summer to allow grass and trees to become established before the fall. To be effective, the type of riprap project has to be tailored to meet the requirements of the individual stream conditions**.**



Maintenance

As a part of an ongoing project, annual checks on stream bank enhancement areas are necessary to make sure that the techniques employed are functioning correctly. This will also provide a better knowledge of measures that worked, and help in future decision-making.

How to undertake a stream blockage removal project



Blockage removal can be an instream enhancement technique undertaken to improve access to spawning habitat for salmon and trout. Many spawning areas are located in the small streams of a river system, and access to these areas is important to trout and salmon populations. In the summer and fall of the year, adult trout and salmon swim upstream in search of suitable spawning sites. Salmon and trout have the ability to jump, move through, or underneath log jams and other natural woody debris piles, however, their journey may be stopped by the presence of blockages such as dams, hanging culverts, or improperly installed bridges. Once they reach a good spawning area, female fish will dig a depression or redd in the gravel/cobble stream bottom in late fall or early winter. The eggs are released into the redd and fall into spaces between the gravel/cobble. The eggs remain there in the redd all winter and hatch in the spring. Juvenile salmon and trout stay in the stream for about two years before they swim downstream to the sea or a lake. Some trout remain in fresh water, while other trout may become sea run. If the fish are lucky enough to survive to be adults, some will return and spawn in the same stream where they were born.

In the past blockage removal projects under the guise of "stream cleaning" or "stream clearing" projects often ended with less than positive results. Some stream projects undertaken in the 1970s, under the direction of government agencies, were set up simply to clear streams. Many systems were cleared of the important large woody debris (fallen trees, sticks, and brush piles) that provided shelter and protection for trout. The overall effect of this work is believed to be a decrease in trout habitat in some areas.

- The clearing of large woody debris from a stream is discouraged.
- If you are uncertain about using stream blockage removal as an enhancement option, contact an experienced stream enhancement technician for advice.

Know Your Watercourse

When planning any stream improvement project, an assessment of the present habitat conditions will determine if blockage removal will be necessary. This can be as simple as walking along a portion of a watercourse and looking for obstructions to fish passage. The number of hanging culverts, improperly installed bridges, old mill sites, and dams are the main considerations in deciding if a stream is a candidate for blockage removal.

Besides the physical considerations, understanding the chemical characteristics and temperature of a watercourse will help in preparation for an enhancement project. For instance, if acidity levels are high, then blockage removal will not be the answer to restoring a low trout or salmon population. In many stream systems in Nova Scotia, summer water temperatures may rise above 20°C. When this occurs, the trout may swim upstream to reach cooler areas of the watercourse. In this situation, it would probably be more beneficial to trout if enhancement efforts were directed at improving access to cool tributaries. Habitat information on local watercourses can be obtained from:

- The Nova Scotia Adopt-A-Stream Program, or related government agencies.
- Recording water temperatures in summer or taking pH (water acidity) measurements in spring and fall.
- Talking to landowners, community members, seniors, and anglers.
- Conducting a habitat survey in a section of the stream.

Landowner Support

About 70% of the land in Nova Scotia is privately owned, and although watercourses are public property, developing and maintaining a good relationship with community members is important. Therefore, permission should be obtained from landowners before starting any enhancement project on or near their property.

The General Rule of a Removal Project "IF IN DOUBT, LEAVE IT!"

Woody Debris

Natural accumulations of woody debris (fallen trees, sticks, or brush) very rarely function as a blockage to fish passage. Additionally, they support the plants and smaller animals, aid in pool creation, and provide shelter and protection from fish predators. As well as being important fish habitat, trees fallen across streams are sometimes used by small mammals such as squirrels, chipmunks, raccoons, bobcats, and porcupines, as a crossing. Therefore, the removal of natural woody debris from a stream is discouraged.

Streamside Vegetation

When undertaking any type of stream enhancement work, streamside vegetation should not be disturbed. Alder tangles that reduce flows and trap large amounts of silt and sand may appear as ugly, messed up areas of the watercourse and the silt and sand trapped in alder tangles can potentially reduce spawning habitat in the immediate area by covering gravel and cobble stream bottoms. However, one must look at the whole picture. The goal of the enhancement project

should not be to make the entire system suitable for spawning. Stream enhancement workers and organizers should understand that different stages of a fish's life cycle require different habitat types. At the egg stage, a gravel or cobble stream bottom is needed for survival, and at the juvenile stage, cover and food is more important. For this reason, silty, alder- tangled stream sections, while not suited for spawning sites, can be very important habitat for juvenile trout. The same can be said about stream sections where there are high numbers of fallen trees, sticks, and brush piles. As part of the overall picture, these alder tangled sections could be important nursery areas for young trout. Overhanging vegetation provides excellent cover for fish, and habitat for insects. Insects fall off overhanging vegetation, becoming part of the stream drift, and a food source for young salmon and trout.

Beaver Dams

Beavers are wetland creators. The dams they build create habitat for ducks, muskrats, insects, amphibians, and fish. Beaver have benefited salmon and trout populations more often than not. Recent studies have shown that beaver ponds function as important winter habitat for adult salmon and trout, and that beaver dams do not prevent downstream movement of juvenile salmon and trout in spring. Moreover, in dry summers, beaver dams sometimes create the main pool habitat in smaller brooks and streams. In the past, beaver dams were considered to restrict movement of salmon and trout, and were removed as apart of a stream enhancement project. Today the importance of beaver dams to the natural ecology of a stream is better understood and their removal is no longer considered an improvement. During low water periods in summer, beaver dams may block upstream movement of fish, however, this blockage is only temporary. When autumn rains come, stream water levels rise and water will flow over dams, allowing fish to swim to upstream areas to spawn. For these reasons, it is recommended that all beaver dams be left in place. The removal of beaver dams is also a concern for biologists at the Nova Scotia Department of Natural Resources (DNR). Permission has to be obtained from the DNR before a beaver dam is removed.

Human-Built Dams

Human-built dams have a headpond of water on the upstream side, which makes them dangerous to remove. Over the years, these pools collect large amounts of fine sediment, and removal of the dam causes this material to wash downstream if proper controls are not used.

- All human-built dams not currently maintained by the owners should be breached or removed. It is important that permission be obtained from the Nova Scotia Department of Environment (NSDOE) before the dam is altered in any way. Where the dam is to remain, every effort should be made to provide upstream fish passage.
- Dams, which have previously been breached and are now blocked with logs or trash may be cleared. Only the material causing the blockage should be removed. The existing dam structure must not be altered.

Hanging Culverts

A hanging culvert is considered a blockage if the distance between the downstream water surface and the culvert bottom is greater than 15cm. The distance is usually greatest during low water conditions in summer. Another problem may be the angle or slope at which the culvert was installed. If the slope of the culvert is high, then the water flow through the structure may be too fast for fish attempting to swim upstream. Baffles can be installed on the bottom of wooden bridges to reduce water speed and create resting areas for fish when they swim under the bridge. The Nova Scotia Department of Transportation and Public Works (NSDTPW) is responsible for maintaining fish passage through public road crossings, and they may be willing to work with enhancement groups to provide fish passage at problem sites. Possible solutions to blockage problems will involve a careful assessment by a stream enhancement technician and/or a stream-crossing engineer from the NSDTPW.

Unnatural Debris and Trash

Debris such as old railway ties, garbage, creosote bridge posts, and related unnatural materials should be removed as soon as possible. Automobile bodies may have to be evaluated, because more damage to the stream may result from their removal. Pop bottles, beer cans, plastic bags, and tires should be collected and disposed in a proper manner.

Materials

A brush axe, chain saw, and hand held saw are suitable tools for most stream projects.
For smaller streams, a work team of three able-bodied workers, properly equipped, makes for an efficient crew. They must know how to move heavy objects safely using bars and lifting with their legs, rather than straining their backs. One worker should have a chain saw and be experienced in its use.

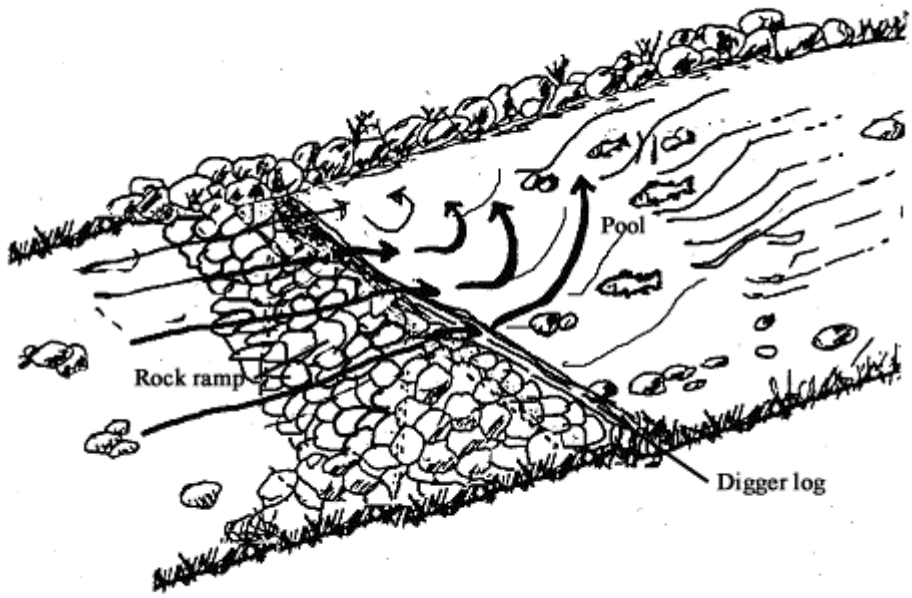
Maintenance

As a part of an ongoing project, annual checks on stream enhancement work are necessary. This will provide a better knowledge of what initiatives worked best, and help in future decision-making and planning.

HOW TO INSTALL A DIGGER LOG

Introduction

Digger logs can be used to improve stream habitat for salmon and trout. Diggers imitate natural wind fallen trees. When trees fall into a stream many wash downstream. Eventually the water flows over the tree and scours a pool on the downstream side. Pools are important holding areas for trout and adult salmon. In many Nova Scotia streams pool habitats are rare or missing. Harmful land clearing practices associated with forestry, agriculture, and other activities have resulted in the removal of trees that protected banks, and that would have eventually fallen into the stream. This loss of large woody debris means that an important element of trout habitat is missing. Loggers of large forested areas in the 1800s used rivers and streams to move their wood. Many streams and rivers were straightened and are now wider and shallower as a result of log driving and land clearing. The proper installation of digger logs can help trout and salmon populations by building new pools and cleaning fine sediments out of spaces between gravel particles, which are important hiding places for juvenile fish, and insects.



Know Your Watercourse

When planning any stream improvement project, an assessment of the present habitat conditions will determine if there are enough pools and deep holding areas. An experienced person can do this by walking along a portion of a watercourse and looking at the habitat quality. Under most natural conditions, meandering (S-shaped) streams will have riffle/pool sequences that are repeated every five to seven stream widths. The stream bottom is also a feature to consider, particularly, the amount of silt in its gravel. The bottom substrate has to be composed of softball sized or smaller rocks that will move with the scouring action of a functioning digger log. Large rock or bedrock bottoms are not suitable sites to install digger logs.

Besides these fairly obvious physical considerations, understanding the chemical characteristics and temperature changes of a watercourse will help to prepare for an enhancement project. For instance, if acidity levels are high, then installing digger logs will not be the answer to improving a low trout population. In many streams and rivers in Nova Scotia, summer water temperatures may rise above 20°C. When this occurs, trout may swim upstream to reach cooler sections of a watercourse. In this situation, it may be beneficial to the trout if diggers were placed in cooler tributaries that serve as summer refuges. In this way, more fish could survive through warm periods. Habitat information on local watercourses can be obtained from:

- The Nova Scotia Adopt-A-Stream Co-ordinator, or related government agencies.
- Recording water temperatures in the summer or taking pH (water acidity) measurements in the spring and fall.
- Talking to landowners, community members, and anglers.
- Recording the percentage of pool habitat and determining its quality.

Landowner Support

About 70% of the land in Nova Scotia is privately owned, and although watercourses are public property, developing and maintaining a good relationship with community members is important. Therefore, permission should be obtained from landowners before starting any enhancement project on or near their property.

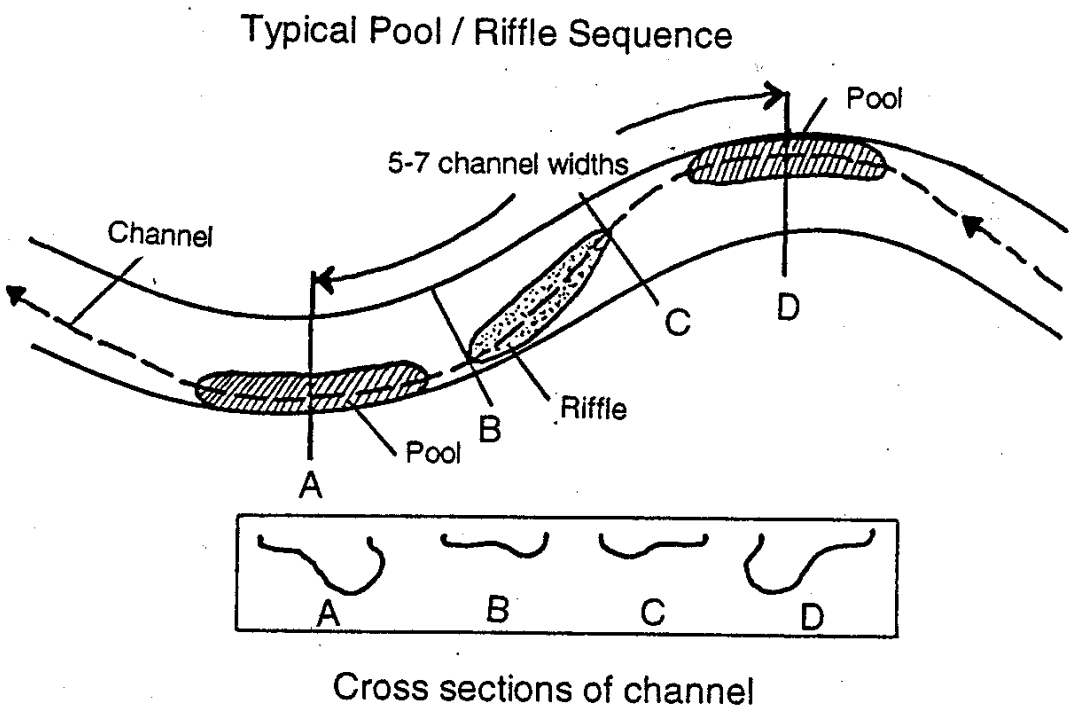
Site Selection

The most difficult part of choosing a site is in determining the natural channel width, and planning and laying out the pool-riffle pattern. The goal of many projects is to work with nature to help restore a natural meander pattern by adding large woody debris in the form of digger logs and/or deflectors. An understanding of the natural processes of a river, and considerable

experience, is required to layout a proper enhancement design. Improper installation of stream enhancement structures can cause stream bank erosion and siltation.

Each stream has its unique problems that may or may not be resolved with the design tools outlined below.

- Consultation with individuals experienced in stream enhancement technology is strongly recommended.
- Diggers work best on one to nine metres wide, low to medium gradient streams.
- Logs should be placed along the stream at distances of five to seven channel widths. In Nova Scotia, six channel widths appears to work well. In these cases, deflectors are often used to narrow the channel in combination with the digger logs.
- Channel widths are measured directly across the stream from vegetation on one bank to vegetation on the other bank, however, streams may be artificially wide after riparian clearing, pulp or log driving, and/or channelization. For design purposes use only channel widths measured in areas where there is still good pool riffle development.
- The first digger log should be located at the head of a good pool located on a bend, or laid out upstream and/or downstream from a stable bedrock pool, bridge/culvert, or similar feature. Several layout scenarios may be necessary in order to find and fit the natural pattern. The stream should be relatively stable, with banks that are well defined.



Work Team

For smaller streams, a team of three able-bodied workers, properly equipped, makes for an efficient crew. They must know how to move heavy objects safely, lifting with bars and their legs, rather than straining their backs. One worker should have a chain saw and be experienced in its use.

Materials and Alignment

The use of local materials (logs and rocks) makes the installation of digger logs cost effective. Digger logs should be placed, with rebar and/or rock, at a 30-degree angle from a direct line taken across the stream from bank to bank which means the log is one-half the channel width further up stream on the pool side. When a log is placed at an angle, it will direct moderate flows in the downstream direction that it faces. This downstream bank should be stable, or it may wash out.

- When rebar is used, logs should be pre-drilled, and rebar hammered through the drilled holes into the streambed at regular intervals along their length. The upstream end of the log should be 8.0cm to 15.0cm lower, so low flow goes over this end, into the pool.
- The use of 1.0cm to 1.5cm diameter rebar is recommended.
- The rebar should penetrate the streambed as far as is reasonably possible. The depth of penetration should be 1 m; however, depending on the substrate, you may get them down only 0.5m or to bedrock.
- After hammering the rebar to help hold the log in place, bend the 20cm to 30cm long end piece of rebar that remains exposed in a downstream direction.

Protect the Stream Bank

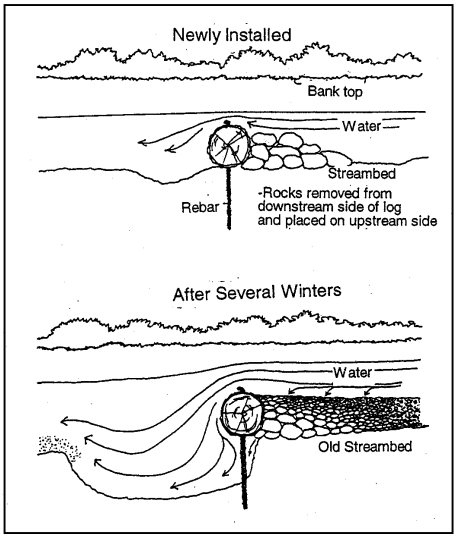
Whenever a structure is placed in a watercourse, there is a tendency for water to flow in the path of least resistance. If diggers are constructed at sites where the bank material is loose (clay or gravel/clay mixture), soil erosion could occur, especially during high flow periods. Rocks should always be used to armour the ends of the digger log.

- A digger log should be no more than one-third the height of the vegetated banks to which it is attached. If higher, it could reduce the flow capacity of the channel, and either wash out or divert the flow, causing bank erosion. Generally, the logs should be 15.0cm to 20.0cm in diameter, no larger.

Rock Ramp

The plunge pool created by a digger will have a natural tendency to undercut the structure. This may lead to the diversion of flow underneath the log, and subsequent structural collapse.

- It is important that a rock ramp be built up across the entire length of the log on the upstream side to deflect flows, ice, and debris over the log.



- The rock placed upstream from the log should be large enough to resist undercutting.

Fish Passage

Install the structure so that its lowest point is on the upstream end, which is also the side the pool will form, so low flows will enter the pool. If needed a notch can be cut one-third of the way across the log from the pool side to ensure passage during low flows.

Maintenance

As part of an ongoing project, annual checks on stream enhancement structures are necessary to make sure that structures are functioning correctly. This will also provide a better knowledge of what structures worked best, and help in future decision making

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Rock sill to create pools

Rock sills are used in the same way as digger logs. They are located in the same place at the head of a pool and aligned in the same way. They can have the lowest end, on the up stream and pool side, for fish passage, as with the digger log, but normally the low point is one-third of the way across from the pool side. The rock at the low point is set less than 7 cm above the bottom and the sill slopes up on a 3% grade toward both ends at the stream design width. At the design width you can place a deflector or bring the sill up on a 30% slope to the existing banks.

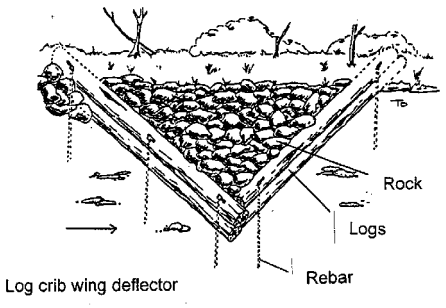
In small streams the sills can be built by hand using small angular boulders dug into the bottom, or on larger rivers they can be built using machines, large boulders or a riprap mix. Rock sills have been used mainly on larger rivers because they can be scaled up to any size where logs are limited in length and diameter. They have the disadvantage of not providing overhead cover for fish and tend to breach if the flow undercuts them. If you use sills, plan to return to the site in a couple of years to install instream cover in the pools for larger fish.

Regular checks and maintenance is thought to be reduced with rock sills, but both digger logs and sills have similar life spans if installed correctly.

Rock sills are not a guidelined restoration technique and require expert design and more detailed approval processes.

HOW TO INSTALL AN INSTREAM DEFLECTOR

Introduction



Log crib wing deflector

Instream deflectors can be used to reduce river and stream widths, deepening and improving habitats for salmon and trout. Deflectors function by diverting water flow and re-establishing natural stream widths, depths, and meander patterns, which may have been lost due to past land use. The natural meander (S-shaped) pattern of a stream is responsible for the variety of instream habitats, which benefit all age classes of salmon and trout. Harmful land clearing practices associated with forestry, agriculture, and other activities have resulted in the removal of large hardwood and some softwood trees that served to anchor the banks. Their large root systems had formerly served to protect banks from ice and erosion. In the 1800s large expanses of Nova Scotia's land base were cut. Streams and rivers were used for log drives, and straightened to improve the downstream transport of logs. Some streams remain wide and shallow as a result of these practices, and tend to flush after a rain.

The proper installation of instream deflectors can greatly benefit trout and salmon populations by restoring pools, and narrowing and deepening the channels.

Know Your Watercourse

When planning for any stream enhancement project, it is important to assess such factors as water depth, the number of pools, and stream habitat diversity. An experienced person can do this by simply inspecting the stream. The type of stream bottom, or substrate present, and the amount of silt through it should also be considered when deciding if a stream is suitable for deflector log installation. The stream substrate should be composed of rocks large enough (hard ball size or larger) to aid in securely anchoring the deflector. Besides these fairly obvious physical considerations, understanding the chemical characteristics and temperature fluctuations of a watercourse will help to prepare for an enhancement project. For instance, if acidity levels are high, then installing deflector logs will not be the answer to improving a low trout population. In many streams and rivers in Nova Scotia, summer water temperatures may rise above 20°C. When this occurs, trout may swim upstream to reach cooler sections of a watercourse. In this situation, it may be beneficial to the trout if deflectors were placed in cooler tributaries that serve as summer refuges. In this way, more fish could survive through warm periods. Habitat information on local watercourses can be obtained from:

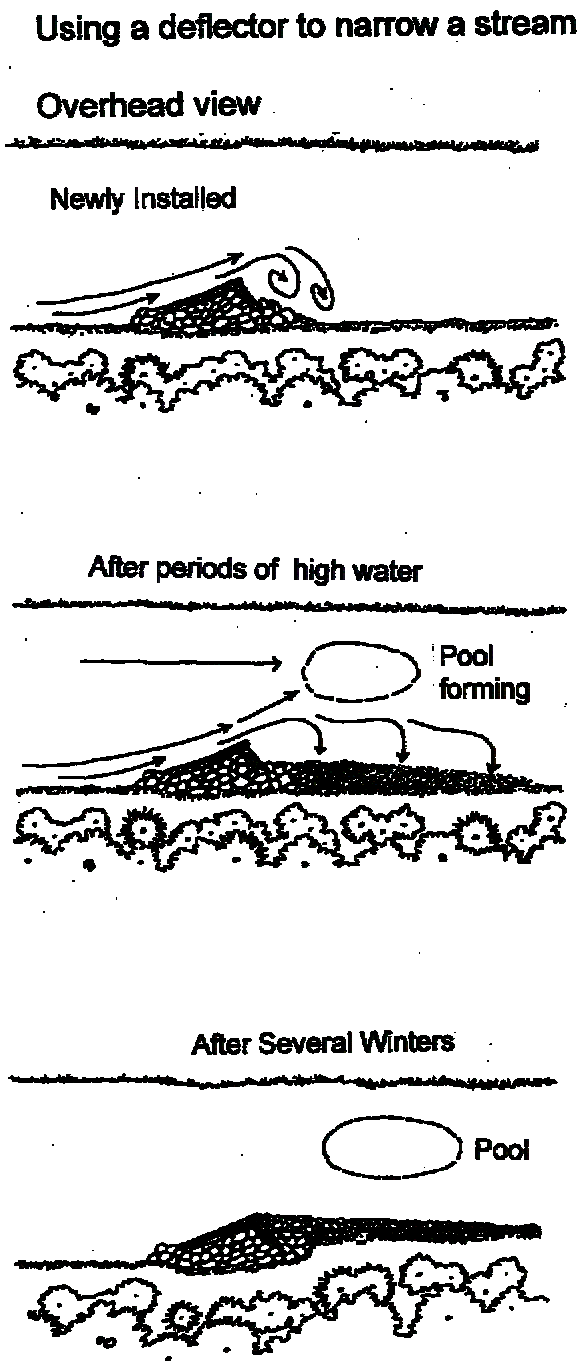
- The Nova Scotia Adopt-A-Stream Program, or related government agencies.
- Recording water temperatures in the summer or taking pH (water acidity) measurements in the spring and fall.
- Talking to landowners, community members, seniors, and anglers.
- Conducting a habitat survey in a section of the stream.

Landowner Support

About 70% of the land in Nova Scotia is privately owned, and although watercourses are public property, the development of a good relationship with community members is important. Therefore, permission should be obtained from landowners prior to starting enhancement activities on or near their property.

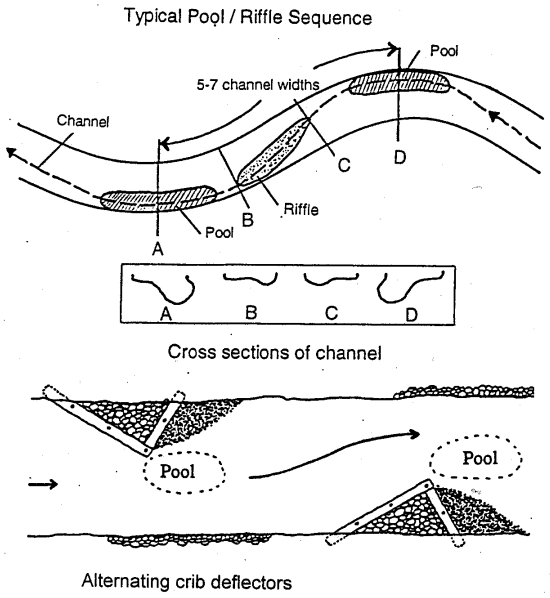
Site Selection

Site selection for a deflector is based on the same principles as for site selection for a digger log. The most difficult part of choosing a site is in determining the natural channel width and the pool-riffle pattern. The goal of these projects is to work with nature to help restore a natural meander pattern by adding large woody debris in the form of digger logs and/or deflectors. An understanding of the natural processes in a river, and considerable experience, is required to execute a good enhancement design. Improper installation of stream enhancement



structures can cause stream bank erosion and siltation. Each stream has its unique problems that may or may not be resolved with the design tools outlined below.

- Consultation with individuals experienced in stream enhancement technology is strongly recommended.
- Deflectors will work on most river and stream sizes with a low to moderate gradient (less than 3.0% slope).
- Logs should be placed along the river or stream at distances of five to seven channel widths. In Nova Scotia, six channel widths works well, however, streams may be artificially wide after land clearing, pulp or log driving, and/or channelization.
- Deflectors can be used with digger logs to help develop the natural pool/riffle sequencing of a watercourse.
- Channel widths are measured directly across the stream from vegetation on one bank to vegetation on the other bank.
- Initial sighting for the first deflector is at the head good pool on a bend, or measured upstream and/or downstream from a stable bedrock pool, bridge/culvert, or similar feature. The stream should be relatively stable, with banks that are well defined.
- Deflectors are placed with their downstream log at the same place and angle as a digger log would start out, on the downstream end of the log. Deflectors start a point bar and place the pool on the opposite side and bit further down stream that a digger log would. They are often placed on the downstream end of a digger log to help lengthen the pool.



Work Team

For smaller streams, a team of three able-bodied workers, properly equipped, makes for an efficient crew. They must know how to move heavy objects, safely lifting with bars and their legs, rather than straining their backs. One worker should have a chain saw, and be experienced in its use.

- Talking to landowners, community members, seniors, and anglers.
- Conducting a habitat survey in a section of the stream.

About 70% of the land in Nova Scotia is privately owned, and although watercourses are public property, the development of a good relationship with community members is important.

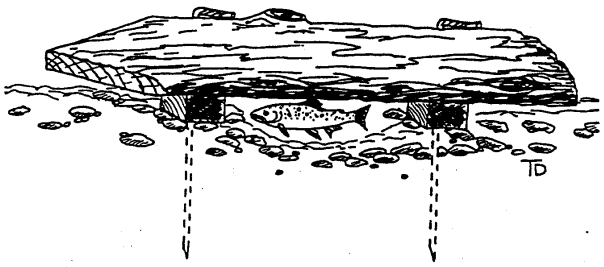
Therefore, permission should be obtained from landowners prior to starting enhancement activities on or near their property.

Maintenance

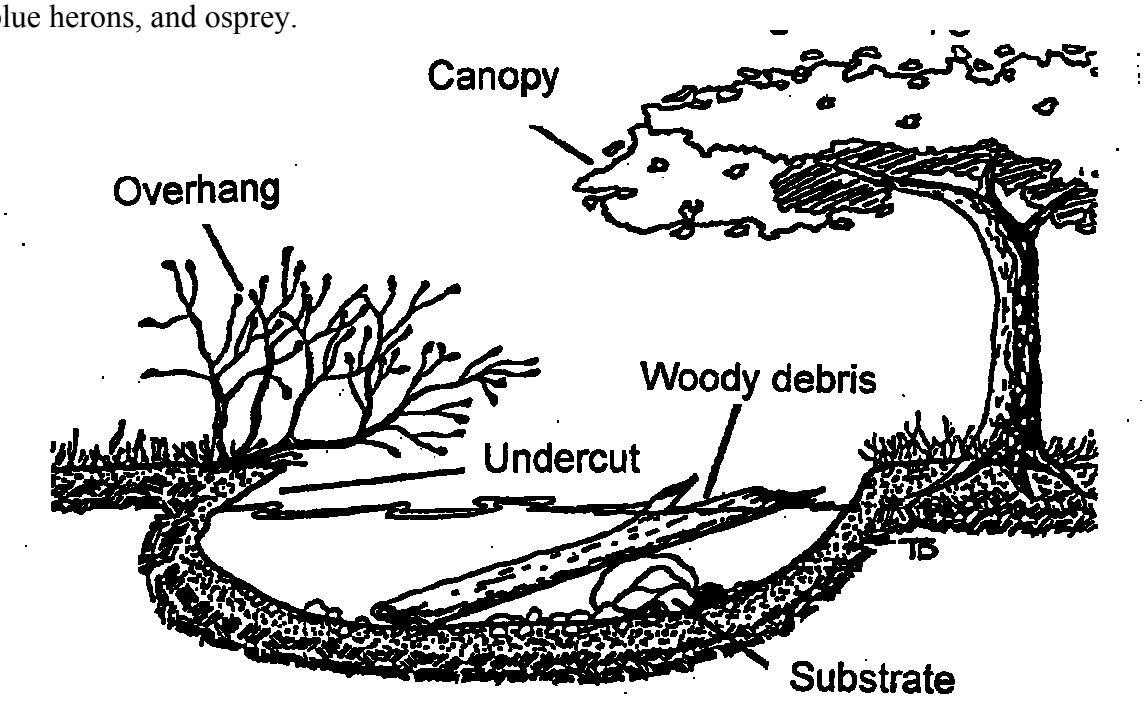
As part of an ongoing project, annual checks on stream enhancement structures are necessary to make sure that structures are functioning correctly. This will also provide a better knowledge of what structures worked best, and help in future decision making.

HOW TO INSTALL AN INSTREAM COVER LOG

Introduction



Cover logs can be used to improve salmon and trout habitat. Cover habitat provides trout and salmon with shelter and protection from predators. More cover means more fish in a stream. This is provided naturally by large woody debris (fallen trees and root wads), aquatic vegetation, undercut banks, and overhanging shrubs. Land clearing practices associated with forestry, agriculture, and other activities have resulted in the removal of streamside trees, and, in the process, have reduced the sources of valuable instream large woody debris. Further impacts of land clearing are bank erosion and stream widening. Increased stream width has resulted in more surface area exposure to sunlight and a reduction in the shaded cover habitat. The proper installation of cover logs can increase the number of hiding places from predators such as kingfishers, great blue herons, and osprey.



Know Your Watercourse

When planning for any stream enhancement project, an assessment of the present habitat conditions will determine if there is enough natural cover, water depth, and variety of stream habitats. An experienced person can do this by walking along a section of a watercourse and visually assessing the stream habitat. The type of stream bottom is also a feature to consider when deciding if installing cover logs will work. The stream substrate should be composed of loose material into which the log can be securely anchored.

Besides these fairly obvious physical considerations, understanding the chemical characteristics and temperature changes of a watercourse will help to prepare for an enhancement project. For instance, if acidity levels are high, then installing cover logs will not be the answer to improving a poor trout population. In many streams and rivers In Nova Scotia, summer water temperatures may rise above 20°C. When this occurs, trout may swim upstream to reach cooler sections of a watercourse. In this situation, it may be beneficial to the trout, if cover logs were placed in cooler tributaries that serve as summer refuges. In this way, more fish could survive through warm periods. Habitat information on local watercourses can be obtained from:

- The Nova Scotia Adopt-A-Stream Program, or related government agencies.
- Recording water temperatures in the summer or taking pH (water acidity) measurements in the spring and fall.
- Talking to landowners, community members, seniors, and anglers.
- Conducting a habitat survey in a stream reach.

Landowner Support

About 70% of the land in Nova Scotia is privately owned, and although watercourses are public property, the development of a good relationship with community members is important. Therefore, permission should be obtained from landowners prior to starting enhancement activities on or near their property.

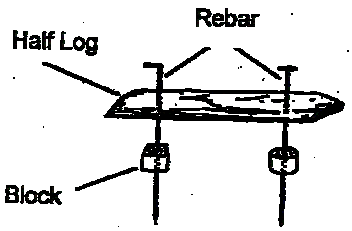
Site Selection

Cover logs should be placed in relatively shallow water (less than 1 m depth). The log should be secured to a relatively stable stream bottom or substrate. Moving bottom rocks, smaller than hardball size, may result in a cover log being buried or lost. Usually restoration work is undertaken during low flow periods, which means workers might not have an appreciation of high water conditions. The power of high water flows and ice in spring may dramatically alter the appearance of a watercourse. Bare, high gravel/cobble bars or altered channels may serve as indicators that cover log installation would not work. This should be kept in mind when selecting a location for any enhancement activity. Cover logs should be placed in open stream

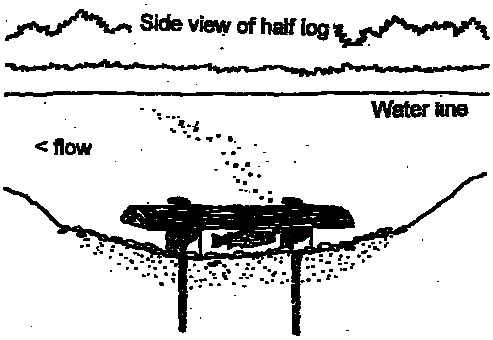
sections where shelter appears to be limiting habitat usage by trout and salmon. Improper installation of stream enhancement structures can cause stream bank erosion and siltation

Work Team

For smaller streams, a team of two or three able-bodied workers, properly equipped, makes for an efficient crew. They must know how to move heavy objects safely using bars and lifting with their legs, rather than straining their backs. One worker should have a chain saw and be experienced in its use.



Materials and Alignment



The use of half logs with bark still intact will give a natural appearance to enhancement work. Bark will protect the cover log from ice scour and debris, and increase its life span. Local saw mills are usually the mostpopular sites to obtain half logs or wood slabs.

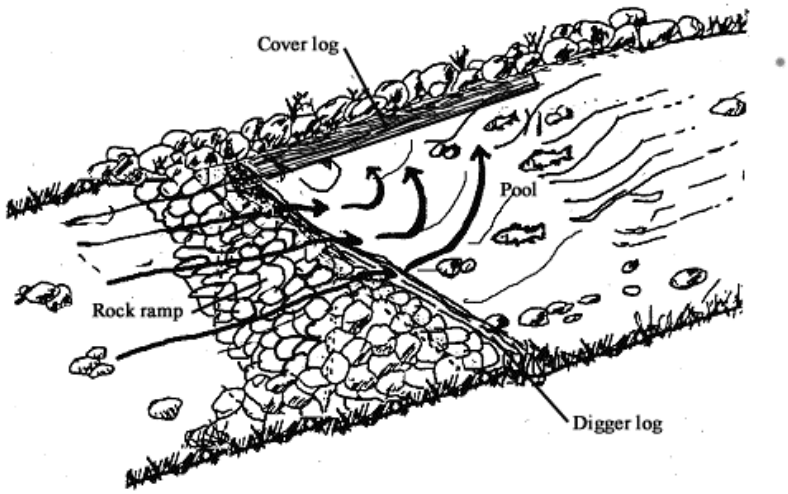
- Half logs and supports should be pre-drilled, and rebar hammered through the drilled holes into the streambed.
- Supports for cover logs should be about 10cm to 20 cm tall in order to provide enough space for fish to hide.
- Half logs are commonly 2m long, 20cm to 30 cm wide, and at least 5cm thick.
- Half logs over two metres long may require a middle support to increase durability.
- 1.0cm to 1.5cm diameter rebar is recommended.
- The rebar should penetrate the streambed as far as reasonably possible. The depth of penetration should be one metre; however, depending on the substrate, you may only get them down to 0.5m, or to bedrock.
- To help hold the log in place, bend the 20cm to 30cm rebar length that remains after hammering in the direction of the stream flow.
- Cover logs should be placed in depths of 30cm to 100cm. Placement of structures in shallower waters may result in damage from debris or ice.

Digger Log/Cover Log Combinations

In most cases, stream enhancement involves the use of different structures to maximize results. Cover logs have been used in combination with digger logs to improve cover after the digger has scoured a pool. Cover logs should only be placed in a pool one or more years after the digger log has been installed.

Additional Cover Enhancement

A watercourse is usually in a constant state of change. Streamside trees often fall in the watercourse and eventually are carried downstream, coming to rest along the banks or in a pool. During the planning stage of the project, it may be useful to map out the deadfall locations. Then decide which ones can be secured in place, or moved to a more suitable location and secured in place. Careful consideration has to be used, because some deadfalls may be protecting the bank, and, therefore, are better left in place and/or secured.



- Strong cable can be used to anchor deadfalls to a suitably sized tree on the bank.
- Rebar can also be used to secure a deadfall in place.
- Do not remove a log that may be protecting the bank from soil erosion or soil loss.

Maintenance

As a part of an ongoing project, annual checks on stream enhancement structures are necessary to ensure that structures are functioning correctly. This will also provide a better knowledge of what structures worked best, and help in future decision making.

9.5. Fishways

Fishways provide fish that migrate upstream with a means to pass natural or man-made obstructions. They are required by law where the Federal Minister of Fisheries and Oceans determines it to be necessary (see **Laws and Regulations**).

Fishways usually consist of a series of steps with baffles that slow the water to a speed such that fish can pass upstream. Fishways may be used to open up new areas suitable for spawning and rearing that have been previously inaccessible, or they may assist fish in reaching traditional spawning areas.

The placement of the entrance to the fishway is important. Some fish may be reluctant to climb it, or may not be able to find it. The entrance should be located where fish tend to gather, at the base of a dam or waterfall. Each species has its own preferred migration flow that dictates their route. Fishway flows must intercept these differing routes and provide suitable attraction.

The two most common types of fishways are the vertical slot fishway and the pool-and-weir type.

The vertical slot fishway consists of a flume with partitions and may be single or double slot, creating a series of stepped pools and drops. Water flows from pool to pool through narrow slots that extend the full height of the partitions. This type of fishway is self-adjusting to changes in stream flow level and volume.

The pool-and-weir type, or "fish ladder", consists of a series of vertical partitions, each slightly lower than the one above it, installed at intervals down the length of the flume. Water flows over the top of the partitions, creating pools. This fishway is most effective on streams with a fairly stable flow.

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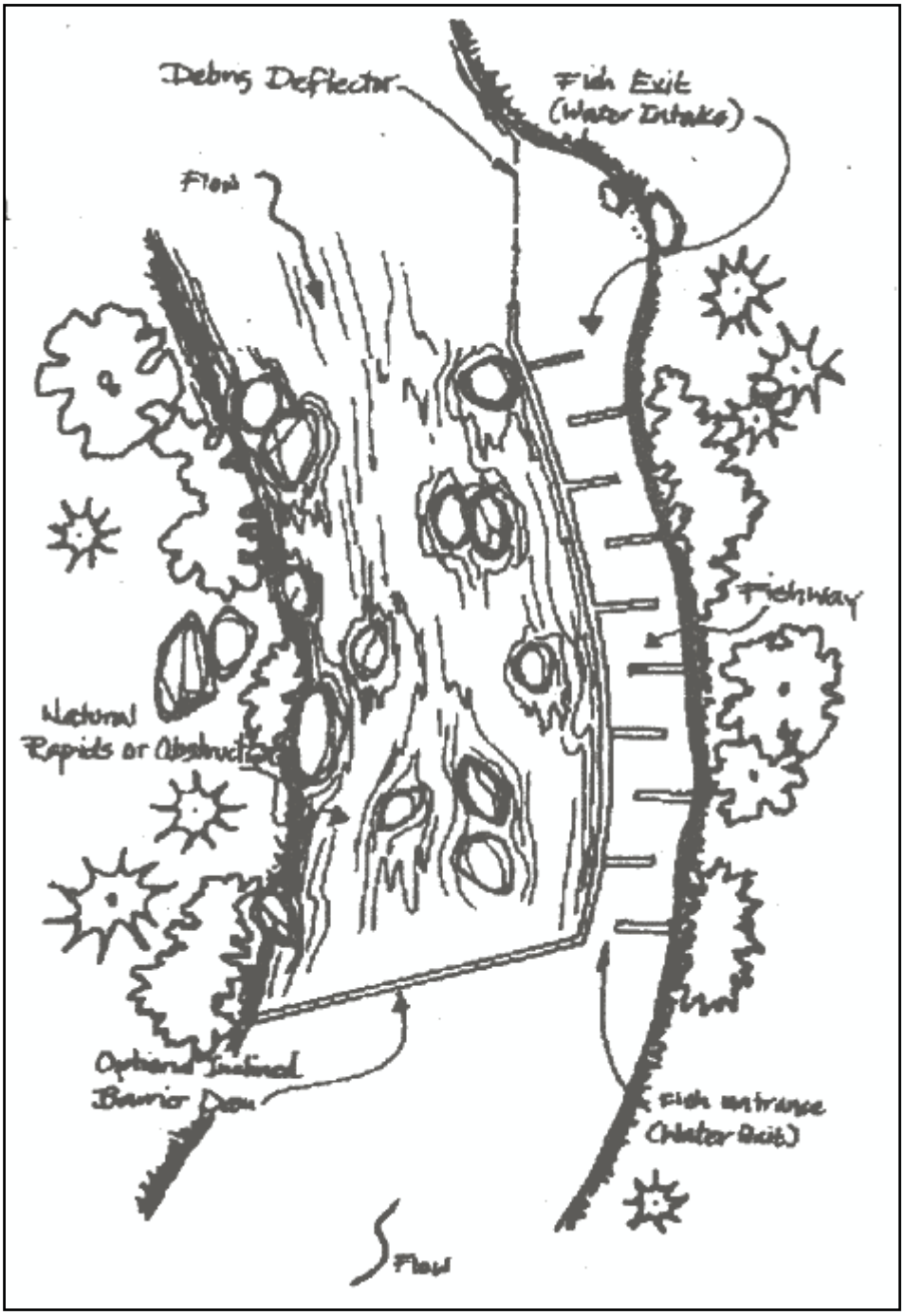
Debris Deflector
Fish Exit
(Water Intake)
Flow
Fishway
Natural
Rapids or Obstruction
Orchard Inclined
Barrier Dam
Fish entrance
(Water Exit)
Flow

9.6. Fish Screens

The Fisheries Act (see **Laws and Regulations**) says that every water intake, ditch, channel, or canal must have a fish screen if habitat officials find it to be necessary. Water is commonly diverted from streams, rivers and lakes for industry, household uses, irrigation, and hydroelectric generation. This diversion is a potential source of injury and death to fish. Several types of screening have been designed to prevent fish from entering these water intakes. One of the principal design considerations is to ensure a means of escape for the fish that accumulate in front of the screen. Another is to provide clear access to the escape area, to keep it free from debris, and to clean the screen itself. Government agencies responsible for the fishery resource are available for consultation and assistance in designing and constructing screens.

*Humans have a tendency to want everything in the natural world to look neat and orderly. This has led to some well-meaning groups trying to improve streams by **removing everything,** including rocks, logs, and all vegetation on the side of the stream. Be careful what you remove!*

9.7. Cleaning up a Watercourse

Logs and debris can create important pools. Obvious garbage such as bottles, cans, drums, plastic and paper should be removed. Trees, stumps, logs, branches, and rocks should be considered carefully. There will be many instances where you will have to decide what is habitat and what is non-essential debris. The answer is not always clear even to a well-trained eye. Sometimes, for example, old tires can be re-used for a useful purpose.

Try to decide the long-term effects of removing an item. Will you increase erosion? Are you removing cover, or a food source? If in doubt, get help from a DFO professional.

Remember that plants along the watercourse are extremely important to the life in the stream. A carefully manicured lawn beside the stream may look attractive, but can cause severe erosion during a storm and bring unneeded fertilizers and toxic herbicides into the water. Overhanging grasses, hedges and shrubs provide shade for the stream, stabilize the banks, attract insects as food for fish, and provide food and shelter for wildlife. Try to disrupt this type of growth as little as possible.

A principal goal is to keep the stream in as natural a state as possible. When you are walking in the water or along the edge, remember you are walking in the home or habitat of many creatures; treat this home with the same respect you would treat your house.

Here are some general rules for conducting a clean-up:

- **Work in pairs or teams**.
- **Where possible, recycle items** found in your clean-up. For example, old tires may be used to stabilize a bank or a bridge area.
- **Make sure all obvious garbage is completely removed** from the area. Your work will involve some trips to the local dump.
- **Leave trees that have fallen across** the stream. These are used as bridges by small land animals and eventually may fall into the stream, helping to create fish habitat by encouraging the formation of a pool.
- **Don't remove trees and logs in the stream** unless they are causing erosion or the stream to change its course. Have a trained professional teach you how to identify damaging natural debris in the stream.
- **Don't trample the work area.** Try and use the same path along the stream bank for travel.
- **Don't add to the watercourse's problems** while you are solving them! Watch out for eroding banks and amounts of silt you may put in the watercourse. Watch that members of your group, especially children, don't slide down banks with loose or sandy soil.
- **All work in the stream or along its edge should be carried out between June 1 and September 31.**
- **Document what you take out of the watercourse**. If you are cleaning a coastal area, the Clean Nova Scotia Foundation may be interested in having you fill out a form as part of their beach clean up (see **Where to Go for Help).** Your records will help others who are dedicated to improving the environment throughout the province.
- **Place trashcans in areas that are used frequently**. This will reduce the need for future cleanups. Someone may have to regularly collect the garbage. Children may want to paint signs encouraging people to not litter.
- **Watch for bird's nests on the banks in spring cleanups**. If birds fly overhead frequently, or fly out of a bush there may be a nest nearby. Treat these areas carefully. If a nest is discovered, leave it undisturbed and do not return regularly to look at it. You will create a path that can be easily followed by a raccoon or fox.
- **Never drive a vehicle (ATV, tractor) in the stream** to help remove debris. This is

illegal and can cause serious damage to the stream bottom.

- **Take "before" and "after" photographs**. These can be used to educate the community about littering and are useful to show funding agencies some documentation of your work.

SAFETY CONSIDERATIONS

Most of these points are common sense but they're worth repeating to everyone in your group!

- Tell someone where you'll be.
- Wear gloves to avoid cuts from glass or rusty metal.
- Wear hip waders or rubber boots.
- Don't go bare foot!
- Use the "buddy system" - don't work alone!
- Don't operate electrical equipment close to water.
- Don't work in lightning storms.
- Walk carefully. Many rocks are covered with algae and can be very slippery.
- In large rivers and lakes make sure people don't get in water that is deeper than they can handle.
- When using boats or working around the water, always wear a life jacket.
- If you are working in areas with deep and/or fast-moving water, you should have some knowledge of basic water safety and rescue procedures.
- Always keep a long branch or stick close-by to reach out to someone who may need assistance. Think before you jump in after someone. Many people drown trying to save someone else.
- Wear sunscreen and a hat to protect yourself from damaging ultra-violet rays.
- Keep a first aid kit near the working site.
- Have an emergency plan for getting help if you are working in a remote area.
- Carry a cell phone.

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Document Your Work

Where possible document your work by using slides, photographs, and video. Keep minutes of your meetings and a logbook of activities to help you write a yearly summary and report.

Documenting your work is valuable for the following reasons:

- Your slides and photographs will help to publicize and promote your program as well as the benefits of good stewardship around watercourses.
- You will develop a Natural History record for your community that will be useful for other projects in the future.
- You can use the documentation to get funding for future projects.
- Groups and volunteers are more inclined to continue working if they develop a sense of pride. Documentation shared with the community (either through newspaper articles or slide presentations) helps develop this pride.
- Groups in other parts of the province who decide to join the Adopt-A-Stream program will be able to benefit from your experience. A visual and written record of your project will be an inspiration and a practical guide.

9.8 Protecting the Habitat and Fishery Resource

River Watch

An important part of the stewardship of a watershed is involving the community of people who live and work in the watershed in its protection and the protection of its resources.

The Nova Scotia Inland Fisheries Advisory Committee (IFAC) has a program called River Watch with a guidebook and training. River Watch is a cooperative program between government and private citizens. The program allows opportunity for enthusiastic and willing people to take responsibility for that part of the environment that they value.

The overall objective of the River Watch program in Nova Scotia is to help the government carry out its mandate to protect aquatic habitats throughout the province, by providing sufficient information for participants to develop an ecosystems approach to the recreational fishery and encourage anglers, landowners, and other members of the general public to join government in the enforcement of regulations designed to protect fish and their habitats.

Further information and materials are available through the NSSA Adopt-a-Stream coordinator.

9.9 Community Education and Awareness

One of the best ways to change attitudes is to get youth involved in activities which teach them about the ecosystem they live in and give them a feeling of responsibility and stewardship ownership.

There are two programs available; one is Fish Friends. The Atlantic Salmon Federation, in cooperation with the Nova Scotia Salmon Association and its affiliate network, delivers its Fish Friends Educational Programs to students in grades 4, 5, and 6.

Students learn about the life of salmon and other aquatic creatures in marine and freshwater ecosystems. Activities teach youngsters important conservation and environmental lessons in a hands-on classroom setting. Over a five-month period (February through June), students absorb information about the life cycles of fish, aquatic habitat, and such concepts as bio-diversity, change over time, adaptation, sustainability, and stewardship.

The premier Fish Friends program is its egg incubation unit in which live fish hatch and grow right in the classroom. At the end of the program, students release their fish into streams near their school.

For further information see

http://www.asf.ca/fishfriends/index.html

A River Rangers program has been developed by the Sackville Rivers Association (SRA) to provide additional school activities that complement the Fish Friends program. They have developed a manual that is intended to be used as a resource by teachers. Teachers without aquariums or teachers outside the Sackville area can still use many of the activities and information contained in this manual.

SRA began this project to create an awareness of the problems that affect the Sackville River and its watershed. It was envisioned that an awareness program targeted at the elementary grades would have the best long-term benefits for the environment. For further information on this Fall program contact the SRA.

9.10. Dealing with the Media

You should plan to publicize your work through your local media.

Press Releases

A press release is an announcement to the media community about an activity, event, or program. By doing a press release you are indicating that you are doing something that is newsworthy. Sometimes a reporter will call or visit to ask more questions about the release. Sometimes the press release is printed exactly as you send it in, and other times a new story is

written using the information in it. A sample press release is contained in the section **Presentation/Press Materials**. You may use this press release word-for-word and substitute the appropriate information. If you want to prepare your own press release, use the sample as a guide. The best way to get continual press coverage is to have the local radio/newspaper/TV media involved in the work.

Community Bulletins

Most TV and Radio stations schedule regular free announcements usually called Community Bulletins. You can use Community Bulletins to advertise meetings. Announcements should be short and simple, no more than a few lines.

Invitations to the Press

You should think about inviting the press to observe your group at work. Invite them on a day when you think there might be good opportunities for taking photos. Make sure you give clear directions about where you'll be, and be there when you say you will. Often reporters have busy schedules. Make sure to tell them if they need special clothing or footwear.

TEST YOUR KNOWLEDGE!
HOW WELL HAVE YOU READ THIS SECTION?

TRUE AND FALSE QUIZ

	True	False
1. Sometimes a simple activity like planting trees along a riverbank can help the watercourse immensely.		
2. Special structures that are placed in the stream to help build pools can be placed just about anywhere to be effective.		
3. A digger log is placed in the stream to help create a pool		
4. A deflector is a device that helps to keep the sun deflected out of the water.		
5. A fishway is a way to help fish move past obstructions.		
6. Logs and other debris should always be removed from a stream.		
7. Grass that is kept well-trimmed is an ideal situation for the edges of streams.		
8. All work in the stream should be carried out before May.		

ANSWERS CAN BE FOUND AT THE END OF THIS MANUAL