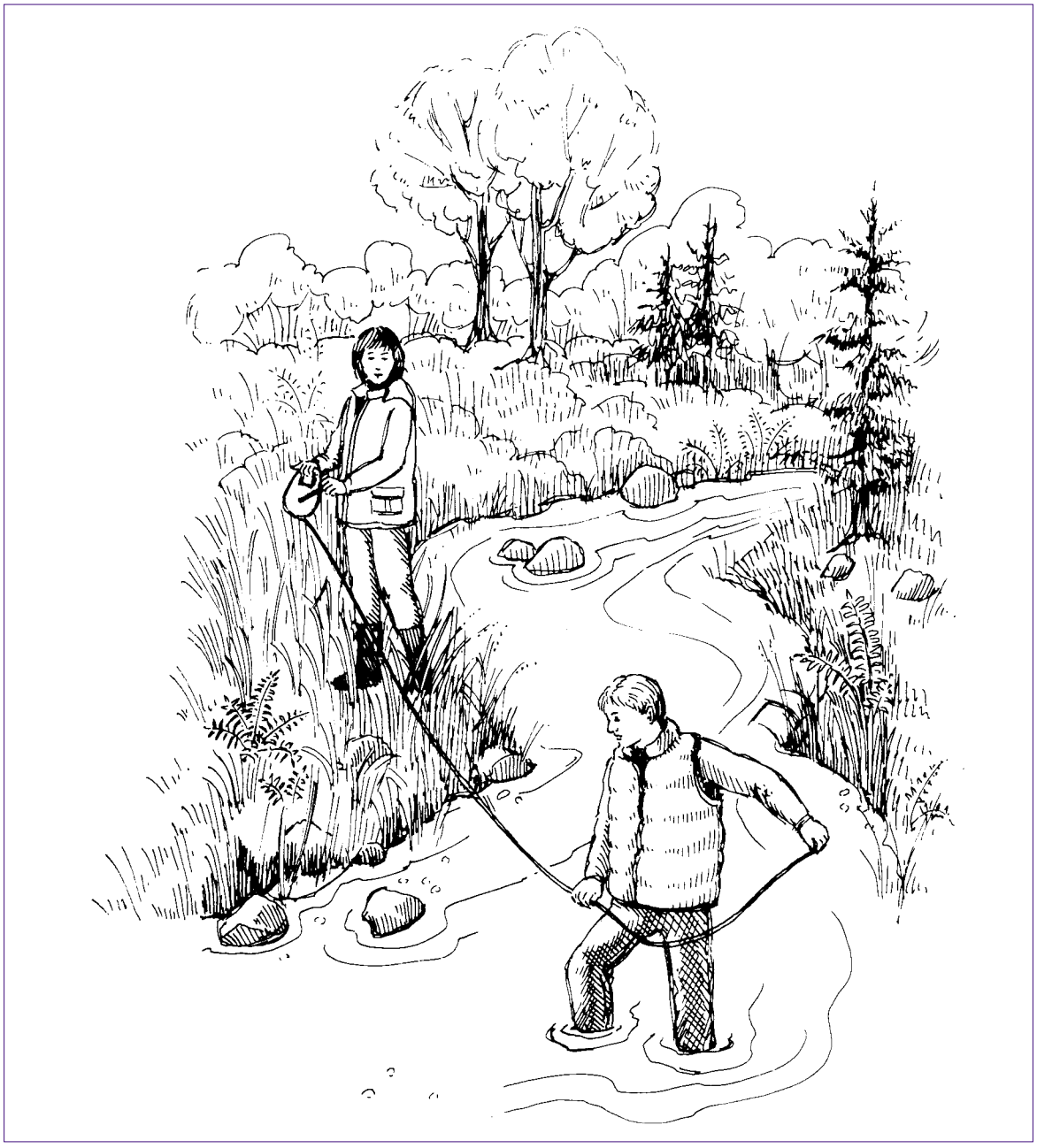
The **Stewardship** Series

The Streamkeepers Handbook

A Practical Guide To Stream And Wetland Care



Canada

Province of British Columbia

Appendix 1
COMMON HABITAT RESTORATION TECHNIQUES

Check Table 3 for the references that provide detailed instructions for these projects. This appendix provides a quick overview of the projects, where to use them, and their advantages and disadvantages. Many of the drawings have been adapted from the publications listed in the reference section. **All the techniques except streamside planting and fencing require technical assistance with project design.**

1. STREAMSIDE PLANTING

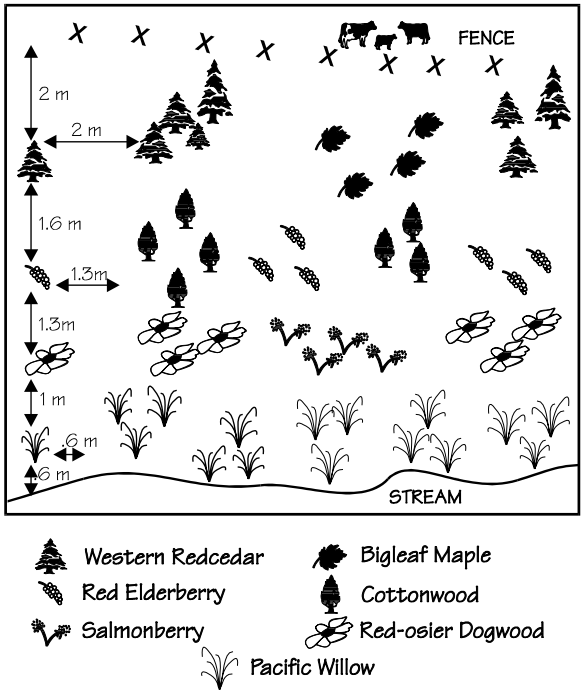
a) the project: Module 7 and other references describe streamside planting in detail. You plant cuttings or seedlings of native species along unvegetated or sparsely vegetated stretches of the stream banks. Other stream improvement projects often include planting.

b) where to use it: Plant on any streambank that lacks sufficient natural vegetation. Use native species adapted to local climate and soil conditions. You may need to stabilize or grade the banks first if the slope is greater than 2:1.

c) advantages: Planting stabilizes the banks and reduces erosion, shades and cools the stream, and reduces the amount of sediment and pollutants entering the stream from runoff. It provides cover for fish, helps moderate stream flows and flood levels, and attracts wildlife and salmonid food species. The project is relatively inexpensive. You can take cuttings from nearby plants adapted to local conditions.

d) disadvantages: You may attract unwanted weed species, so you will need to do some maintenance. Some species are hard to propagate, particularly from cuttings.

Example of a Planting Plan



2. STREAMSIDE FENCING

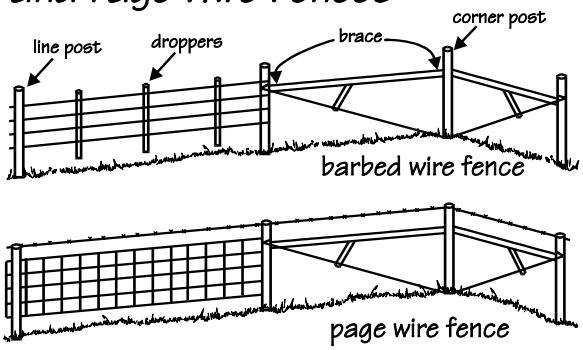
a) the project: Module 8 and other references provide instructions on building fences along streams. You build these fences along the stream corridor to protect stream banks, vegetation, and the stream itself. This is a good project to combine with a streamside planting project in agricultural areas, although the stream and banks also will recover slowly if left alone.

b) where to use it: Build fences in areas where livestock have unrestricted access to the stream. If you have limited resources, start with productive salmonid habitat such as spawning areas.

c) advantages: Fencing restricts livestock access to the stream, which stops further bank erosion and allows vegetation to grow back. It also improves water quality by reducing inputs of sediment and animal wastes. The advantages described for streamside planting also apply.

d) disadvantages: You must consult with landowners and have their approval. Since many landowners do not want to change old practices, you may need to explain how fencing will benefit them. The project can be expensive, especially for long, meandering streams. You may need to provide alternate water sources for livestock. You need to inspect and maintain fences regularly.

Examples of Barbed Wire and Page Wire Fences



3. ROCK RIP-RAP

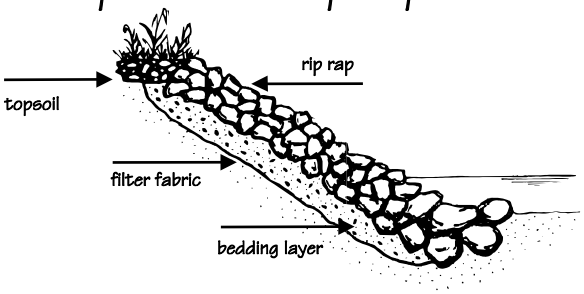
a) the project: You place hard angular rocks (e.g., granite) of various sizes so they lock together along the banks. This protects the banks and stabilizes the soil. You can use rip-rap to prevent other stream improvement structures from being washed away.

b) where to use it: Use this technique in areas where streambanks are eroding and are composed mainly of sand or fine sediments. You can use it in wide channels with low habitat diversity. Rip-rap works best on banks with slope less than 2:1 and on streams with maximum water velocity less than 4.0 m/sec.

c) advantages: Rip-rap is stable at most flow levels, very durable, straight forward to install and easy to maintain, and can improve habitat for fish and other aquatic organisms when installed with that objective in mind.

d) disadvantages: You need to use heavy machinery for most construction phases. Large projects are costly to install. Rip-rap looks unnatural, restricts natural channel movement, and can cause erosion problems upstream or downstream when installed improperly. It is difficult to establish vegetation on rip-rapped banks.

Example of Rock Rip Rap



4. SPILING AND WATTLING

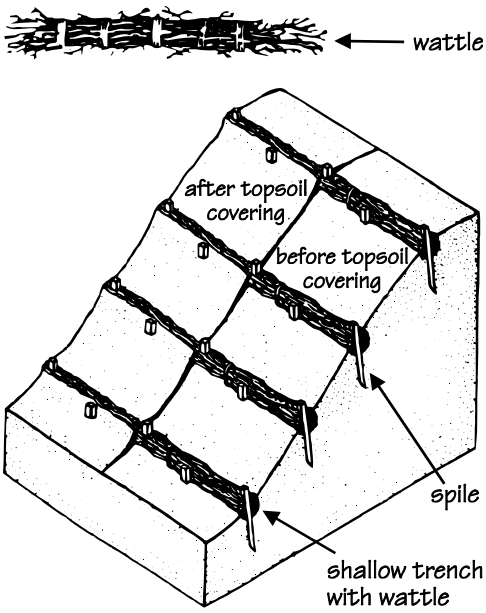
a) the project: You can use spiles and wattles to stabilize banks. Wattles made of willow cuttings are woven through spiles, or anchor posts, on the bank. The "wall" of willow cuttings takes root, grows, and stabilizes the bank.

b) where to use it: Install spiles and wattles to stabilize eroding stream banks.

c) advantages. This is a relatively simple and inexpensive method to stabilize eroding banks. The woven network of stakes and willow whips provides short-term structural stability until the willows develop root networks along the bank.

d) disadvantages: You can use spiles and wattles only on stream banks with low and moderate flows. You need to do some follow-up maintenance.

Spiles and Wattles



5. TREE REVETMENTS

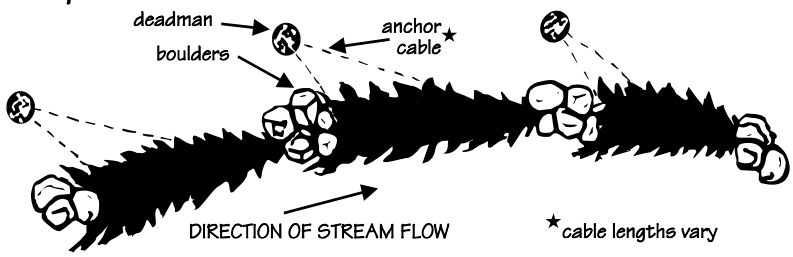
a) the project: You groom the stream bank to a slope no greater than 2:1 and cable durable green coniferous trees, such as cedar and pine, to the bank. The tree tops rest in the stream and are anchored in place. The branches dissipate stream energy that otherwise would erode the bank. Sediments settle behind the branches and begin to rebuild the bank. After establishing the revetment, you should plant the banks.

b) where to use it: Use revetments to protect rapidly eroding stream banks.

c) advantages: Revetments dissipate stream energy at the erosion site without narrowing the stream channel. They create new fish habitat and often attract juvenile fish. They also provide stable areas where new vegetation can become established.

d) disadvantages: You need heavy equipment to groom the bank. Further erosion may occur upstream or downstream of the trees. The revetment lasts only five to ten years, so you should ensure that bank vegetation grows back.

Example of Secured Trees for a Tree Revetment



6. LOG CRIBS

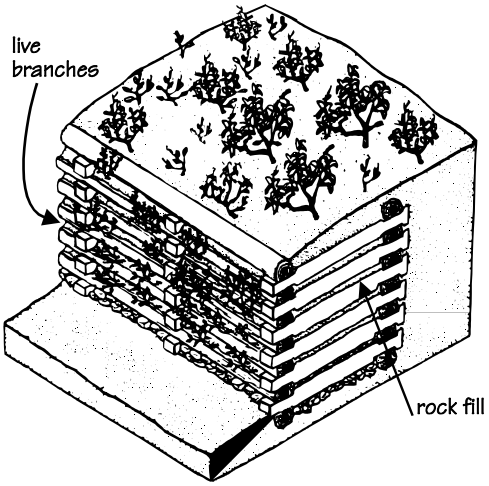
a) the project: You add a log wall, crib-style, to protect eroding banks and provide cover for fish. You should plant vegetation on the top of the wall behind the crib and on the vertical surface.

b) where to use it: Install log cribs in streams with eroding banks and with low to moderate gradient, flood flows, and banks.

c) advantages: Cribs provide excellent protection from bank erosion and require little maintenance. They increase habitat diversity for juvenile fish and decrease sedimentation in the stream.

d) disadvantages: They are time consuming, labour intensive, complex and costly to build. They last five or more years, depending on the materials used.

Example of a Log Crib



7. LOG BANK COVER

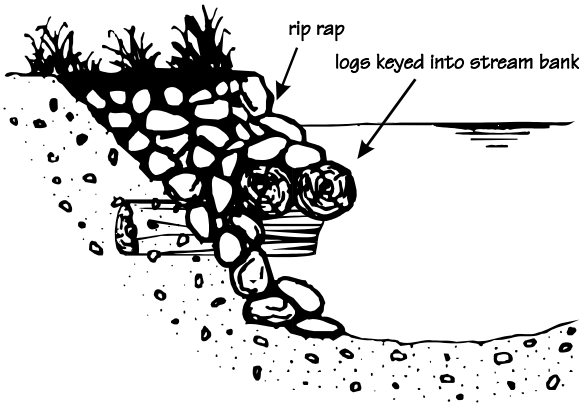
a) the project: You build a shelf from lumber or logs, install it along a bank, then cover and plant vegetation on it. This creates an undercut bank effect, which provides cover for juvenile and adult fish.

b) where to use it: You can add log bank cover to streams with low to moderate gradient, stable flows, and a relatively stable channel.

c) advantages: These structures provide stable overhead cover, and offer some bank protection. They also create pools when areas under the structure are scoured.

d) disadvantages: Log bank covers are labour intensive to build and may be costly. They are not durable in large streams.

Example of Log Bank Cover



8. CULVERT PASSAGE

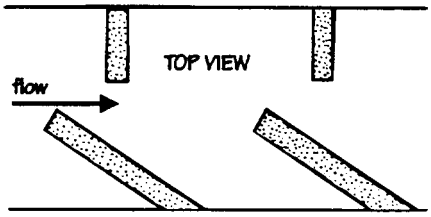
a) **the project:** Older culverts may have been poorly designed or installed. You can install baffles in culverts where water velocities are too great or depths too shallow to allow for the passage of fish. You can construct outlet pools where there is an impassable drop at the culvert outlet.

b) **where to use it:** Consider modifying any culvert that delays fish passage for more than three consecutive days during the migration period. These conditions restrict adult fish passage: water velocities greater than 0.9 to 1.2 m/sec (depending on length of culvert); water depth less than 0.23 m in the culvert; a vertical drop of more than 0.31 m at the culvert outlet, and a slope of greater than 0.5 to 1%, depending on culvert length. These conditions hinder juvenile fish passage: water velocities greater than 0.3m/sec; any vertical drop at the outlet, and any slope.

c) **advantages:** Fish can migrate beyond previously impassable culverts. Baffles and outlet pools usually cost less than replacing the whole culvert.

d) **disadvantages:** An engineer or technician should design the modification. Often, he or she decides that the culvert is undersized already. Since baffles reduce the flow capacity of the culvert, an engineer may want to replace it with a larger culvert. You need specialized equipment to modify the culvert. You need to clean out trapped debris occasionally.

Example of Culvert Baffles



9. FISHWAY

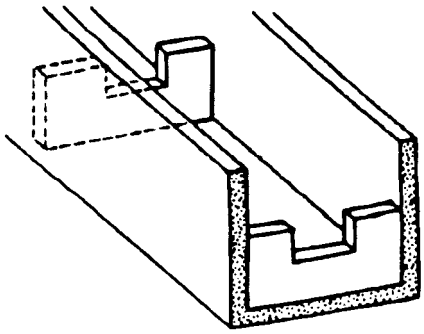
a) **the project:** You install a fishway to provide passage around natural or artificial barriers to fish migration. Use a pool-and-weir fishway on streams with consistent water levels and a vertical slot fishway on streams with widely fluctuating water levels. Use a denil fishway in a temporary situation or on a steeply sloped passage. A natural looking sequence of pools and riffles also can be constructed to help fish get past a barrier using rock weirs.

b) **where to use it:** Use fishways to provide passage around artificial barriers such as culverts, dams, and weirs. You may need to consider fisheries management concerns when contemplating a fishway around natural barriers such as chutes and falls. Removing natural barriers and providing access to previously unused habitats may negatively affect the native species upstream.

c) **advantages:** Fishways allow migration past obstructions and can introduce fish into previously unused areas. You can design a fishway to select certain species.

d) **disadvantages:** Most fishways involve detailed engineering studies, relatively high costs, and much labour. They also require some maintenance.

A Pool and Weir Fishway



10. BEAVER DAM MANAGEMENT

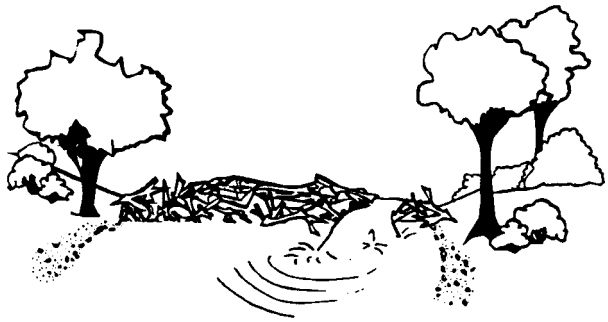
a) **the project:** Most beaver dams are best left in place, since they provide excellent summer and winter rearing habitat for juvenile salmonids. The impounded water behind the dam can augment stream flows during dry periods. You can improve fish passage by opening holes in the dam at critical times. In some areas, fencing the stream bank has kept beavers from returning to rebuild the dam. If you must remove a beaver dam, dismantle it by hand down to the stream bed.

b) **where to use it:** Modify or remove only those dams that prevent fish from reaching spawning or rearing habitat further upstream.

c) **advantages:** A properly managed beaver dam provides fish passage during critical migration periods while maintaining rearing habitat and water storage benefits.

d) **disadvantages:** Beavers often return and repair the dam, so you need to be constantly vigilant to maintain an opening. Removing the dam may reduce rearing habitat, particularly the critical overwintering habitat, or affect the habitat of other species.

Breached Beaver Dam



11. LOG AND DEBRIS JAM MANAGEMENT

a) **the project:** Fisheries staff should assess the net benefit of debris removal and supervise the project. Many jams only appear to be impassable so you should check fish populations above and below the jam to assess the extent of the blockage. Large woody debris provides important fish habitat, so you should remove it only if it forms a migration barrier, flood threat, or erosion problem. Often, you can improve water and fish passage by selectively removing some material using a chain saw, winch, block and tackle, or commercial log yarder.

b) **where to use it:** Remove only those jams that prevent or harmfully delay salmonid migration, cause sedimentation, or erode the banks.

c) **advantages:** Removing a log or debris jam allows access to upstream areas.

d) **disadvantages:** Working in and around a debris jam is dangerous. You may need to salvage the juvenile fish and dewater the site. Removing the blockage may cause more harm than good, by reducing the amount of rearing habitat or instream cover, or by releasing large amounts of sediment.

Jammed Logs

12. FISH SCREENS (WATER INTAKE SCREENS)

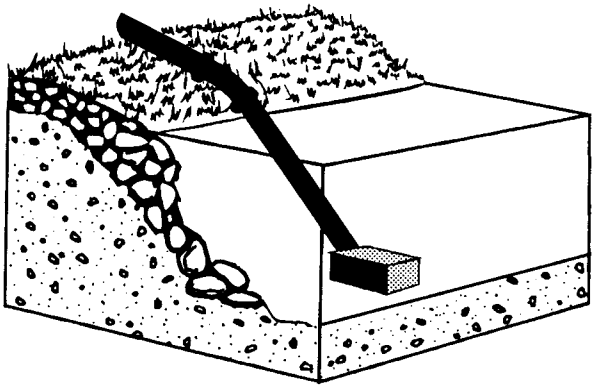
a) the project: You cover entrances to water intake pipes or diversion channels with fixed or movable screens. This prevents juvenile fish from being sucked into the water intake.

b) where to use it: Screen any water intakes on streams and lakes where water is removed for human consumption, industry, or agriculture. The surface area of the intake screen should be large enough to prevent fish from being sucked up against it.

c) advantages: Screening the intakes prevents fish from entering the pipes and dying. You can install a self-cleaning system to reduce maintenance on streams that carry a heavy debris load.

d) disadvantages: Engineers and qualified contractors should design and build larger fish screens. Most screens require routine cleaning and main- tenance.

Example of a Screened Intake



13. ROCK OR LOG WEIRS

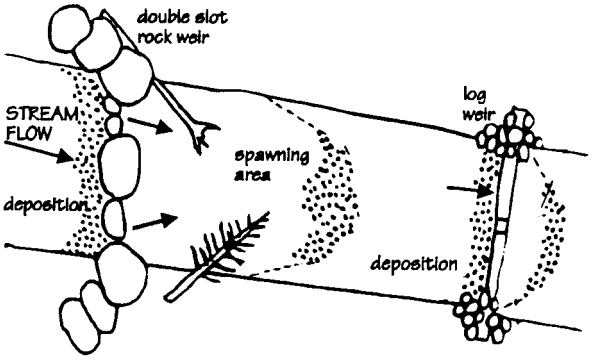
a) the project: Rock or log weirs modify stream flow and increase the number of pools in a stream. Pools provide valuable rearing habitat for salmonids. Plunge or scour pools develop downstream of the weir and spawning gravels accumulate upstream of it.

b) where to use it: Consider adding weirs to streams with insufficient pool habitat, or to catch and retain spawning gravel. Install them where the stream gradient is 1 to 3%, the banks are low, and the channel is wider than average. They work best on streams less than 10 m wide.

c) advantages: Weirs create valuable rearing and spawning habitat and look natural in the stream. The materials are inex- pensive when they are available at the site. Weirs usually need very little maintenance.

d) disadvantages: A hydrologist or hydraulic engineer should help design and install the weir. You may cause bank erosion down- stream if you do not protect adjacent stream banks properly.

Example of Rock and Log Weirs



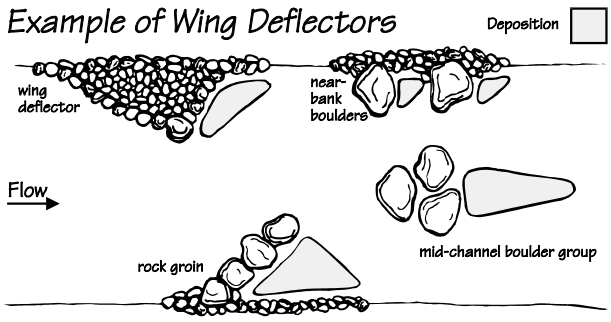
14. WING OR FLOW DEFLECTORS

a) the project: You place rocks along a stream bank or at mid-channel to redirect the flow of water and scour bed material. The stream deposits the material below the deflectors further downstream.

b) where to use it: Install deflectors on streams with low to moderate gradients, in wide, slow, silty areas or areas with eroding banks.

c) advantages: Deflectors can be used to direct flow away from eroding stream banks and improve fish habitat by creating scour pools and cleaning spawning gravel. Adding large woody debris enhances the effectiveness of deflectors in creating fish habitat.

d) disadvantages: Deflectors restrict natural channel movement. Installation can be expensive and require heavy equipment. Poorly constructed deflectors can create erosion problems downstream or on the opposite bank.



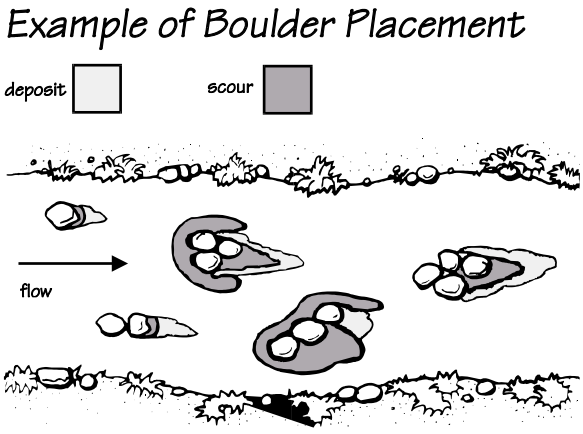
15. BOULDER PLACEMENT

a) the project: Place clusters of large boulders in a stream to increase habitat diversity. Clusters create substantially more fish habitat than do single boulders.There are several cluster designs that achieve various patterns of scour and deposition on the stream bed.

b) where to use it: You can place boulders in streams with a gradient less than 3%, relatively stable banks, and low habitat diversity. Add boulder clusters to the middle or downstream end of a riffle, or the upstream end of a pool or run. Place them in the deepest part of the channel.

c) advantages: Material costs are low and the structure requires very little main- tenance. The added boulders look natural and provide resting areas for fish and cover in the form of turbulent surface layer, scour pools and overhangs.

d) disadvantages: The project is labour intensive and may require machinery. Improperly placed boulders can lead to erosion of unstable banks. Boulders can shift if the stream bed is unstable.



16. GRAVEL CATCHMENT/PLACEMENT

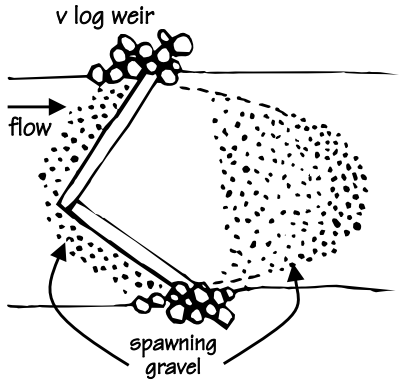
a) the project: You place clean river-run gravel into a suitable spawning area of the stream. You also may install a log or boulder weir to hold the gravel in place, or trap gravel moving downstream.

b) where to use it: You can add gravel to areas of a stream that have limited spawning habitat and enough rearing habitat to support increased fry production. The technique often is used to enhance pink and chum salmon production. Since juveniles rear in the ocean, the factor limiting production is spawning habitat. Make sure that flood flows are unlikely to wash out the gravel. Choose areas of low to moderate tractive force. Gravel placement is most effective in low gradient areas that lack a natural source of gravel, such as a lake outlet.

c) advantages: Adding gravel improves spawning success and increases production of aquatic insects and fish.

d) disadvantages: Gravel often gets washed out of flood-prone coastal streams. You may need to add a gravel catchment weir to prevent this.

Example of Gravel Catchment



17. LARGE WOODY DEBRIS (LWD) PLACEMENT

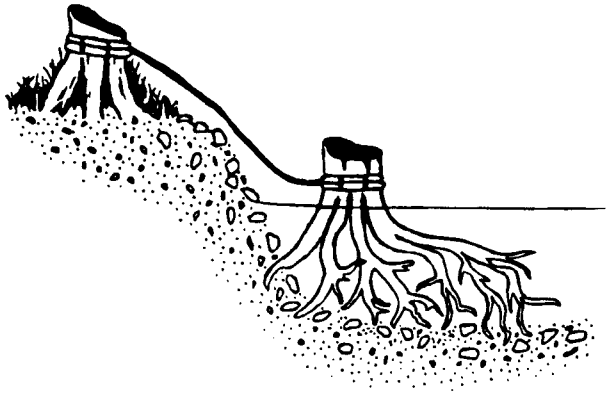
a) the project: You anchor root wads, coniferous trees, or logs in pools or along the outside edge of curves in the stream.

b) where to use it: Place LWD in streams where there is not enough cover for fish. Use it in moderate and low gradient streams less than 15 m wide, or less than 20 m wide if the stream is lake fed. Place the LWD in relatively deep water.

c) advantages: Adding LWD increases the amount of submerged and overhead cover for juvenile and adult fish.

d) disadvantages: LWD may catch debris or sediment, which can alter flow or partially dam the stream.

Root Wad Secured in a Stream



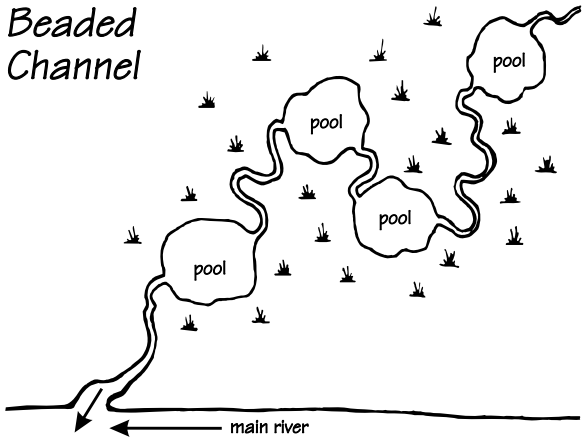
18. OFF-CHANNEL HABITAT DEVELOPMENT

a) the project: You can provide extra fish habitat by constructing side channels, spring or groundwater-fed channels, or overwintering ponds next to the main channel. You also can add channels in areas beyond the current floodplain, such as behind dykes or in old side channels.

b) where to use it: Consider developing off-channel habitat in streams that lack sufficient spawning, rearing, or overwintering habitat. These areas provide a refuge and reduce fish mortality caused by flood or drought in the main stream.

c) advantages: These projects increase salmonid production greatly by creating additional spawning or rearing habitat.

d) disadvantages: Off-channel developments can be expensive to build and require substantial engineering expertise and heavy machinery. Poorly designed systems can run dry in the summer and trap fish. You may need to clear debris from side channels or clean the substrate occasionally with heavy machinery.



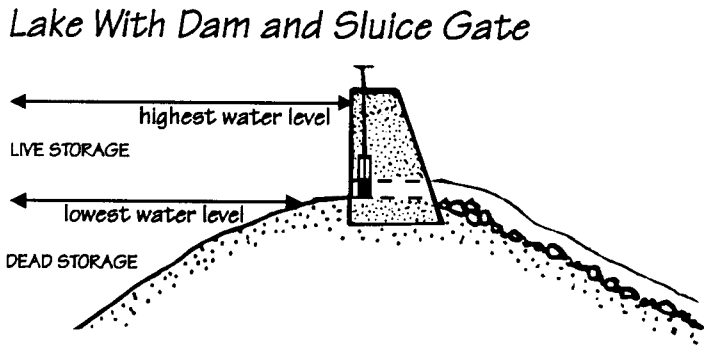
19. FLOW AUGMENTATION

a) the project: You build a flow control structure on a lake to regulate stream flow. The structure stores water during periods of high runoff and releases it during periods of low runoff.

b) where to use it: Consider increasing the water storage capacity on streams where you have evidence that low summer flow significantly limits fish production.

c) advantages: Regulating stream flow avoids severe floods and droughts, which otherwise would decrease survival of fish eggs and juveniles. You can control water temperature by releasing water from specific depths in a lake. Small scale projects are inexpensive.

d) disadvantages: Dams should include a fishway to allow free passage of fish. Fluctuating water levels in the impoundment can affect shoreline areas. Medium and large scale projects can be expensive. Someone needs to monitor flows, adjust flows, and maintain the structure.



20. STORMWATER DETENTION

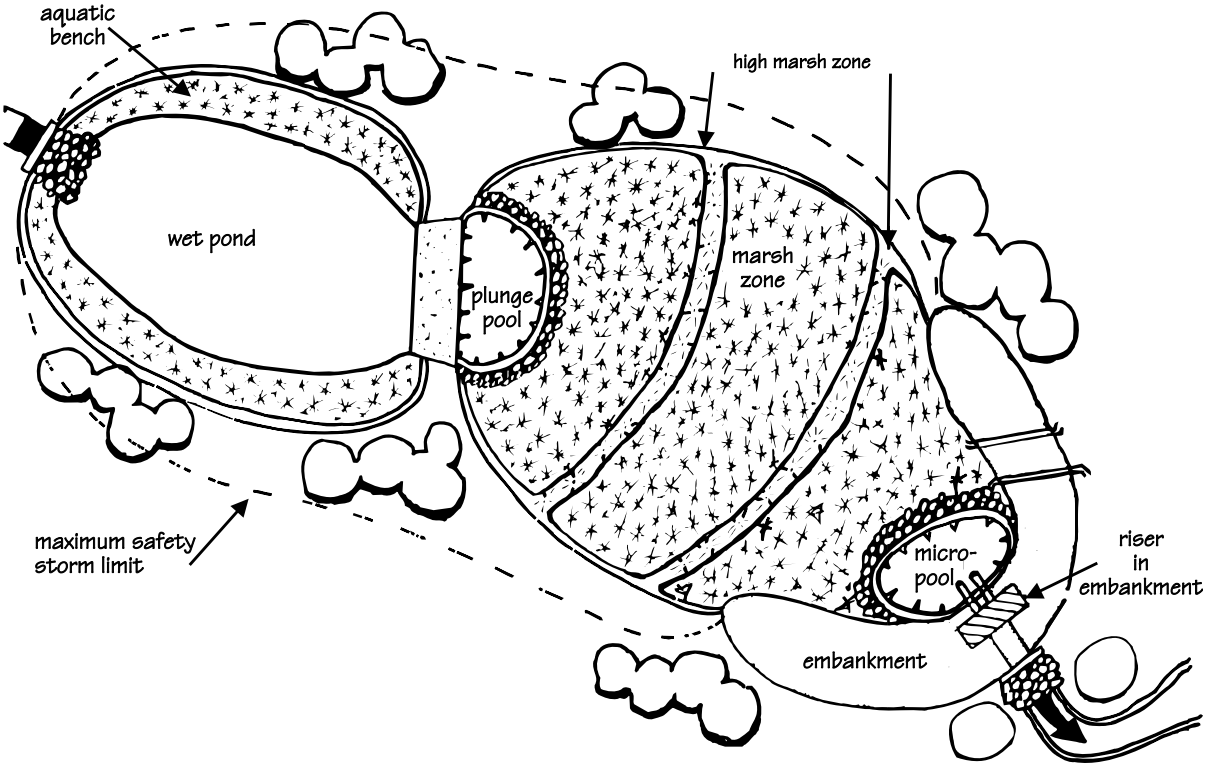
a) the project: You can encourage municipal planners and developers to build better systems to treat stormwater runoff in urban areas. Available technologies include in-ground tanks, oil/water separators, infiltration systems, ponds, and wetlands. These systems help detain runoff, provide infiltration and replenish groundwater supplies, and remove some sediment and pollutants in urban runoff. Public education (Module 10) and storm drain marking projects (Module 5) also help improve quality of the stormwater runoff.

b) where to use it: Consider installing these systems in urban areas where stormwater is collected and discharged to streams or other water bodies. They intercept runoff from streets, roofs, and parking lots before it enters a body of water.

c) advantages: These systems are long lived, adaptable to many locations, and remove pollutants reliably when maintained properly. Systems that include wetlands have the potential to increase wildlife habitat.

d) disadvantages: Storm water detention systems should be designed by engineers, can be expensive to install, require relatively large areas of land, and require ongoing maintenance.

Example of a Stormwater Detention Pond Layout



Appendix 2: Application Form

Environmental Review: *Notification for Proposed Works and Changes In and About a Stream under the Section 7 Regulation of the Water Act*

Notification for Proposed Works and Changes In and About a Stream under the Section 7 Regulation of the Water Act

Please refer to the application guidelines when completing this Notification Form

1. **Applicant Name:** _____
   Address: _____
   City & Province: _____
   Postal Code: _____ Telephone: _____

2. **Location of Works:**
   Stream Name: _____
   Location on Stream: _____
   What stream/river/lake does it flow into? _____
   Address, if different from above: _____
   Legal description of property: _____

3. **Sketch Plan:** attach drawing showing lot boundaries, location of proposed works, stream direction and flow and location of buildings.

4. **Proposed Timing:**
   Start (day/month/year): _____
   Finish (day/month/year): _____

5. **Type of Works (Check (✓) appropriate box):**

☐ **Routine maintenance by a public utility**	☐ **Clear span bridge**
☐ **Pipeline crossing in a naturally dry channel**	☐ **Pier or wharf**
☐ **Fish habitat restoration or maintenance by government**	☐ **Ice bridge or winter ford**
☐ **Flow or water level measuring device by government**	☐ **Aquatic vegetation control**
☐ **Existing dike or erosion protection works repair or maintenance**	☐ **Cutting annual vegetation**
☐ **Stream channel restoration or maintenance by a municipality or the province**	☐ **Road crossing culvert**
☐ **Fish fences or screens, fish or game guards by government**	☐ **Storm sewer outfalls**

Dimensions of the proposed works: Length: _____ Width: _____ Diameter: _____

6. **Do you own the land on which the works are to be located? yes ____ no ____ (check one)**
   If not, who owns the land?
   Land Ownership: Private: _____ Crown: _____
   Landowner's approval, if different from applicant:
   Landowner's Name: _____
   Address: _____
   Postal Code: _____
   Telephone: _____
   Landowner's Signature: _____
   (Attach tenure document for Crown land)

7. **Who is doing the work?**
   Contractor: if different from applicant:
   Company Name: _____
   Contact Name: _____
   Address: _____
   Postal Code: _____
   Telephone: _____

The information on this notification form will be made available to the public under the Freedom of Information legislation, if requested.

8. **Statement of Intent:**

   I declare that the information contained on this form is complete and accurate information. I have read, understood and will meet the requirements to construct works and changes in and about a stream in accordance with Section 7 of the *Water Act* and the Regulation.

   Signed: _____ Date: _____

Ministry Use Only:

_____ :Meets the requirements to proceed under regulation _____ :Approval required

OP15456-1

Notification for Proposed Works and Changes In and About a Stream under the Section 7 Regulation of the Water Act

Application Guidelines

Please fill in all sections of the form, incomplete forms do not constitute a notification and will not be processed.

1. Name and mailing address

Enter your name, mailing address and telephone number.

2. Location of works

- Identify the name of the stream on which you intend to carry out the proposed works.
- Specify where on the stream are the works to take place (e.g. distance from road crossing or confluence with another stream).
- Indicate what stream, river or lake the stream flows into.
- Indicate location of works if different from your mailing address.
- Enter a complete legal description of the property on which the works are to be carried out (e.g. Lot 1 of Section 31, Township 20, Range 12, W6M, Kamloops Division of Yale District, Plan 18411). This information is listed on your annual assessment or land tax notice, or you may obtain it by requesting a copy of your Certificate of Title from the appropriate Land Title Office.

3. Sketch Plan

Attach a drawing which clearly shows:

- the lot boundaries of the property on which the works are to take place
- the location of proposed works
- the stream and direction flow
- the location of house/buildings
- the approximate scale (e.g., 1cm=10m)

A copy of part of a cadastral or topographic map or legal plan, at a reasonable scale, may be used for the drawing.

4. Proposed Timing

Indicate proposed start and finish of the works (day/month/year).

5. Type of Works

Identify the nature of the works by checking one of the boxes. Also, note the dimensions of the works and list length, width and diameter where appropriate.

6. Ownership of the Land

- If you own the land on which the works are to be carried out check "yes" and go to question 7.
- If you are not the owner of the land, indicate whether the land is privately owned or owned by the Crown.
- You must have the landowner's approval. The landowner must enter his/her address, telephone number and postal code and sign. If the land is owned by the Crown, please attach the appropriate tenure document.

7. Who is Doing the Work

If you are not carrying out the work, indicate contractor/company's name, mailing address, postal code and telephone numbers.

8. Statement of Intent

Make sure each section of the form is filled out and that the information is accurate and complete. After having read and understood the conditions outlined in the Section 7 Regulation, and ensured that your project meets all requirements, sign and date the form.

When your form is complete, send it along with the sketch plan to the BC Environment regional office located nearest to the proposed works. This notification form must be completed, by providing the information specified, and must be **received** by a habitat officer in the nearest Ministry of Environment, Lands and Parks office at least 45 days prior to the proposed commencement of the work.