Gravel Placement in Streams

The movement of water from its source to the ocean is a complex, ever changing energy force that has physical impact in its route. As the volume and velocity of the water changes so does the force exerted on the channel confining it. In its natural state, this channel, the river or stream, changes slowly through rock canyons and quickly through loose packed gravels and soils. The gravel composition of a stream reflects these various hydrologic, hydraulic, and geologic conditions present throughout the watershed. Streamed materials that are washed away are replaced by materials of similar composition. Over successive generations, if the changes are not too severe, salmonids adapt to these changes as they occur and continue to flourish. They seek new spawning areas on relocated or new gravels of optimum size with optimum water flow over and through it.

Human activity in a watershed adds to the complexity of the system. Changes to the structure of the channel banks or bed, and the removal or deposition of water or solid materials in the watershed, accelerate those ongoing natural changes. In many cases, salmonids are unable to adapt fast enough and the watercourse itself does not stabilize between disruptions. Scouring can remove entire spawning areas and if gravel recruitment or replacement material is no longer available the area will remain unproductive for salmonid spawning.

Project Guidance and Approval

Not all stretches of the watershed are suitable for gravel placement. The completion of earlier Streamkeeper modules in particular Modules One and Two, (http://www.pskf.ca/publications/handbook.html) will assist you and agency staff in determining the best locations for gravel for the species to be enhanced. As this type of project requires disruption of the watercourse itself, approvals from the Department of Fisheries and Oceans, the Ministry of Environment, municipal agencies, and the landowners are required. For this reason adequate lead time should be allowed (up to one year or more). Your Community Advisor will be able to guide you through the required process.

Level of Effort

At least three people should be involved in the initial survey of the location thought to be a good candidate for gravel placement. In most cases two people are required for measuring and one for recording. Sometimes all three will be involved in taking measurements. Efforts will depend on the site location and access available. Enough data can be gathered in an hour from a site adjacent

to a highway with easy access, while less accessible sites will take longer. To survey a whole watershed may take a year if high water levels are not easily discernible or the watershed is large. Bear in mind that if access is difficult for the initial survey then the physical movement of rock and gravel to the site will be even more so.

Time of Year and Working Conditions

The collection of data for gravel placement is best done in the summer months when it is possible to travel along and across the watercourse. To confirm the boundaries of high flows and the location and type of spawning salmonids it may be necessary to monitor the watershed during the fall and winter months. Gravel placement is usually confined to the late summer months when fish presence and movement, and water flows are minimal.

Personal Safety

Concern for personal safety is essential when working outdoors. Always tell someone where you are going and when you will return. Work in pairs, never alone. Carry a cell phone and emergency phone numbers for police and ambulance.

Do not attempt to wade fast water, or water deeper than 20 cm. Watch out for slippery stream beds, undercut banks, waterfalls, and fast flowing areas. Take care when walking on and around log jams as they are often unstable.

Get permission to cross or use private property.

Beware of dogs, farm animals, wildlife and wasps.

When using shovels and other tools, you should be aware of the people around you.

Watch for tools left on the ground

Materials and Equipment

- Topographic map of the area, 1:5000
- Flagging tape
- Waterproof boots
- Safety items
- 100 ft. measuring tape
- Roll of 20lb. test fishing line
- 1 five meter pole
- Compass
- Notebook and pencils
- Meter stick

- Calculator (metric-imperial)
- 2-3 meter poles marked in centimeters
- Hand level

Background Information

Putting gravel into streams is a useful habitat improvement technique that will aid spawning as well as the production of small fry and the insects that they feed on. Before you start shoveling gravel there are a number of questions that require answers.

1. Is this area really a spawning area for salmonids?
2. Why is there insufficient or no useful gravel there now?
3. If we put gravel here will it stay?
4. What species am I trying to enhance and will gravel placement work?

Is this area really a spawning area for salmonids?

The first thing to do is to complete a local survey of your stream (refer to Module #1 and #2 Mapping). This will help you understand the forces at work in the stream. It is important to know where the salmonids are now spawning and the size and depth of gravel in that area. Stream records from the Department of Fisheries and Oceans and the Provincial Fish and Wildlife branches will assist you in determining the numbers, species and preferred location of returning spawners. (Your Community Advisor should be able to help you access these files.) The replacement or augmentation of gravel to existing spawning areas is easier than creating new spawning areas or channels in locations with no historic record of spawning activity.

It is important to note that all salmonids do not use the same spawning area within the same stream. For example: Coho, Cutthroat and Steelhead will deposit their eggs as far upstream as they are physically able to migrate. Sockeye, Pink and Chinook salmon prefer the middle gradients, while Chum salmon will spawn in the lowest portion of the creek, often digging in sand and silt to clean out a redd. Not only does the geographic location within the watershed have to be well suited to the species but the depth, size and shape of the gravel, and the depth and velocity of water over the spawning beds are critical factors.

Why is there insufficient or no useful gravel there now?

In many urban streams where there is concern over the lack of adequate spawning areas, the culprit is often high water flow incidents (floods.) The movement of sediment and the rolling of rocks along a stream channel are caused by water velocity.

This force varies greatly depending on gradient and water volume. The natural tendency is for rain and snow melt to sink into the ground, where it is then released slowly into the creeks. Disturbances in the watershed such as large logged over areas, huge paved parking lots, subdivisions, etc., cause precipitation to flow directly into drainage channels and creeks. This increase in volume and flow physically moves the streambed downstream. It does not disappear – it just moves downstream to an area where the gradient and the flow lessen and then it settles to the bottom. This process works equally throughout the watershed. The uppermost streambed will consist of large boulders, middle sections will contain gravels, and the lower reaches will be composed of sands and silts. Chances are your gravel has been washed away and never replaced.

Perhaps the gravel was never there. Look around; if the upper area has no gravel banks or slide areas to produce or recruit gravel, maybe there never was any. The outlet of lakes is a good example of this. Any moving sediments that are swept downstream settle out in the lakes. Therefore, the outlet of a lake may lack spawning gravels. Built up areas that do not allow a stream to wander and erode its banks will be unable to pick up gravel to replace what is washed downstream.

<u>If I put gravel here, will it stay?</u>

Gravel cannot just be placed anywhere and expected to attract spawning salmonids. Below a certain gradient it will not be kept clean by the stream flow, and will actually attract fine sands and silts by increasing the roughness factor of the stream bottom. This will plug up the spawning gravel and make the project useless. Above a certain gradient the gravel will simply be swept away. Two conditions must be met in order to have the gravel stay in place.

The gravels must be of sufficient size so that high flow conditions do not move them. To calculate (from the date of our stream mapping and survey) the size of gravel that will stay in place we must know two things:

1. The depth of water flowing over the gravel. As it is obvious that low flows do not move gravel it must be the high flows that are doing this work.

   To determine the maximum flow that regularly occurs and moves gravels in your stream we must use some standard level. The open stream channel represents the channel that the highest frequent flows can maintain and keep the channel clean. Otherwise, permanent vegetation would start to fill in and establish a new margin for the stream. This is called the Bank Full Width.

To establish channel depth at flood, a string or fishing line can be drawn across the creek from bank full width to the uppermost water height on each bank and then a meter stick can be used to measure the flood water depth. Considerable judgment is required to obtain a representative figure for the flood height. Be sure you do not go beyond the clean channel for your water height. The water may go above the bank in exceptional conditions, but if it did this regularly the channel would be scoured open to that point. Remember to keep your measurements within the stream channel and its banks. Sites must be chosen where the best evidence of channel boundaries exists. Avoid areas that are artificially heightened by beaver dams, log jams, etc. The measurement you obtain should be recorded in meters at the place where you wish to place the gravel.

2. The steepness of the stream flow has to be calculated. The slope of gradient of the channel is done by measuring (in meters) a length of stream and over that distance finding out how much it drops. This can be done by using a hand level, or more accurately with a survey instrument. The location should be relatively straight and you should try to get a reading over as long a distance as possible while maintaining accuracy (per 50 – 100 meters.) Be sure to include representative pools and riffles in the stream section. This measurement should also be recorded in meters.

   Now that you have the essential measurements, you can calculate the size of rock or gravel that a flood will not move for that area. The difference in elevation over the area measured is divided by the length of the area.

   e.g.: Stream section = 51 meters long
   Vertical drop = 1.86 meters
   1.86/51 = 0.04 slope

   This information can now be used in the following formula to determine the size of gravel that will remain in that location.

   1000 x depth x slope = largest diameter (in centimeters) of material in motion at flood condition.

   e.g.: Height = 0.5 meters
   1000 x 0.5 x 0.04 = 20 centimeter rock will move

The velocity needed to set in motion packed gravel that is cemented in place by closely packed particles or flat shale may vary greatly from that needed to move rounder rocks. The formula represents a direct relationship between slope,

depth and velocity needed to move loose streambed rock. This can be a valuable tool for gravel placement.

Designs for spawning channels which are ideal in terms of flow, gradient, and cross-section are designed at 0.05 – 0.20 slope. High slopes can be worked on if the stream has gravel catchment devices. These can be stop logs set into streambeds, large boulder clusters or pervious boulder weirs. These should allow water to pass but trap gravels that are moving. Consult your Community Advisor for design and installation instructions on gravel platforms and catchment devices. At grades steeper than 1.5%, gravel catchment devices should be considered unsuitable.

What species am I trying to enhance?

As you read earlier, where you place your gravel in a stream will generally determine what species you will help. Other things to consider are the depth of your gravel placement, the size of gravel, and the depth and velocity of water over the gravel when the spawners are present. Figure 1 is a table that will explain this.

FIGURE 1

Fish Species	Minimum Depth (M)	Velocity of Stream (M/S)	Gravel Size (MM)
Fall Chinook	0.24	0.30-0.91	20-150
Spring Chinook	0.24	0.30-0.91	20-150
Summer Chinook	0.3	0.32-1.09	20-150
Chum	0.18	0.46-1.01	20-150
Coho	0.18	0.30-0.91	13-102
Pink	0.15	0.21-1.01	13-102
Sockeye	0.15	0.21-1.01	13-102
Steelhead	0.24	0.40-0.91	6-102
Cutthroat	0.06	0.11-0.72	6-102

The gravel you need for your placement must be round stream or drain rock of the appropriate size. The rock should be washed clean of all sand, clay and fines. Under no circumstances should you use cracked or crushed rock for spawning gravel. Gravels are sorted and screened to various sizes at the quarry. Wherever possible, visit the quarry and look over the exact gravel you will purchase. Check that this is what you are receiving when it is being delivered and still in the truck. It is very difficult and expensive to reload gravel onto a truck once it is dumped.

Gravel will weigh about two tons per cubic meter. This is heavy stuff to move around and lots of people are required if it's to be done manually. A good example of creative thinking for moving gravel is to use floating wheelbarrows. Where the stream flow is deep enough, a sportyak is to be used. The gravel is deposited at a nearby dump, perhaps near a road crossing. The gravel is loaded into the sportyak, floated downstream and dumped. Lots of gravel can be moved this way with minimum effort.

For those of you that are unfamiliar with a sportyak, this is a trade name for a small boat, usually 8-10 feet in length, which resembles a solid plastic rubber raft. They are sturdy, durable and can be tipped over easily when they are fully loaded with gravel. This is a technique for a small stream that is knee-deep and wadeable. Do not do this in a larger stream.

Another method of delivering gravel is by using a cement truck. Make sure the truck is clean. Load it up with the desired size of gravel. When you arrive at the stream, grind the gravel out of the cement truck like it was concrete – down the chutes and into place. This works well when there is an access road next to the stream.

The back breaking job of gravel movement requires gloves (a necessity), buckets and shovels. Just carry the gravel down to the stream. Be advised that it is far better to put the gravel into a stream slowly without disturbing streamside vegetation than it is to get it all in at once with big machinery that will leave the stream bank a mess.

Some gravel can be carried to the location by the force of the water. After calculating the size of the gravel that should hold in the area that you wish to deposit the gravel, line the area with boulders in random patterns to "catch" the gravel as it's washed downstream. This is very effective but must be monitored very carefully over several seasons.

For more information on gravel placements in your area and the ingenious and successful ways that volunteers have calculated and moved these into place, contact your local Community Advisor at the Department of Fisheries and Oceans.