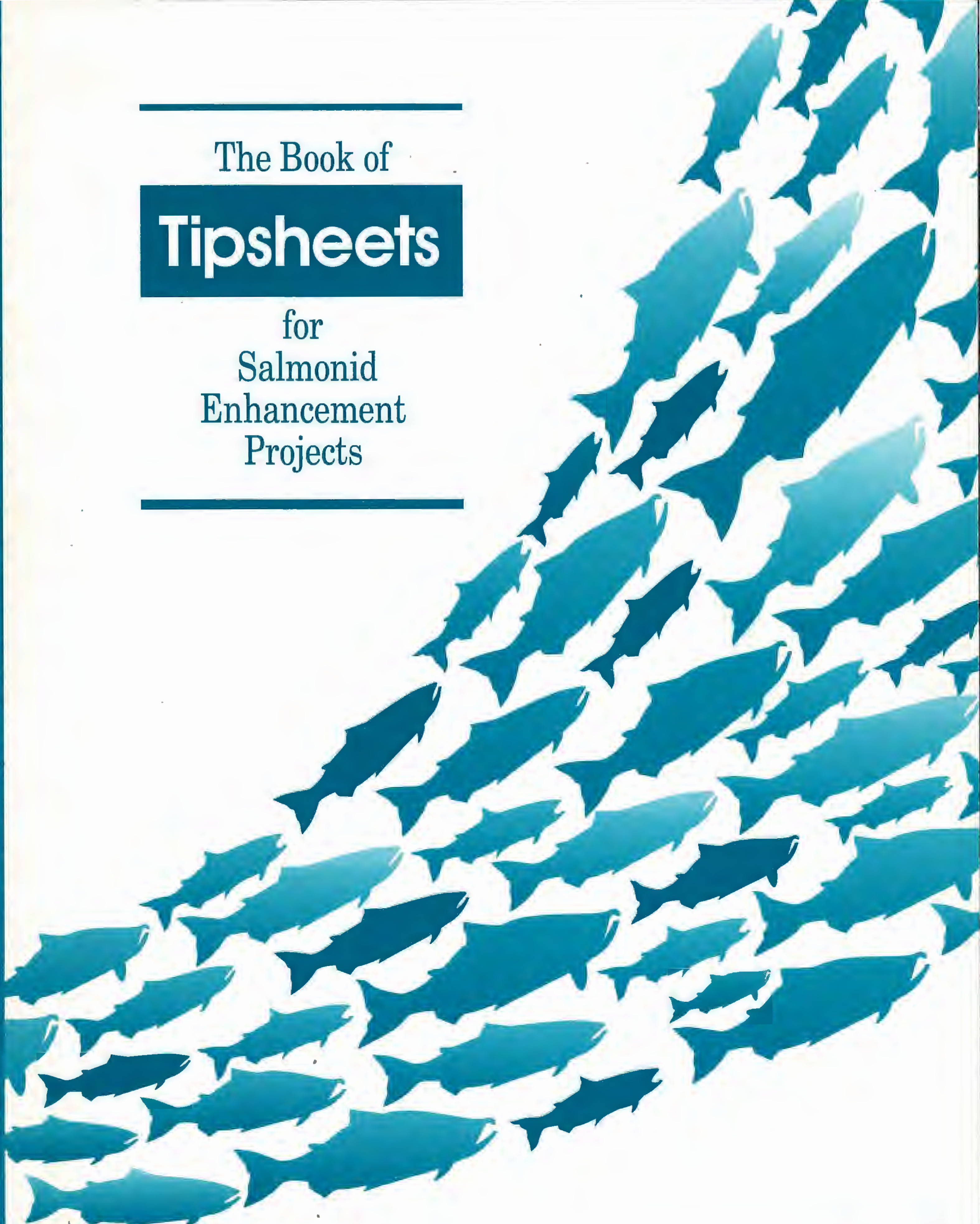
The Book of Tipsheets for Salmonid Enhancement Projects



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The Book of Tipsheets
for Salmonid Enhancement Projects

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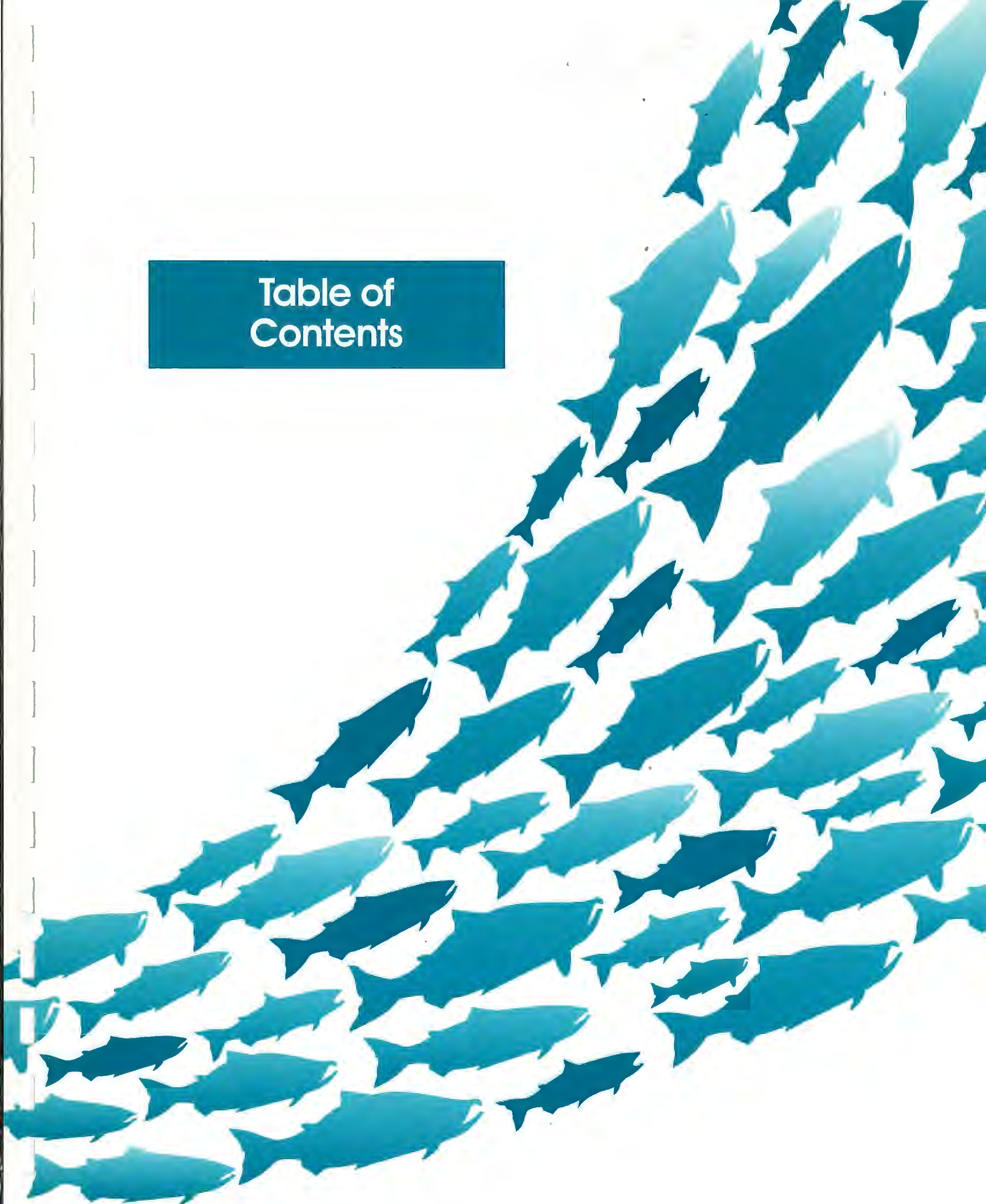

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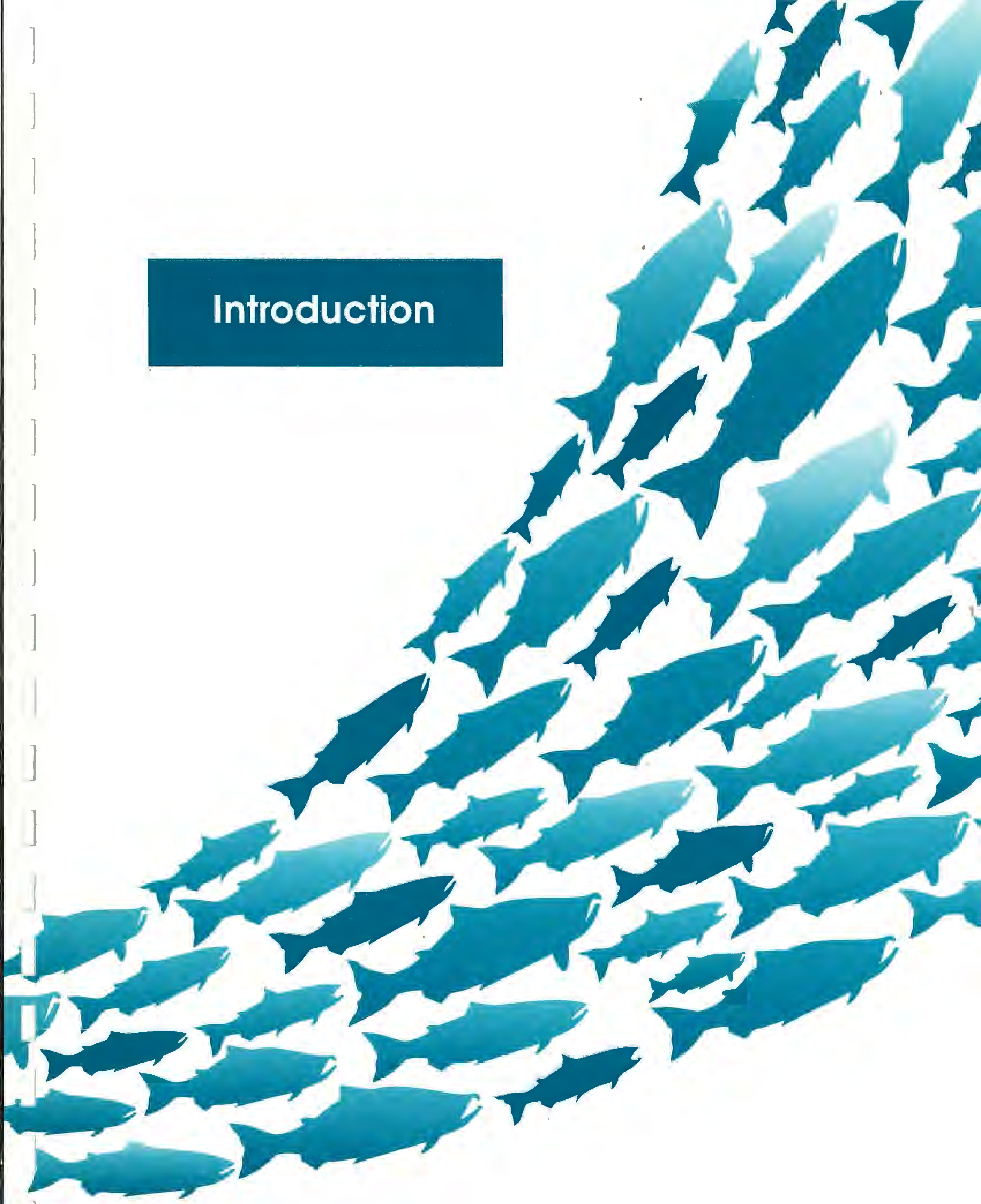


Introduction

SEP (Salmonid Enhancement Program) began publishing **PIPNews**, a newsletter for volunteers, in 1984. One of the publication's major objectives was to provide volunteers and enhancement workers with technical information on various aspects of enhancement. To meet this need, **Tipsheets** were included in each issue. Over its ten-year history, first as **PIPNews** and, more recently, as **StreamTalk**, the newsletter has published more than 40 **Tipsheets**, addressing fish culture, habitat, equipment and other technical subjects. From the first issue, **Tipsheets** were designed to be kept, and were hole-punched for storage in three-ring binders. Many such "books" of **Tipsheets** no doubt sit on the reference shelves of contract and volunteer projects throughout British Columbia and, perhaps, beyond.

Over the years, as new projects came on-stream, new contractors were engaged, and new volunteers joined Public Involvement groups, SEP's Community Involvement Division received requests for copies of old **Tipsheets**. Initially, we were able to accommodate these requests but, over time, supplies have dwindled. Most of the early editions are now "out of print." Most are hard to find and increased knowledge had rendered some obsolete.

As a collection, the **Tipsheets** are a valuable resource — dozens of hands-on, practical how-to tips addressing all aspects of enhancement work. They represent the best ideas generated by resourceful volunteers and the best advice gleaned from Fisheries and Oceans staff over a ten-year period.

In 1992, in response to suggestions from staff members, contractors, and volunteers, SEP decided to investigate the possibility of assembling all existing **Tipsheets** in book format. The volume you hold is the result of that decision.

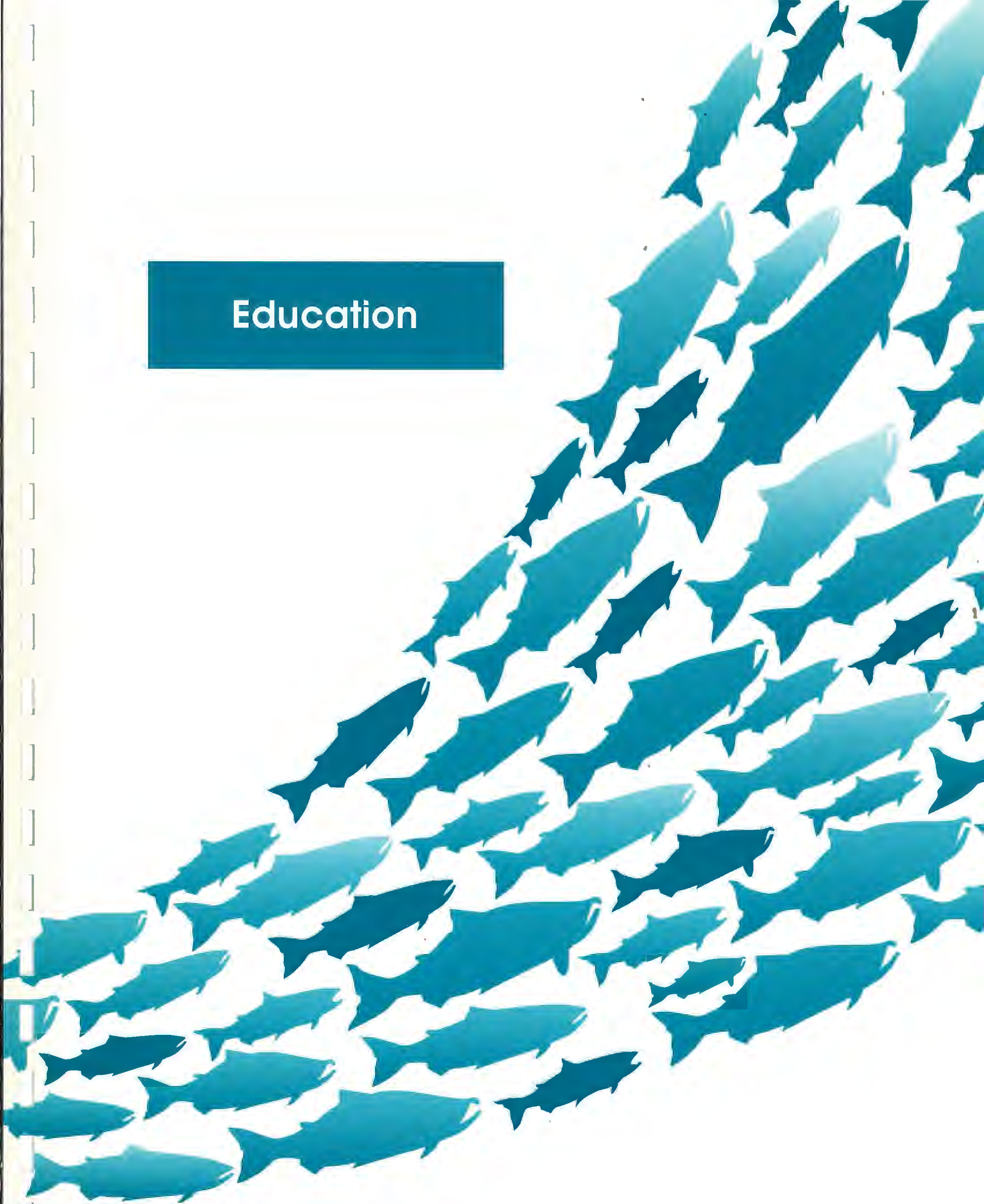
Producing "The Book of Tipsheets" was not an easy matter. Some fifty **Tipsheets** were pulled from files and computer discs. All were submitted to a committee of SEP staff for evaluation and updating. Some were obsolete and were dropped and many were extensively re-written to reflect the growing body of knowledge about enhancement techniques. Individual topics were grouped (at the editor's discretion) under several broad headings for ease of reference. Finally, all the existing artwork was assembled and inserted where needed.

You will find some variation in style in these pages, in both the writing and the art. This is not surprising; over the past ten years, several artists have produced illustrations, and, from the start, **Tipsheets** have been written by any of three editors and by a number of SEP staff members and volunteers. Each contributor had developed or discovered something that worked and was willing to share the information.

We thank them all, and dedicate this book to their efforts and to their concern for the salmonid resource that is so vital to the west coast and its people.

Don Lawseth
Chief, Community Involvement Division
Salmonid Enhancement Program 1994.

Education



Heath tray for classroom incubation

Classroom incubation of salmonids is an increasingly popular educational activity. Students enjoy the hands-on experience and learn a lot about fish biology, water quality and associated subjects. It does, however, require setting up and successfully operating an incubation unit. Both DFO staff and B.C. teachers have developed a number of systems over the years. For more information, or other methods, consult your local Community Advisor or Education Coordinator.

Robertson Creek hatchery on Vancouver Island supplied information on this design.

Flow-through incubator for classrooms

This system for incubating coho salmon in a closed system was tested by teachers in School District 70. Much of the effort in developing this "Heath tray" type of incubator was made by teacher Dave Lowe of Alberni Elementary School in Port Alberni.

An "Aqua-Clear 610" water filter pump was used. It aerates and filters the water within the system. This pump can deliver up to eight litres per minute which is more than sufficient for incubating up to 700 eggs. Air diffuser stones aid in oxygenating the water within the tank. One stone is placed in the outflow of the filter pump and a second stone is placed at the opposite end of the aquarium.

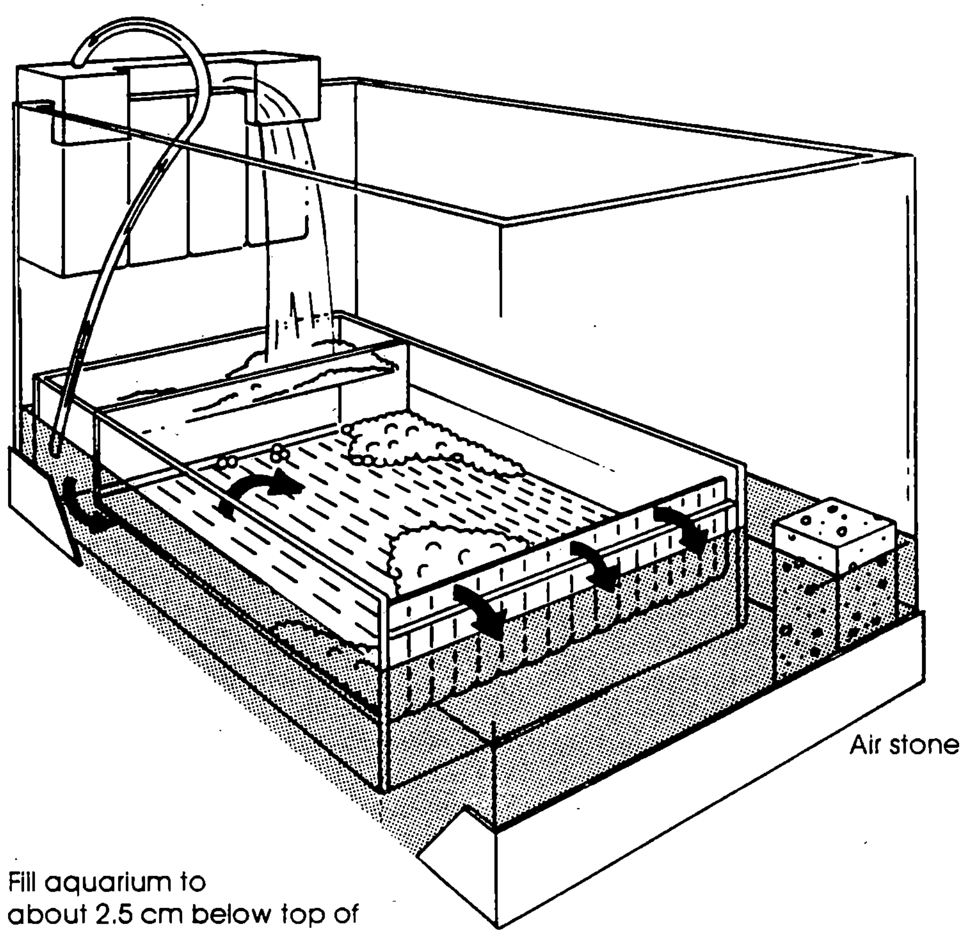
The incubator is constructed of 1/4 inch clear Plexiglas. It is glued using methylene chloride, then sealed with silicone. There are advantages and disadvantages:

Advantages

- a constant flow of clean aerated water through eggs/alevin
- a clear unobstructed view of egg development for students
- a single layer of eggs near surface is easily accessible
- the tray can be used from green eggs to button up
- it is easy to clean
- it is all one piece
- the aluminum screen prevents rust or tears
- the sponge and charcoal filters are easy to clean
- the tray and eggs can be removed when changing water
- the unit can be made to any size.

Disadvantages

- the pump will lose prime with power fluctuations (this is why two air stones are used)
- air bubbles may form under the screen and cause flow blockage unless inflow water is diffused.



Fill aquarium to about 2.5 cm below top of "Heath tray."

Supplies

- ✓ Air diffuser stones (1 1/2 inch by 1/ 1/2 inch by 3 inch)
- ✓ Aqua-Clear 610 filters
- ✓ Clear 1/4 inch thick Plexiglas
- ✓ Methylene chloride
- ✓ Silicone sealer
- ✓ Perforated aluminum

Additional information

Some points regarding all classroom aquariums for salmonid incubation.

1. You must contact your Community Advisor or Education Coordinator to obtain eggs for incubation and to get a permit to release the fry.

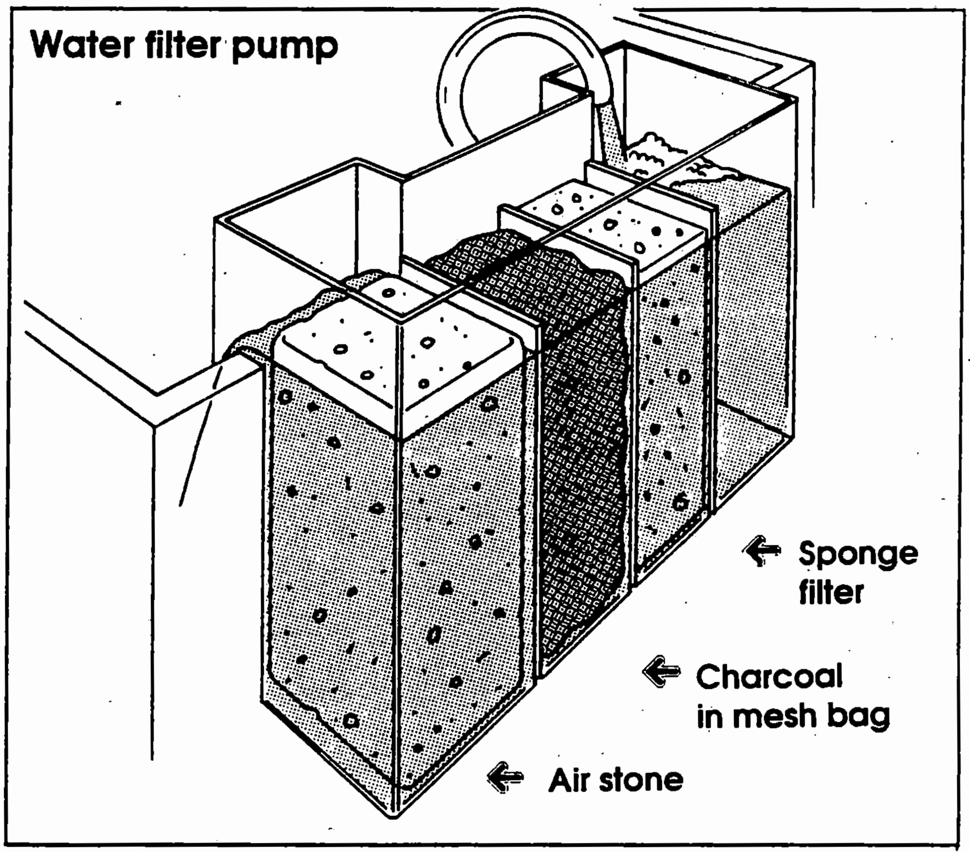
2. Tanks must be *clean*: wash with a mild detergent (if necessary, you can use steel wool, but extra rinsing will be required), then rinse *thoroughly* before use.

3. Never use chlorinated (tap) water for fish — it is lethal. Chemical removal of chlorine is essential unless you "inport" water from a clean stream.

4. Place your tank in a quiet corner. Try to pick an area where it will receive little or no heat, sunlight or physical disturbances. Styrofoam, glued to all sides and top, can be used to keep light out while adding insulation; provide a "window" that can be removed for viewing.

5. Use "eyed" as opposed to "green" eggs. Eyed eggs have already survived the most sensitive stages of development and you will experience fewer mortalities. Eyed eggs are usually available in January or February.

6. If you use water running through a hose in your tank to keep water cool, try to connect the cooling system so that it cannot be shut off easily (utilize the water line under the sink, or at least remove both hot and cold tap handles).



7. Keep your tank clean. Change one-third to one-half of the water on a weekly basis once you begin feeding your fry. Portable test kits are available for checking dissolved oxygen, pH, and ammonia levels.

After the eggs hatch, a white foam will appear on the surface and may turn the water cloudy. This embryonic fluid is not harmful. Simply remove the foam from the surface with a spoon or dip net; the filter will do the rest.

8. Record daily temperatures. This will help you to predict dates for hatch and swim-up. See **Tipsheet** on ATUs for more information.

9. Respect your CA or education coordinator's time. They assist many projects and cannot be available at all times. Try to get help from other teachers in your school or district before you call.

Teachers may be interested in viewing the video production *The Classroom Incubator*. This production features the classroom project at Stoney Creek Community School in Burnaby. Teacher Yvonne Gaetz discusses how she carries out the incubation of coho eggs, how the class engages in further activities and how the entire school benefited from her group's involvement.

This video can be obtained through your community advisor, your local education coordinator or from the Community Involvement Division, Salmonid Enhancement Program, Fisheries and Oceans Canada, #400 - 555 West Hastings St., Vancouver, B.C. V6B 5G3.

Equipment and Materials

Automatic feeders

Feeding fry for the first two or three weeks should increase later survivals. Just-hatched fry should be fed almost continually during the day. Often, that requires an automated feeder.

The initial feeding is critical; do it by hand if possible.

Cautions: use dry feeds; moist feeds clog easily; feeders can quit; check often.

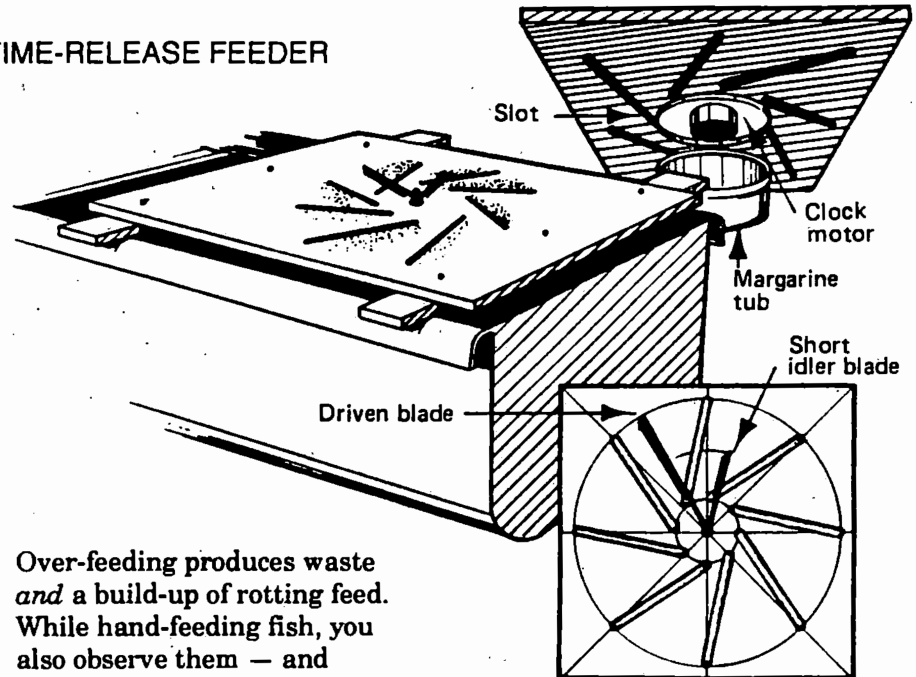
Advantages

- Continuous or regular feeding when no one is present.
- Project can rear more fry than if hand feeding.
- If the human fish feeder is delayed, the fish still get fed.

Disadvantages:

- Even dry feed is not totally dry; it may gum up and clog.
- The coastal climate *adds* moisture — causing clogs.

TIME-RELEASE FEEDER



- Over-feeding produces waste *and* a build-up of rotting feed.
- While hand-feeding fish, you also observe them — and behaviour can be a valuable way to judge health. Do watch them.

Time-release feeder (above)

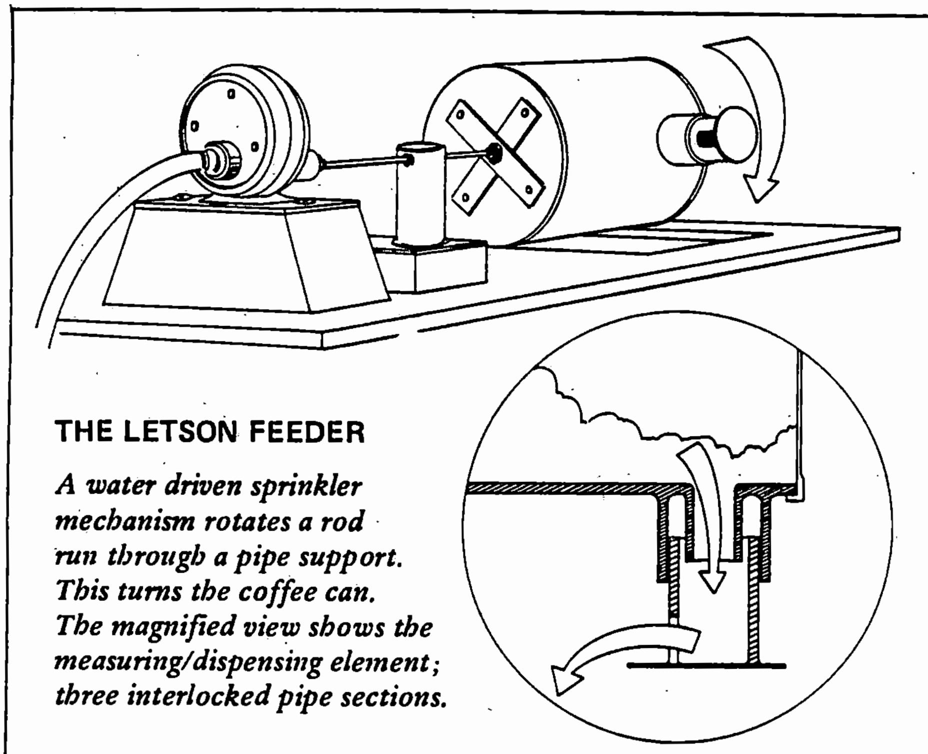
This feeder is made with a clockwork mechanism on a slotted board. It may be a wound, battery or electrically-run clock.

The clock mechanism is set with the hour hand close to the board, as on a clock face. The minute hand is removed — it moves too fast. A windshield wiper blade is attached to the hour hand so it will travel around the top of the board. Spread feed on the board; the blade pushes it through the slots.

Cut the slots at an angle to dispense feed a bit at a time. This might help to keep feed from jamming up in the slot.

A double ratchet system would provide a longer feeding time. Set a second blade, attached to the clock spindle but not driven by it, and only half the radius of the circle being swept, behind the driven blade. The driven blade revolves for a complete circle, (12 hour), then picks up the second blade which sweeps for another 12.

A margarine tub will keep the clockworks covered. A larger tub or box could cover the whole assembly for more protection.



THE LETSON FEEDER

A water driven sprinkler mechanism rotates a rod run through a pipe support. This turns the coffee can. The magnified view shows the measuring/dispensing element; three interlocked pipe sections.

Equipment and materials

Belt feeder

Another feeder uses the conveyor belt principle. This one is made of window screening and two old paint rollers.

The screening is made into a continuous loop by joining a strip of it at the ends with a hot-melt glue gun. The loop is stretched tight over the two foam covered rollers. One of the rollers provides the drive by means of an attached circular saw blade which is turned by a wire hook that operates off the crank of a garden sprinkler.

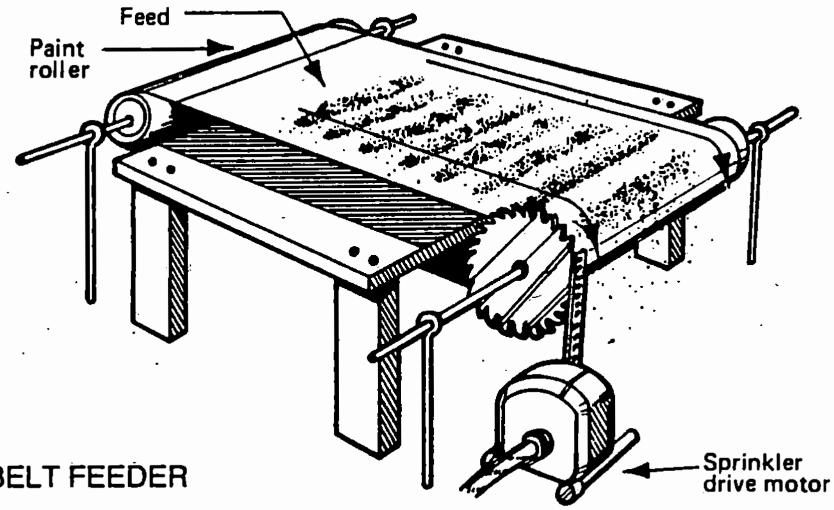
Feeding is accomplished by spreading the feed on top of the screen belt. The belt is supported with a piece of board or plastic to prevent sagging. As the belt moves the feed is dumped off the end into the water. Feed rates and times are varied by placement of the food on the belt.

Chinnick feed drill

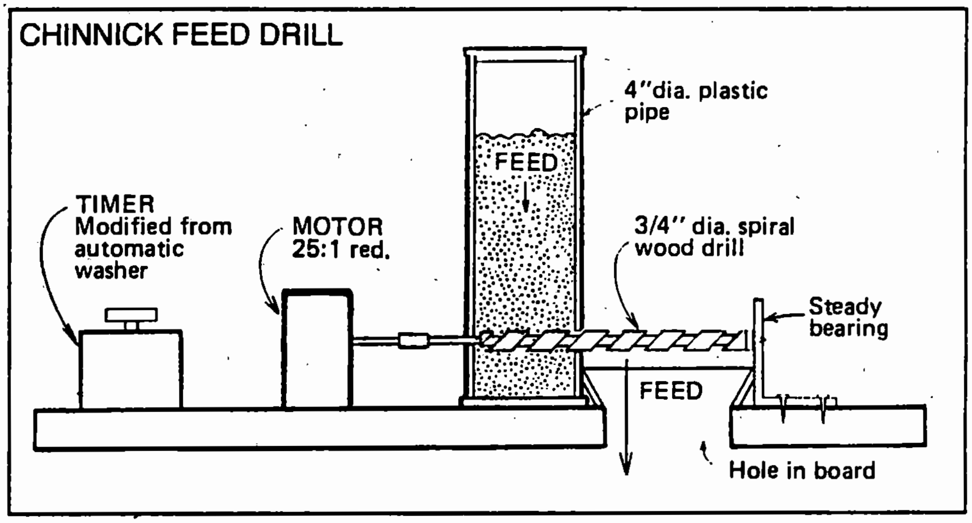
The auger is a long-standing way to move grain. Bill Chinnick's design operates on this principle. The feeder uses a washing machine motor, a timer, and wood drill bit driven by a computer reduction motor. It provides a steady and dependable flow of feed to the fry.

Demand feeder

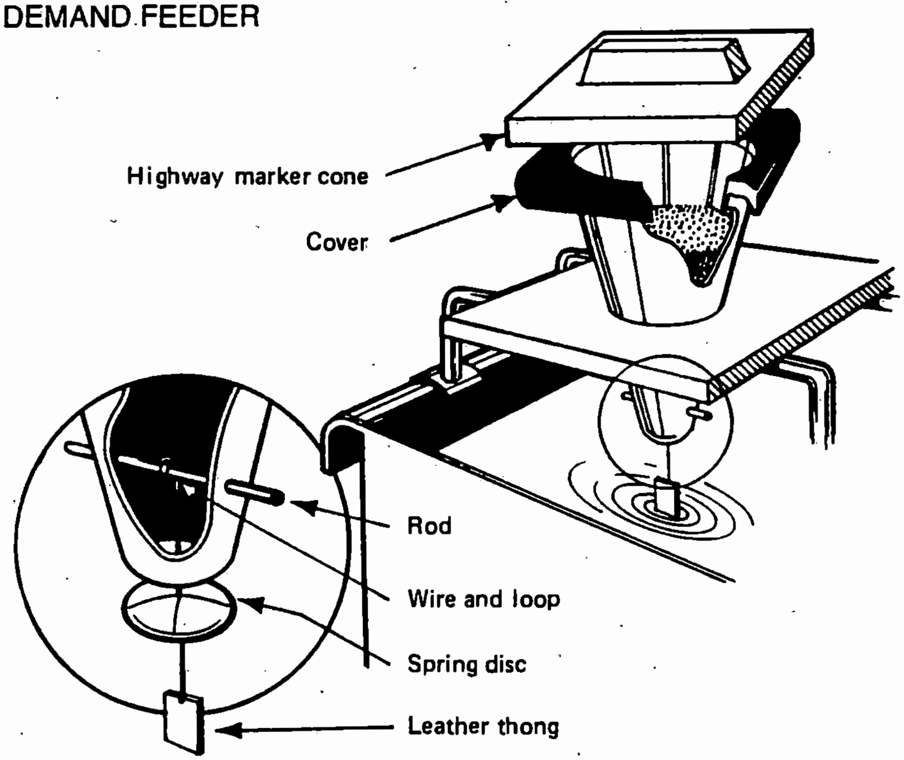
The demand feeder is suited to larger fish. You can make one from a cone with gently sloping sides (like a highway marker cone). Support it narrow end down, above the rearing container. It will create a steady flow of feed. A wire and disc arrangement (see illustration) controls the flow and a mechanism the fish can pull or nudge, such as a leather tab or metal strip just at water level, causes feed to flow. A series of these over a raceway or pond provides good distribution.



BELT FEEDER



DEMAND FEEDER



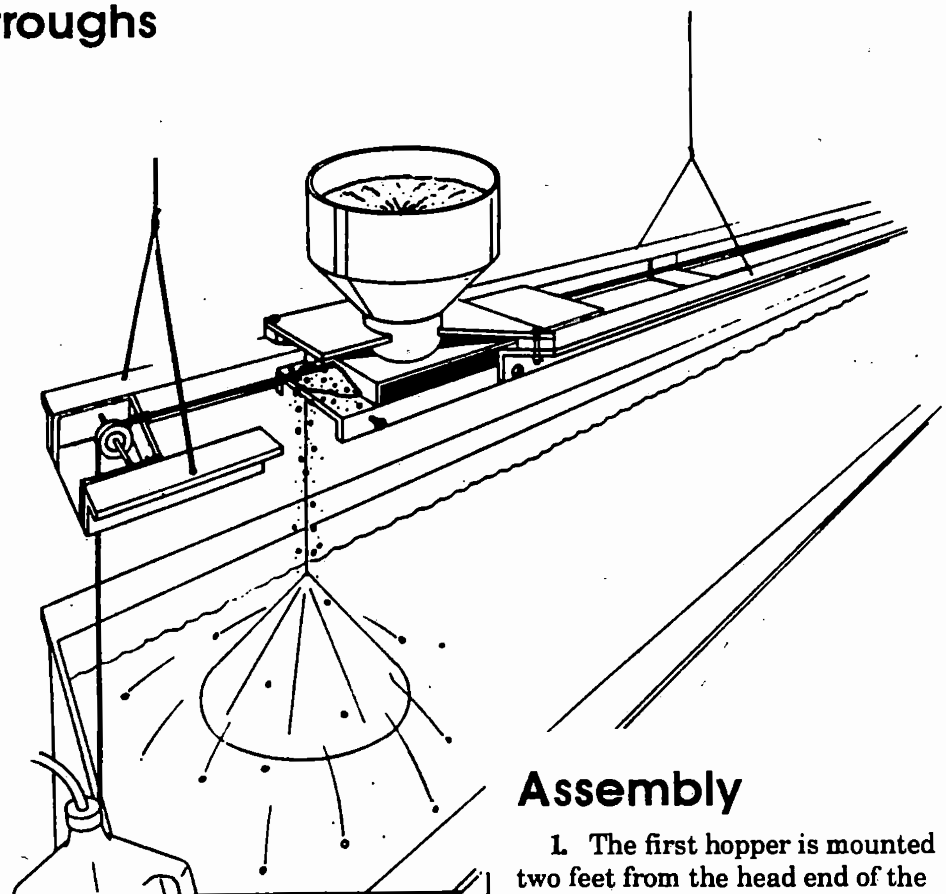
Feeder for Capilano troughs

This feeder was designed by Roy Sloan for the Semiahmoo Fish and Game Club project on the Little Campbell River in Surrey. It feeds young fry in Capilano troughs. It works well in the indoor environment at Semiahmoo, although each feeder is covered with plastic to keep condensation from the ceiling off the feed. If you have an outdoor setup, this type of feeder might present problems unless more adequately protected.

The principle is simple; the parts, fairly inexpensive. The major requirement is careful labour to assemble the feeders so that everything works smoothly.

Materials:

✓ electric timer
✓ electric pump suitable for your water source
✓ two pieces 3.8 cm (1 1/2 inch) right-angle aluminum, each 3.5 metres (10 feet) long
✓ five (per feeder) pieces 7.62 cm (3 inch) U-shaped aluminum channel, each cut about 2.54 cm (1 inch) wide
✓ ABS pipe reduction sections (4 inch down to 2 inch); five per feeder
✓ sheet Plexiglas 1/8 inch thickness
✓ soft stainless wire for slide connectors plus some coat hanger wire for control
✓ 15.25 cm (6 inch) squares of Lexan, five per feeder
✓ plastic glue
✓ nuts and bolts (or screws)
✓ plastic tubing (1/4 inch diameter)
✓ ceiling light fixture fitting; hollow, threaded pipe with locknut; one per feeder
✓ nylon cord.



Preparation

Note: measurements are in feet and inches. Conversion to metric might affect accuracy.

1. Use the channel sections to evenly space two sections of right angle aluminum for their full 10 foot length — you should use four.
2. Use one channel section, mounted horizontally, for the control mechanism. Predrill it to accept the ceiling fixture.
3. Cut pieces of Plexiglas for: two slide sections, one hopper mount and two side supports. The two slide sections must be **exactly** 2 15/16 inches wide. Length must be at least five inches, but can be longer.
4. Cut three strips (2 15/16 inches by 1/2 inch) Plexiglas for each side. These form the pusher units and wire guide.

Assembly

1. The first hopper is mounted two feet from the head end of the feeder; others are spaced 20 inches apart.
2. Mount supports, notched to hold the bottom slide section, on the inside of the angle aluminum — attach with rivets or screws.
3. Make a shallow saw cut in short (1/2 inch) sections of Plexiglas to act as a guide for the wire. Make the pushers with this cut side against the underside of slide top section. Add a second thickness. This creates a 1/4 inch deep pusher lip. Drill a small hole (diameter of the wire) in the center of each top slide section. Glue a second saw-cut piece of Plexiglas to top surface at the other end.
4. Prepare the holder for the hopper by cutting a hole — **exactly** 2 3/4 inches in diameter — in a square of Plexiglas.
5. Position the bottom slide sections, then the top. Use risers as necessary to position top surface of the hopper holder **exactly** one

inch above the surface of the top side section. This will allow the feed hopper to touch, but not bind against, the sliding feed dispenser.

6. Thread wire into each top slide sections as follows:

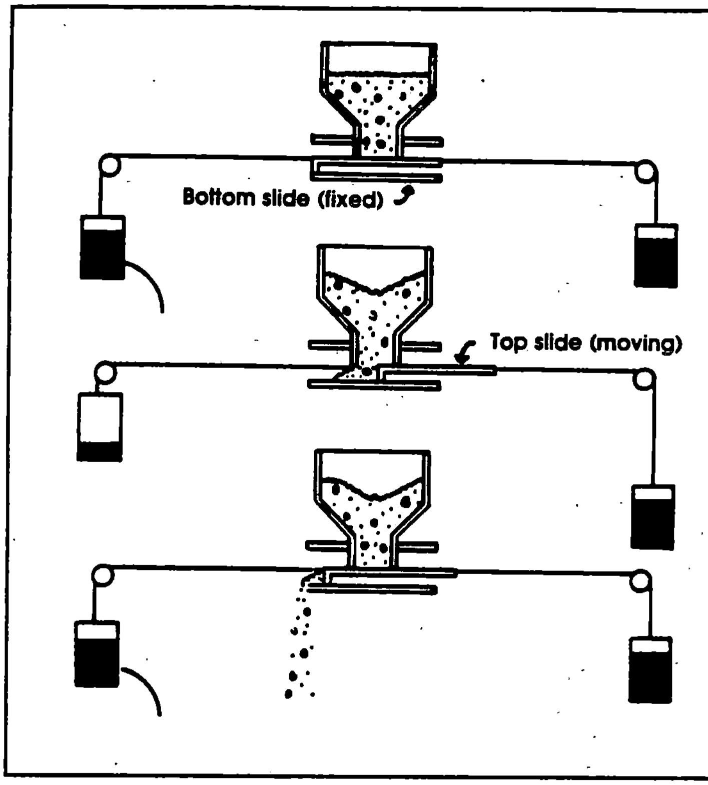
- Wire enters the slide between pusher and slide section. It runs along the underside of the slide section to the hole, then up and backward along the top surface to the rear end where it exits through the second slotted guide.
- Put a loop in one end of the wire and make a hook in the other, spaced far enough apart to connect each of the five hoppers in series. These separations in the wire simplify dismantling the sections for cleaning or moving.
- Assemble the sections of each feed hopper along the frame. Hook the wires together and attach end of wire nearest the water source to a short length of coat hanger wire. Bend the outermost end of the coat hanger wire to form a hook that will stop the wire from entering the ceiling connection threaded pipe. Run the other end of the wire through the hollow tube (positioned in the channel section) and attach it to the end of the connection wire. At each end of assembly, attach a length of nylon cord to the wires. Position a pulley at each end of the feeder and run cord over these pulleys. Attach the empty one-gallon jugs to each cord.
- Hang the assembled feeder, using heavy wire, over your Capilano trough. Run a length of wire above the hoppers and drape heavy plastic over each feeder to protect the hoppers and slides from falling condensation. Fill the jug at the outer end of the assembly with five gallons of water (equals about 42 pounds). Drill a small hole (about 1/8 or 9/16 inch diameter) in bottom of other water jug (at operating end of feeder).
- Run flexible tubing from pump into the jug. Connect pump to timer.

Spreader cones

Make cones to hang under the hoppers (to spread falling feed) from six-inch squares of Lexan.

Drill a 1/4 inch hole in the center of each square. Cut out one quarter of the square and round off the remaining three corners. Drill two small holes near the center. Place Lexan squares in a warm oven to soften. When pliable, shape each into a cone and hold until set.

Run wire through the two small holes; bend the end to hold. Leave about six inches above the cone; cut. Make a hook in the cut end and use it to hang the assembly about one inch below feed dispensing lip. As the feed falls, the cone will scatter it.



Operation

Fill hoppers with feed — about 250 grams each. Set timer to operate pump for five minutes every half-hour. Observe; adjust as necessary for optimum feed rate.

Adjustments

If the initial installation is not providing exactly the right amount of feed, you can adjust it as follows:

- Set the timer for longer or shorter cycles.
- Vary the length of the "pull" on the upper dispensing slides by making the electrical ceiling fixture tube longer or shorter. This varies the length of motion on each cycle. A longer stroke will dispense more feed.

Plastic pipe: bending & belling

Pipes made of thermo-plastics, such as PVC and ABS, can be bent or formed by the application of heat.

When these pipes are in use for small stream projects, you may need to perform these operations on site. Given a suitable heat source and some simple tools, this can be done successfully.

Forming a bell or socket

Heat sources:

- An oil or glycol (anti-freeze) bath heated to 176°C (350°F)
- Radiant heat (infrared tubes)
- Hot air or an open flame.

The glycol bath is the preferred method, but the others can give acceptable results.

The bell is formed over a mold. The professionals use pre-formed molds of aluminum. A wood plug is fine, or you can achieve good results with a piece of ordinary heavy-wall pipe if you bevel the end.

Procedure:

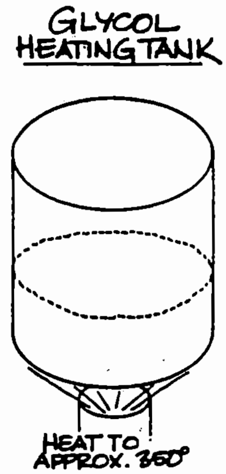
1. Heat the end of the pipe. In a hot bath it will take from one to 10 minutes, depending on the thickness of the pipe, before the end turns rubbery.
2. Push the heated end over the mold (or substitute). It will expand over the mold.
3. Leave to cool, or speed cooling (especially with large fittings) by wiping with water.
4. Extract the mold or plug. This may be difficult, particularly with large fittings. You may have to use a stick and hammer to knock it loose.

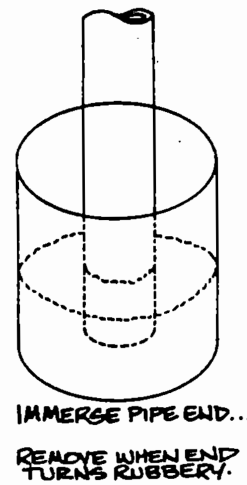
Things to remember

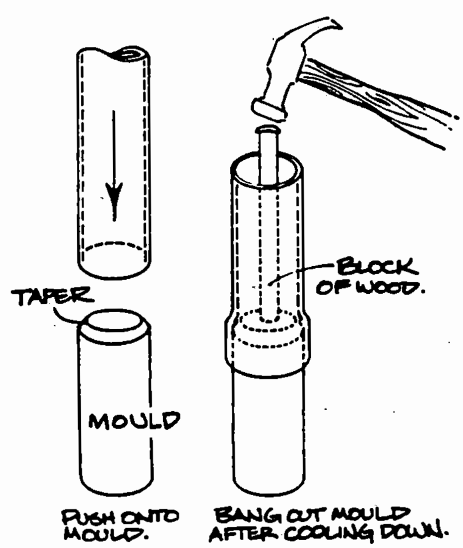
- Always handle hot pipe with heavy gloves
- Glycol is preferable to oil. Oil darkens and is also hard to remove from the pipe later.
- All traces of either oil or glycol must be removed before cementing the pipe.

Quick tip

An almost perfect cone for the top of an aeration inlet can be formed by simply pressing the heated end of a pipe into a flat surface. The inlet will curve smoothly... then just let it cool — no mold needed!







Equipment and materials

Pipe bending

Professionals bend pipe using dies, air pressure or springs to form and hold a bend. They also use heat ovens or barbecue rotisseries to heat the pipe.

This equipment is not really essential — you can get a very good bend without it. Certain aspects of the process, however, are very important.

Heating methods

To make a good bend when working in the field, you must heat the pipe equally around its circumference. Also, the longer the section of pipe you heat, the smoother (and better) the resulting bend will be and the sharper the angle to which you can bend the pipe.

As a rule of thumb, remember; to make a 90° bend, heat a length of pipe about 16 times its diameter. For example, to bend a 50 mm (2 inch) diameter pipe, you should heat about 1 metre (3 feet) of its length. A less severe bend (22 1/2°) requires heating of only about 23 cm (9 inches).

The best heat source for bending is hot air, but a large, wide, open flame can be used very successfully.

A flat forming table plus a simple masonite jig will serve to hold the bend while the pipe cools.

Procedure

1. Heat the necessary length of the pipe. Rotate the pipe often and rapidly, to heat evenly and prevent burning.
2. Bend the pipe to fit into the jig.
3. Let cool, or cool with wet rags.
4. Remove the jig.

Things to remember

- The sharper the bend, the greater the length of pipe you should heat.
- Heavy walled pipe gives a better bend than thin (less chance of kinking).
- Do not bend near the end of the pipe... any bend will prevent cementing of a socket fitting to the pipe. Leave an unheated section for the join.
- Try to avoid having to heat the pipe in cold or windy locations.

Quick tip

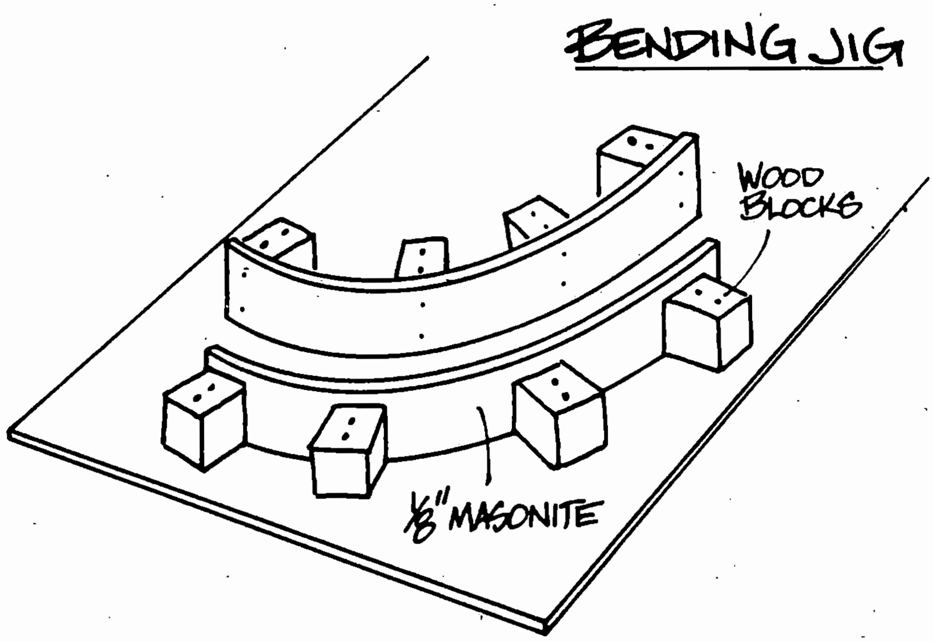
An old (but effective) method: pack the pipe with sand and tamp down. Plug both ends and heat. You need heat only eight to 10 times the pipe diameter to get a 90° bend.

Characteristics of other plastics

Special techniques are needed to bend Polyethylene (Pe), Polypropylene (PP) and Polybutadiene (PB) plastic pipes.

These materials have a tremendous memory. To get a 90° bend, you may have to bend the pipe much more sharply (to 85° or less). Upon cooling, it will spring back.

This characteristic will allow a very tight fit between plastic pipe and steel pipe. Heat form a socket in the plastic, then re-heat the socket over the steel pipe. The plastic will contract very tightly as it "tries to remember" its original dimension and shrink back to that size.



PVC pipe: cementing

Polyvinyl chloride is a strong, flexible and durable plastic which has become standard material in construction and industrial applications over the past 25 years.

It is commonly used as a piping material on small stream enhancement projects for which it is well-suited because of its versatility. Cementing two pieces of PVC pip can be a headache unless certain rules are followed. The following tips are to be used in addition to, not in place of, the instructions provided by your PVC supplier.

Cement

There are about seven different types of PVC cement and four grades of primer. Also available are several multi-purpose plastic cements. Some have slower drying times or perform better in humid conditions. Check the labels. Weld-ON 705 is recommended for water lines to incubation boxes and troughs.

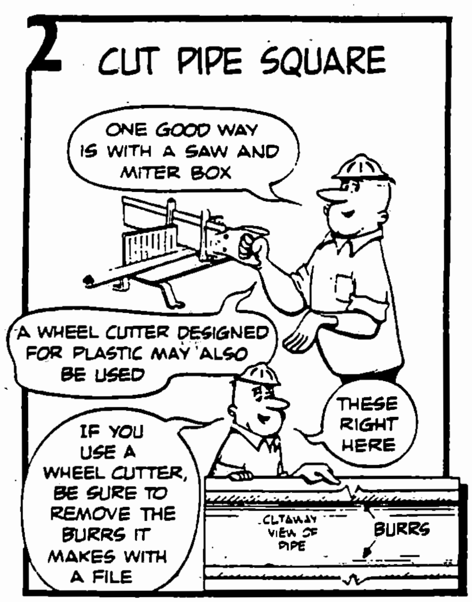
Preparation for cementing

Assemble the following materials:

✓ miter box and saw
✓ clean rags
✓ knife, file or sandpaper
✓ correct cement for the type and size of PVC pipe
✓ correct size of applicator for size of pipe.

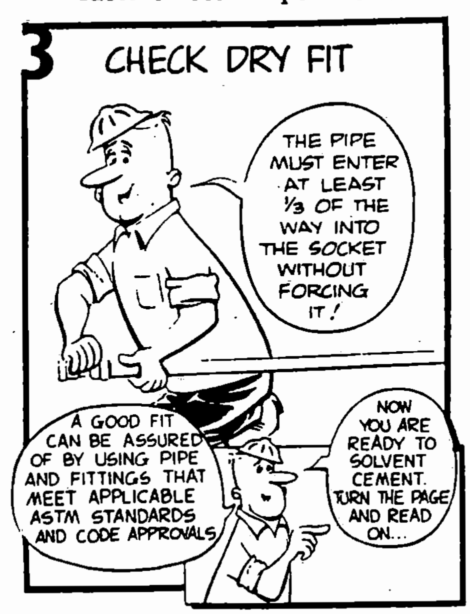
Use saw and miter box to cut square end on pipe

1. remove burrs with knife, file or sandpaper
2. remove all moisture and dirt with a clean rag
3. check dry fit.

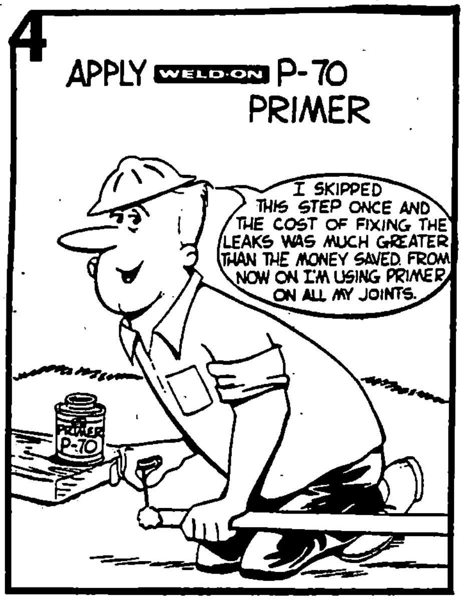


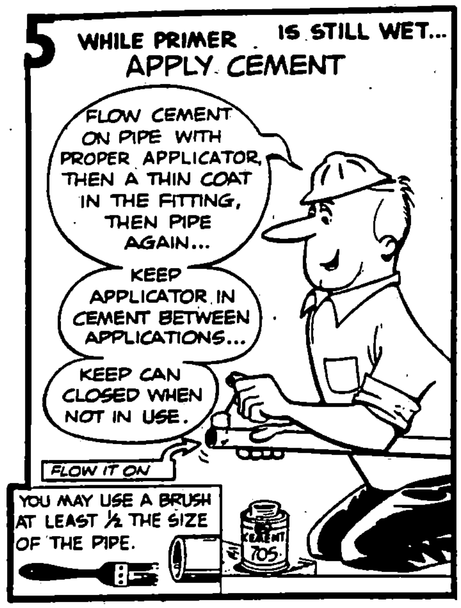
Gluing instructions

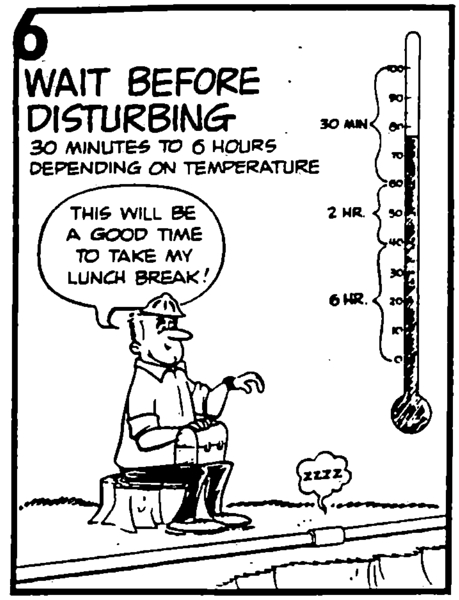
1. Apply the primer to the socket, then to the pipe, then to the socket again.
2. While primer is still wet, apply the correct cement to the pipe end, then to the socket, then to the pipe again. Remember, glue in the opposite order of priming.
3. Do not apply excessive amounts of glue.
4. Do not allow primer to dry before applying glue.
5. Push both ends together firmly to seat the pipe in the socket (you may need to twist it slightly). If you are working with large pipe sizes, two people make this easier. Hold for a minute. Wipe off excess cement.
6. Allow drying time of 30 minutes to six hours, depending on air temperature, before disturbing the pipe. Wait longer in low air temperatures, high humidity, for large pipes, slow-drying cements or loose joints.
7. If pressure testing is necessary, wait 24 to 48 hours, depending on the factors noted in point six.



Equipment and materials







Things to avoid

Problems usually result from incorrect procedures, such as using a wrench to overtighten threaded plastic fittings; letting the primer dry before cementing; priming only one of the two components; using thin cement on large fittings; adding cement to the outside of fittings.

Trouble shooting

If you have followed the instructions but the joint is leaking, there are three possible solutions:

1. Cut out and re-cement, using a new connector,
2. use a repair coupling,
3. backweld (this should not be necessary if instructions are followed).

Backwelding

Backwelding, using a thermo-plastic hot air welding gun and welding rod, can repair a leaky joint, but it is more properly used to strengthen secure joints.

When backwelding:

- wait for at least 24 hours after cementing (otherwise the heat will stress the joint by forcing the partially dried cement into a gaseous state)
- remove all traces of cement beforehand
- drain and dry the line first.

Remember

Joining socketed PVC is similar to painting an interior wall of your house. Always clean the surface first. Use the right size of applicator for the job. Use the correct types of cement and primer. Always use two coats — primer and cement.

Bleeding rack

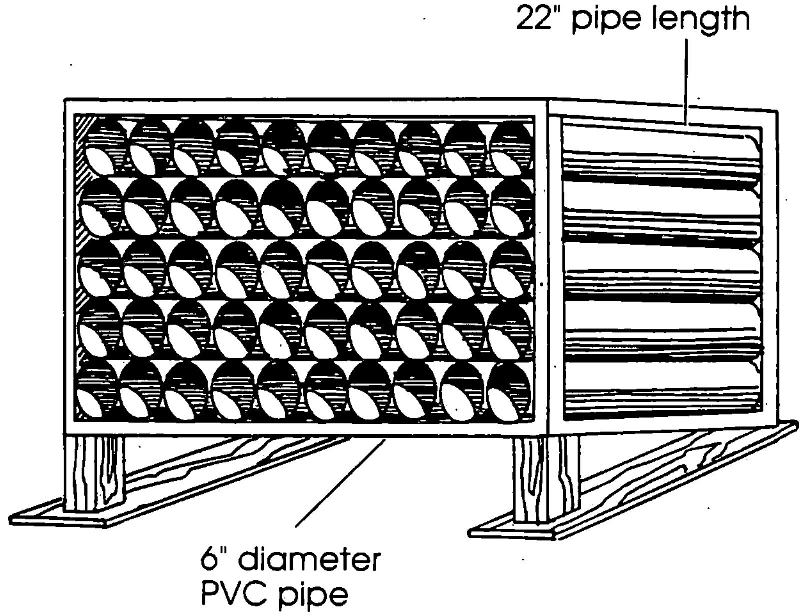
Bleeding adult salmon before removing the eggs is a fairly common practice and requires use of a rack or framework to hang the fish in a head-down position.

Most racks consist of a series of sharp spikes on which the fish are impaled just ahead of the caudal fin (tail).

The spikes may protrude unprotected from a framework, or be welded to a hinge that allows the spike to be pushed away from the operator when impaling fish. Racks with hooks and nylon rope loops are used for chinook salmon.

The exposed spike rack is extremely dangerous since a worker can be impaled as easily as a fish. The hinged spike is only somewhat safer.

The Chilliwack hatchery developed a safe, easy to operate bleeding rack using lengths of 15 cm (six-inch) PVC pipes mounted in an aluminum frame. It is primarily used for coho, chum and steelhead, since chinook may be too large to fit into the tubes.



Construction

The rack is made from a number of 56 cm (22 inch) lengths of 15.24 (six-inch) diameter 63 class PVC (thin-walled) pipe. These are mounted in an aluminum frame that slopes 18 cm (seven inches) from front to back. The number of tubes (and, therefore, the size of frame) is determined by preference and space available. Fifty tubes will hold between 100 and 150 fish.

In use

The fish is killed and the caudal artery (the major blood vessel running through the throat area just below the gills) is cut, then the fish is placed head first into the slanted tube. The framework partially blocks the rear of the tube; fish cannot fall through. Tubes can be hosed clean.

Another angle

PVC pipe can also be used for holding adults in Capilano troughs. This design cuts handling, which reduces stress, disease and egg loss.

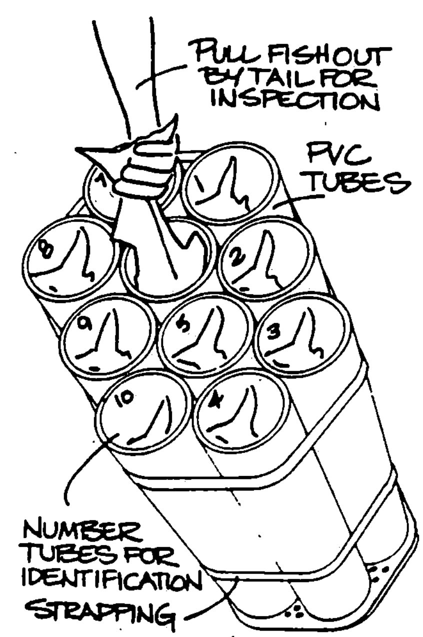
The pipe should be:

- 15 cm diameter for females, 20 for males
- slightly longer than the fish (75 cm for coho)
- smooth on the inside.

The pipe lengths are bundled as shown and tied with sash cord. Each tube is numbered and each bundle lettered for identification. Bundles are separated with cut-to-fit, perforated sheets of plywood as they are placed in the trough. The open end of the last bundle is covered with a screen or final sheet of perforated plywood. Rocks or cement blocks prevent floating. Water flow should not exceed 200 litres per minute.

For inspection, lift the downstream end of a bundle to about 45° and pull each fish out by the tail.

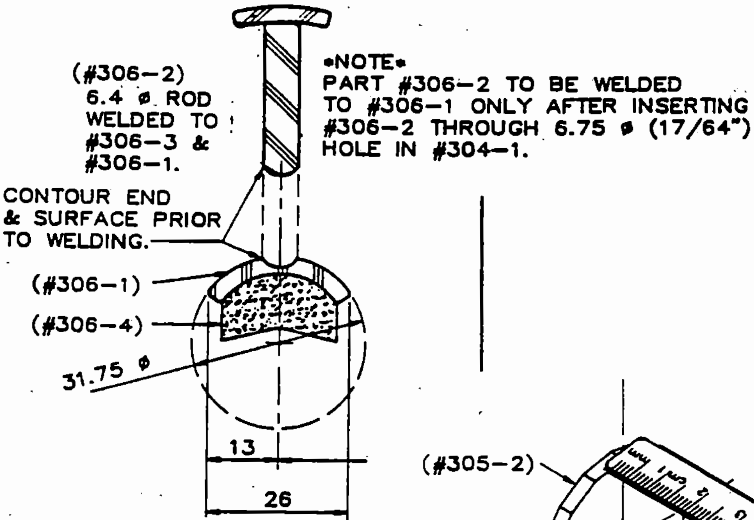
Fish must show some colouration before holding this way; silver brights do not mature well and may re-absorb eggs. Fish have been held in this system for up to three months.

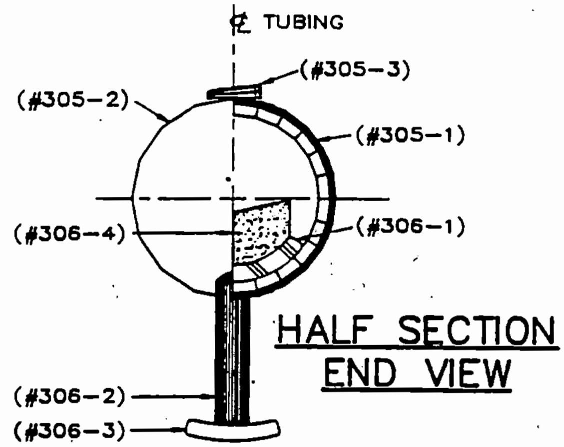


Equipment and materials

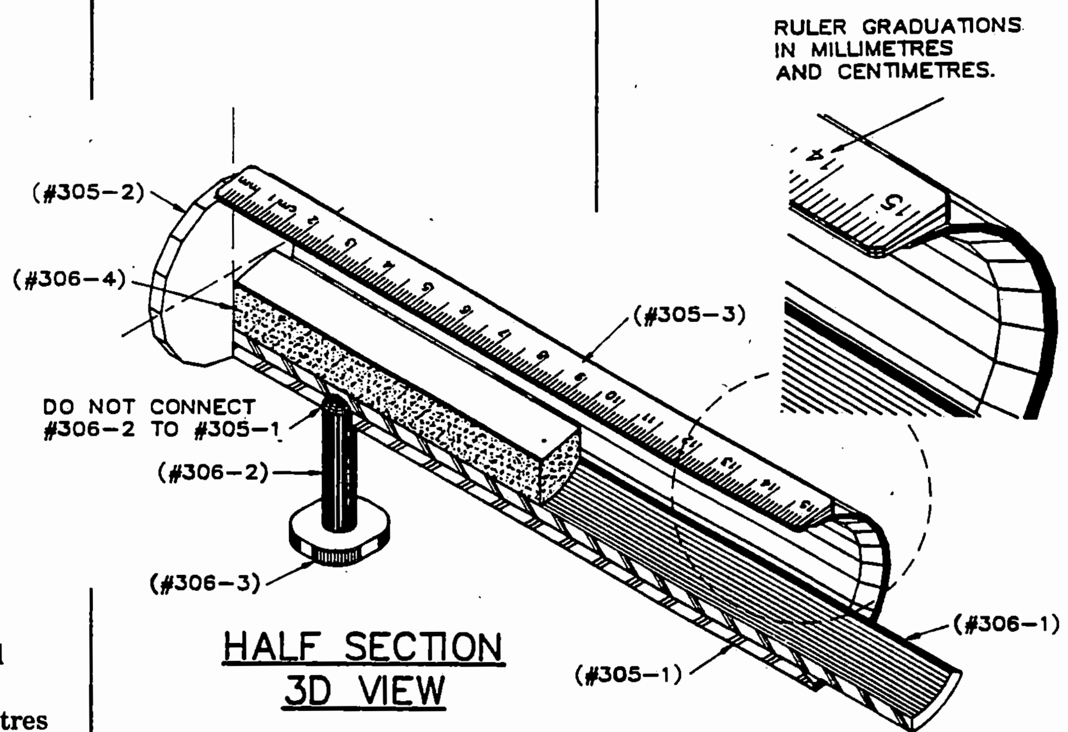
Penny fry measure

How do you get fry lengths without using a chemical anaesthetic? Try this simple juvenile measuring device invented by Clarence Boudreau at the Penny hatchery in northern B.C.





HALF SECTION
END VIEW



HALF SECTION
3D VIEW

The measure has three parts:

- a plastic tube with one end sealed,
- a ruler, marked in millimetres and centimetres, glued to the outside of the tube, and
- a foam-covered strip of plastic inside, with a plunger rod to press the fry, gently, against the side of the tube.

The drawings show how to build your own fry measure.

1. Unless otherwise noted, all parts are of clear, cast, extruded or sheet acrylic, solvent welded.
2. All corners and cut edges must be ground smooth.

Materials:

- 38.1 X 3.2 wall tubing (155 mm long)
- 6.4 rod (27 mm long)
- 10 mm thick polyurethane foam
- 177 mm strip cut from 31.75 X 3.2 wall tubing
- a clear plastic ruler graded in mm and cm
- solvent.

Assemble as shown.

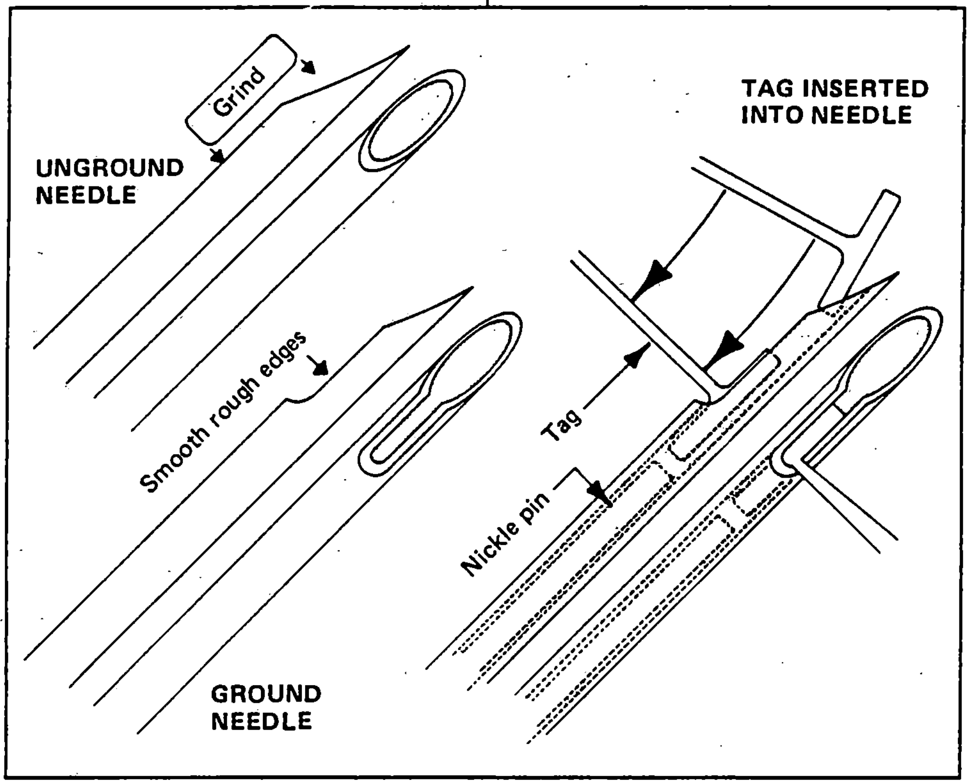
To use:

To use the measure, partly fill the tube with water, slip fry in, head down, lying between the foam and the side of the tube. Gently compress the foam strip to hold fry against side of tube. Read measure from rule. Release pressure and return fry, alert and unharmed, to the water.

Replace water in tube after a few fry to keep oxygen level up.

Things to build

Tagging gun



A gun for spaghetti tagging adult salmonids is costly, so SEP's Joe Kambeitz designed a one-shot, inexpensive tagging needle.

They are made from horse-size hypodermic needles (No. 14 gauge), available from veterinary supply stores.

To make each tagging needle, insert a piece of wire (to fit) into the hollow needle. This keeps the sides from collapsing while you grind off the side of the needle on a bench grinder. The slot created should be wide enough to allow the attachment line of the tag to go down it, and long enough to fit the tee and hold it securely (see right).

This leaves sharp edges that will cut the tee off. To smooth them, lock a pin (head out) into a drill, dip the needle into grinding compound and run the pin into the needle slot a few times.

Epoxy cement the needle to a one-cc syringe, pull out the plunger, remove the rubber cap, and stick a long nickel pin through the cap (the best are the ones that hold Petersen disc tags through the back of adult fish). Replace the plunger, push as far forward as possible; cut off the pin.

To use, clip a tag cleanly from the bandolier and insert the tee down the bore of the hypo (it can now be carried in a corked cigar tube). Tag a fish alongside the dorsal fin by sticking the needle along, just under the skin, up to the coloured portion of the tag. Press the plunger and remove the needle. Give the tag a good yank to set the tee crosswise and release the fish. Be sure the tag is not sticking out to twist in the current and create an open wound.

You can also try to anchor the tag amongst the bottom of the dorsal-rays, but be sure it is lying flat alongside the fish.

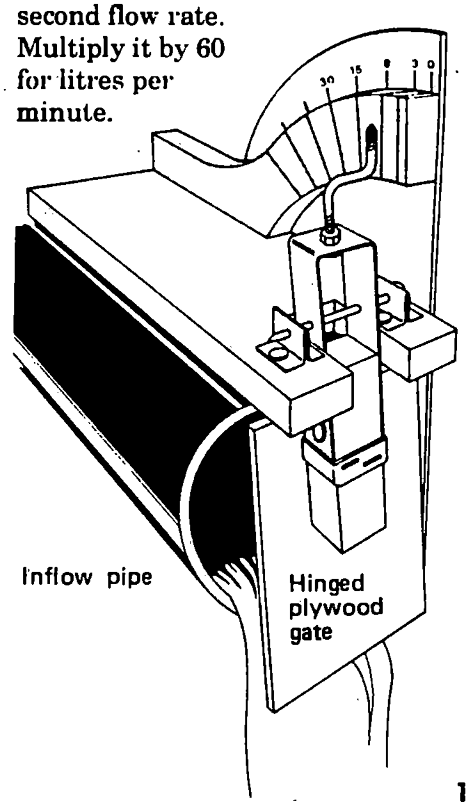
Flow gauge

Bill Chinnick designed this simple flow measurement gauge.

A piece of plywood forms a hinged gate. It hangs against the open end of the inflow pipe. The more water there is flowing out of the pipe, the wider the gate opens. A second piece of plywood is used to shape a gauge, secured atop the pipe. A bent wire, attached to the gate, moves across the face of the gauge (see drawing).

To set gauge, use the traditional calculation method once (see below*) at each of the several flow rates. Mark the position of the wire at each flow rate. In future, just read the gauge.

*To measure water flow rates: use a 25-litre pail, marked with waterproof ink or paint on the inside at 5, 10, 15, 20 and 25 litres. Put container under the flow and, *at the same moment*, start stop–watch. When water reaches one of the marks, pull the bucket away and stop the watch. Divide the number of litres by the number of seconds for a litre per second flow rate. Multiply it by 60 for litres per minute.



Equipment and materials

"Magic" intake

A great deal of material travels over a flat perforated intake plate at grade level in a stream. As small stones roll across the plate, some settle into the intake holes. The entire plate can get plugged.

A corrugated aluminum intake plate improves the situa–tion. The corrugations run **the same way** as the flow. Drill intake holes along the **ridges** of the corrugations (see illustration).

Sand and silt wash along down in the grooves; cleaner water enters through the intake holes on the crest of the corrugations.

This plate is .9 metres (36 inches) square and has 3000 holes, 0.5 cm (1/8 inch) diameter drilled into it. The holes begin 20 cm (8 inches) back from the leading (upstream) edge of the plate. This allows the sand and gravel to sink into the grooves before the water reaches the first of the intake holes.

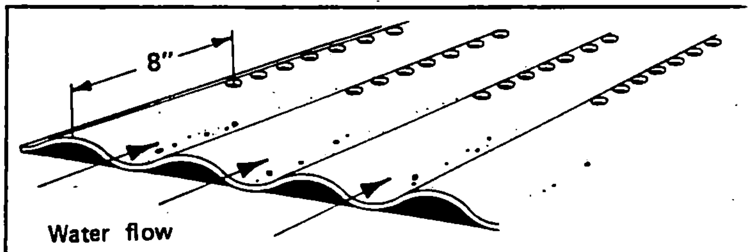
Normal operation draws 136 - 182 litres (30 - 40 gallons) per minute through the intake plate, at a 30 cm (12 inch) head using 76 mm (3 inch) diameter pipe. The intake box is equipped with a one-inch diameter bleed line at the bottom..

This works except at very high flows, when the groves cannot handle the amount of sand and gravel traveling over the plate.

A solution was devised, based on the fact that an old sandbag swished through water comes out clean because the holes in the sack are flexible. When the burlap weave moves, virtually all the material plugging it drops free.

A fine **nylon** cloth (not a mesh) over the plate takes advantage of this tendency to self-clean. Put the piece of nylon over the intake plate, attaching it only to the leading edge.

The holes in the nylon are less than one-quarter the diameter of the holes in the plate, so any material that passes through the cloth will pass easily through the plate. The movement of the water moves the cloth, keeping it clean. Maintenance is done, infrequently, with a broom. The cloth is 1/32 marquisette, available from Redden Net Company, Vancouver.

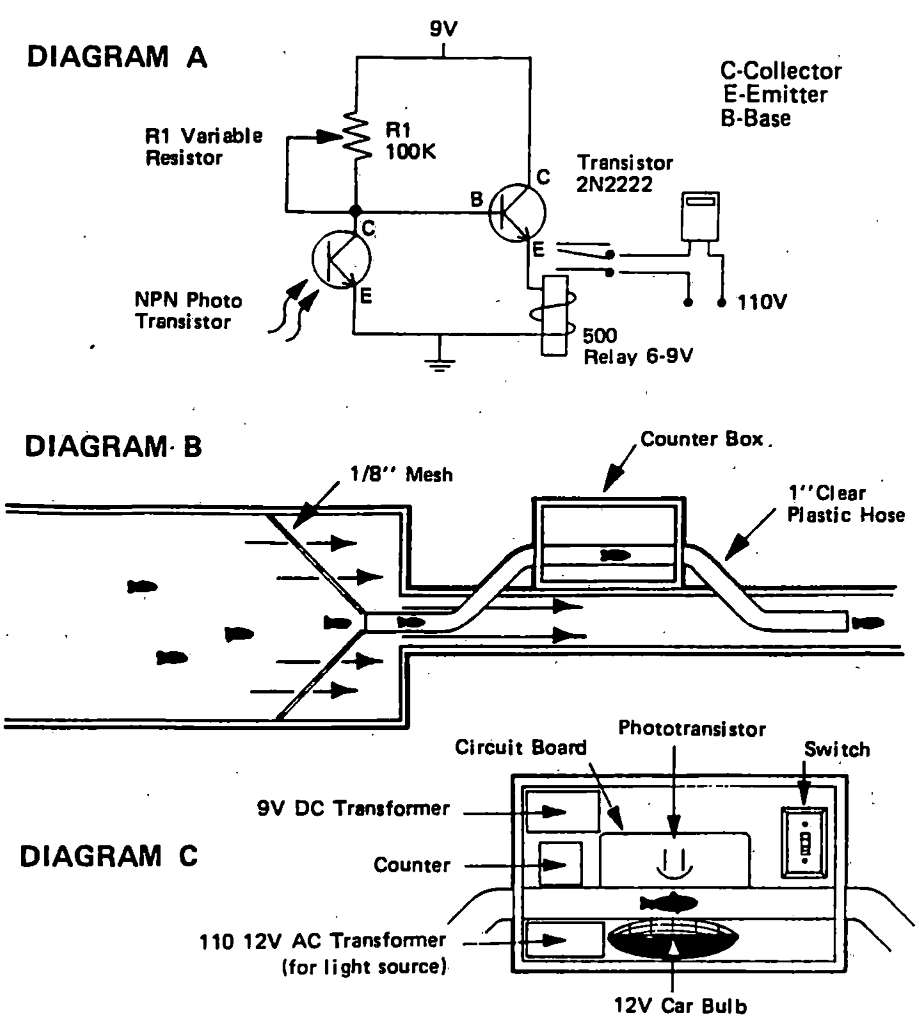


CORRUGATED INTAKE PLATE

Fry counter

The diagram below shows how to build a simple fry counting device for your project.

Phototransistor to count fry



The Tynehead egg saver

At a large hatchery, with million of eggs incubating, the loss of a few may not seem to be a serious matter. For a volunteer project, however, a few eggs lost is cause for concern.

Volunteers at the Tynehead hatchery in Surrey were concerned about one cause of egg losses. Like creative volunteers throughout B.C., they invented a solution.

In the shocking process, eggs are poured from the Heath tray. Tynehead volunteers noticed that, during this procedure, the eggs seem to bunch up, then fall all at once. As a result, a number would miss the bucket and fall onto the floor or down the drain.

Dave Harrison, one of the volunteers, came up with a simple way to solve the problem and stop the losses. Dubbed the "Tynhead egg saver," it is easy to build, inexpensive and functional. The diagram shows how it is built and gives dimensions so others can copy the design and save eggs at their projects.

Material needed:

1. 121.9 cm (48 inches) of 8 mm by 8 mm (5/8" by 5/8") wood for frame
2. 3 mm (1/8") Plexiglas to cover frame
3. 11 brass screws.

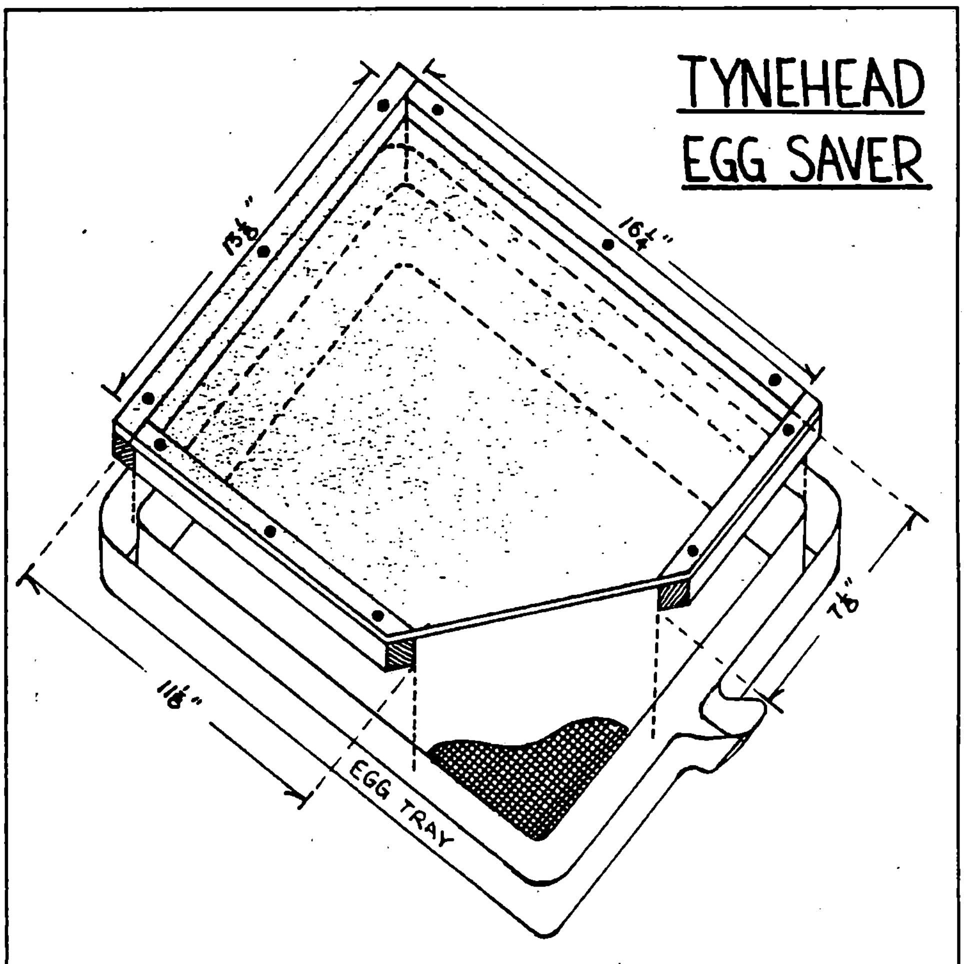
The egg saver is a see-through cover for the Heath tray. The wood frame fits into the lip around the Heath tray to hold the cover in place. When the assembled device is tipped, it funnels the eggs out through an opening in one corner.

The device has an additional benefit, too. If necessary, you can play water through the screen to wash down any reluctant eggs that have built up in the screen.

"It works well for us," say the Tynehead volunteers, "maybe it can help you, too."

Metric equivalents to diagram measurements:

11 1/8"	=	28.2 cm
13 1/8"	=	33.2 cm
16 1/4"	=	40.9 cm
7 1/8"	=	18.0 cm



The umbrella tank cover

This tank cover for round rearing tanks offers protection from birds — no small benefit. During the fall months, when the leaves are falling, it will help you keep the tanks cleaner, too.

Bill Chinnick, of the Granthams Landing Salmon Association on the Sunshine Coast, who provided this design also provided instructions on how to build an automatic feeder for Public Involvement projects (see page 7).

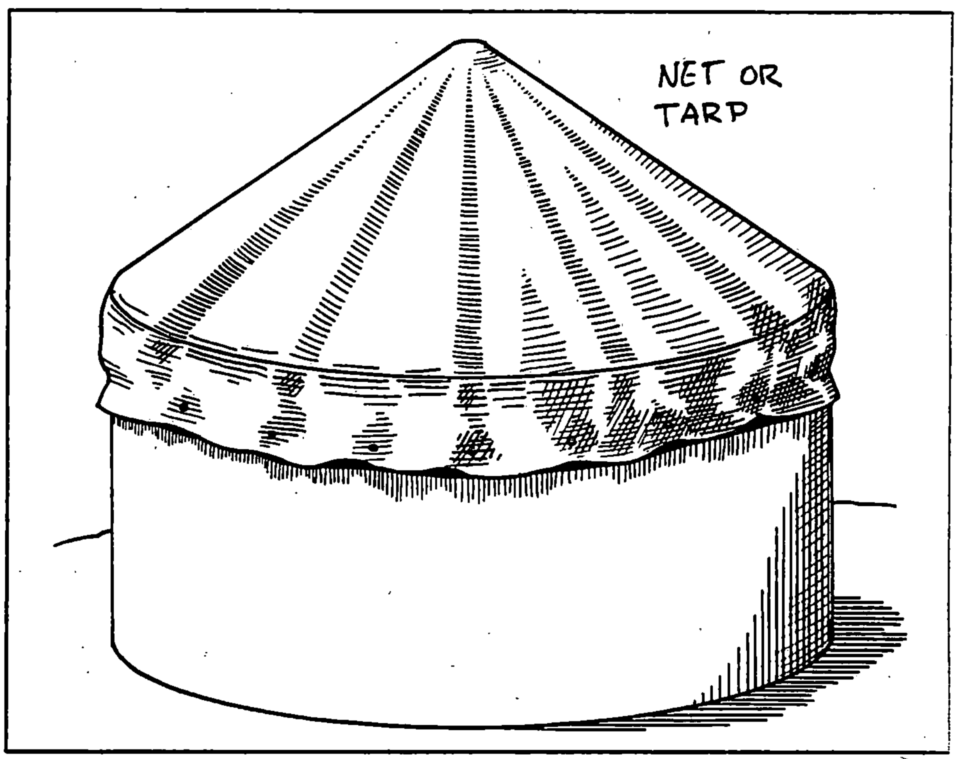
The tank cover is a simple design that can be built from easy-to-get materials. For instructions, see next page.

Different covers for different needs

The Soames Creek project, which uses this cover, has 2.44 m (eight foot) diameter tanks but this cover could be built to any size.

The umbrella-like device could be covered with netting to keep hungry birds at bay or it could be used with a tarp covering to keep out leaves and pine needles.

The Umbrella tank cover is easy to construct, made from readily-available materials, and is free-standing once in place. Disassembled, it is easy to store.



It may resemble a circus tent, but enhancement experts will recognize a circular rearing tub under the cover shown above. The device, topped with a net, foils hungry birds. Covered with a tarp, it can cut down on your cleaning chores by keeping out leaves and pine needles.

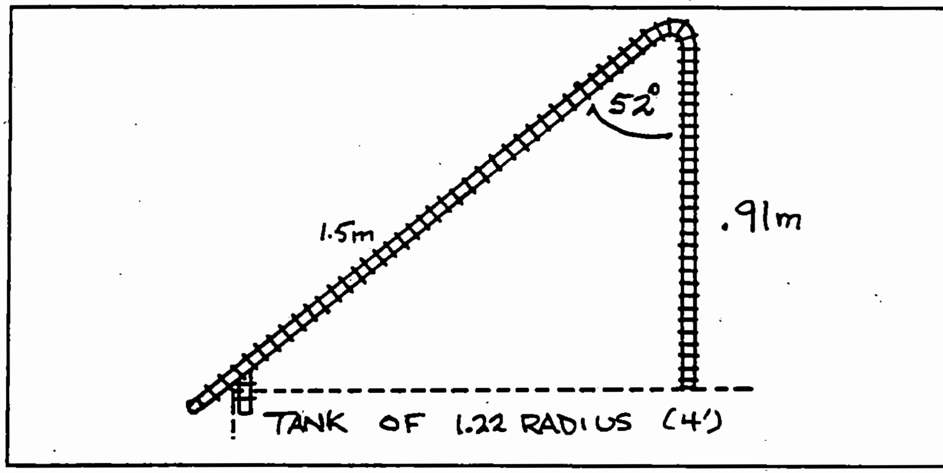
Materials needed:

✓ 10 to 12 lengths of # 4 rebar, 139.7 cm (55 inches) long (for a larger tank, use #5)

✓ one length of redi-rod or a long bolt

✓ two large washers and two nuts to fit redi-rod

✓ one length of 3.8 or 5.8 cm (1 1/2 or 2 inch) steel pipe (to hold number of arms you are using).



Method:

❍ Bend rebar lengths at one end to length indicated (for size shown, .91 metres, or three feet).

❍ Weld short stubs to bottom side a short distance from outer ends.

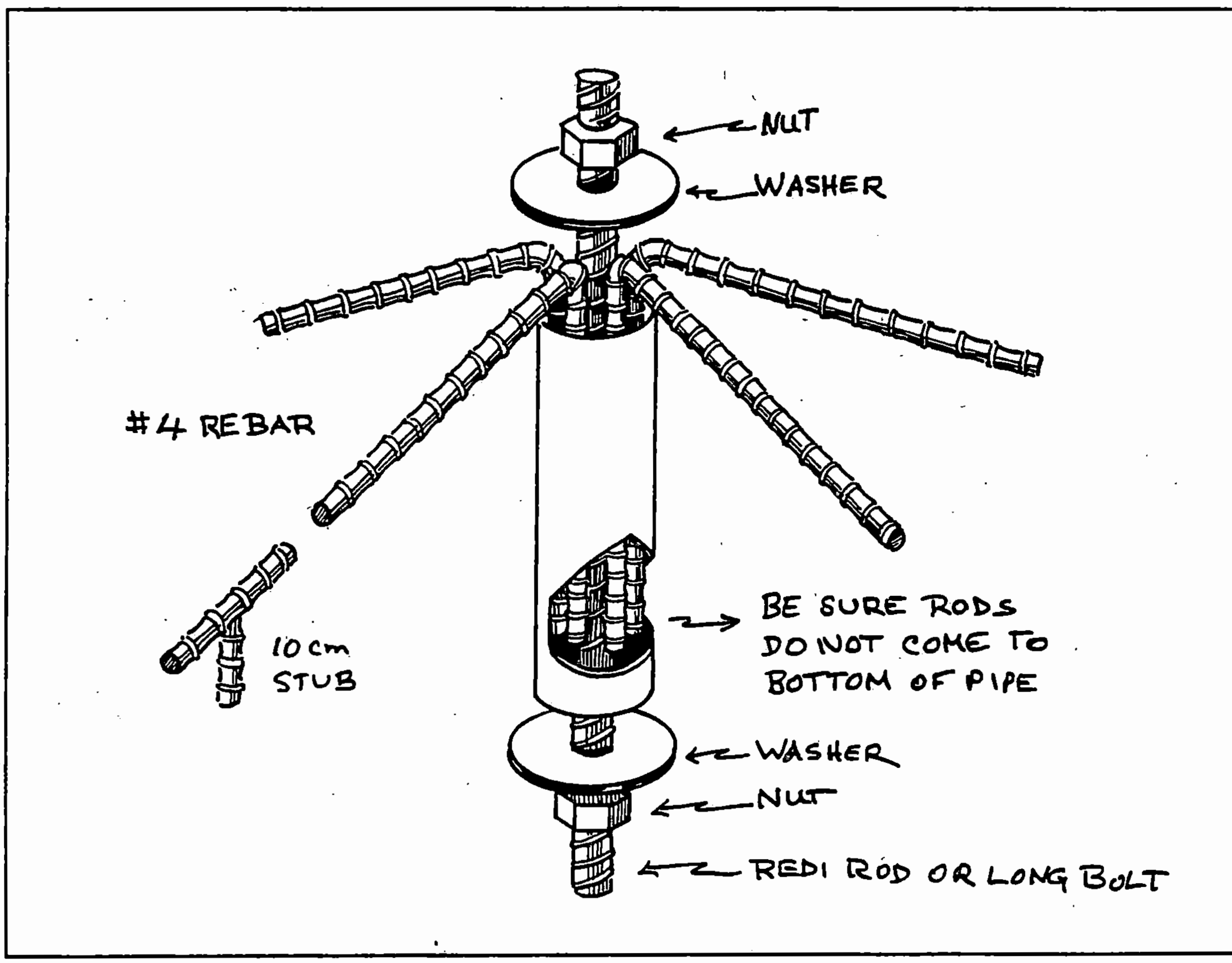
❍ Assemble center section; thread washer and nut onto bottom of redi-rod.

❍ Drop pipe onto rod and arrange rebar arms around perimeter.

❍ Add second nut and tighten to achieve umbrella effect with arms.

❍ Position unit on top of tank and cover with netting or tarp.

Note: To achieve a slope of three in twelve, use the dimensions shown.



Waders and wading

Fall brings broodstock capture. That usually means getting into the river. SEP community advisor Barry Peters (Terrace) offers the following suggestions for getting through the season without getting your feet wet.

It's November, raining of course, and I've just stepped into the river to look for coho broodstock. With Polaroid glasses on, a warm peaked hat, and my trusty waders, I should be ready to face the day.

Materials and cost

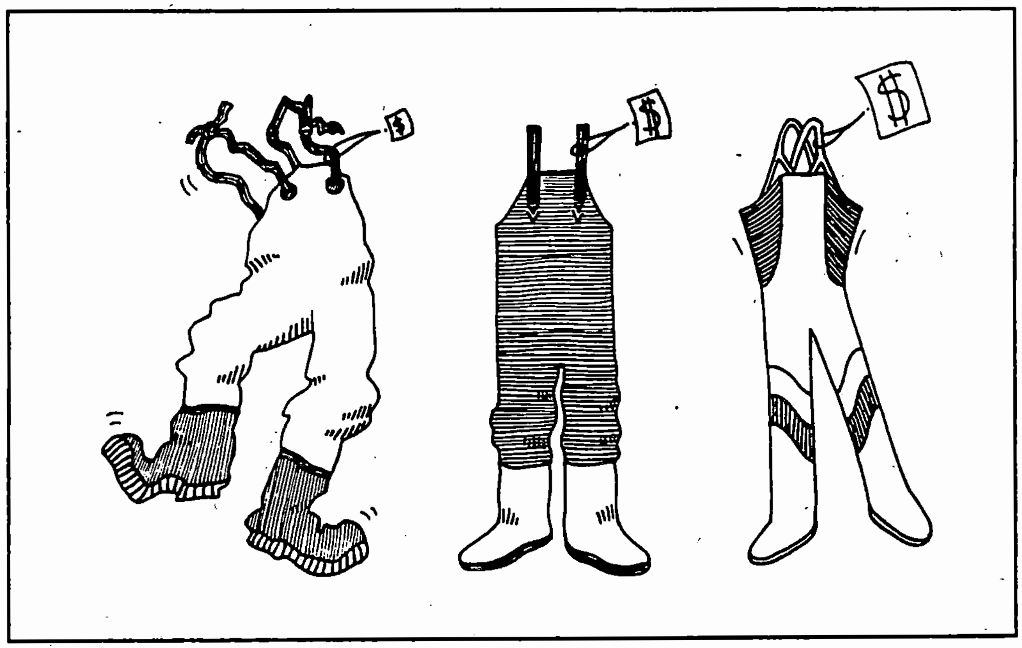
Properly dressed and outfitted you can be comfortable in almost any weather on the river. Your waders are of prime importance because they keep you dry and in some cases, as in the neoprene types, also provide insulation from the cold. There are many types of material; neoprene, rubber, vinyl, etc... all have their good and bad points. Neoprene is warm in winter but hot in summer. Leaks are sometimes hard to find and harder to patch. Rubber waders are heavy and don't insulate from the cold well but are fairly durable and easy to patch. Vinyl and nylon are light but may tear easily. Holes are fairly easy to patch, but rips are almost impossible to deal with. Neoprene can be welded back together if a rip is too large for a patch.

When wading in the river, use waders with felt soles if possible. They make a big difference in traction.

Cost is usually a factor. Made to measure neoprene waders will be at the top of the price list with rubber, nylon and vinyl following, usually in that order.

If the shoe fits...

Fit is important. Always get waders that have long enough legs to allow you to step over logs, etc. Having the crotch down around your knees will make any movement awkward and dangerous. Having a roomy but tidy fit around the body is important when you are working around nets. One accessory is important, too; a good set of suspenders usually takes a lot of tug off your shoulders. By the end of a long day, you'll notice the difference.



Rules to live by

There are some safety rules that should always be followed when you have to enter the river.

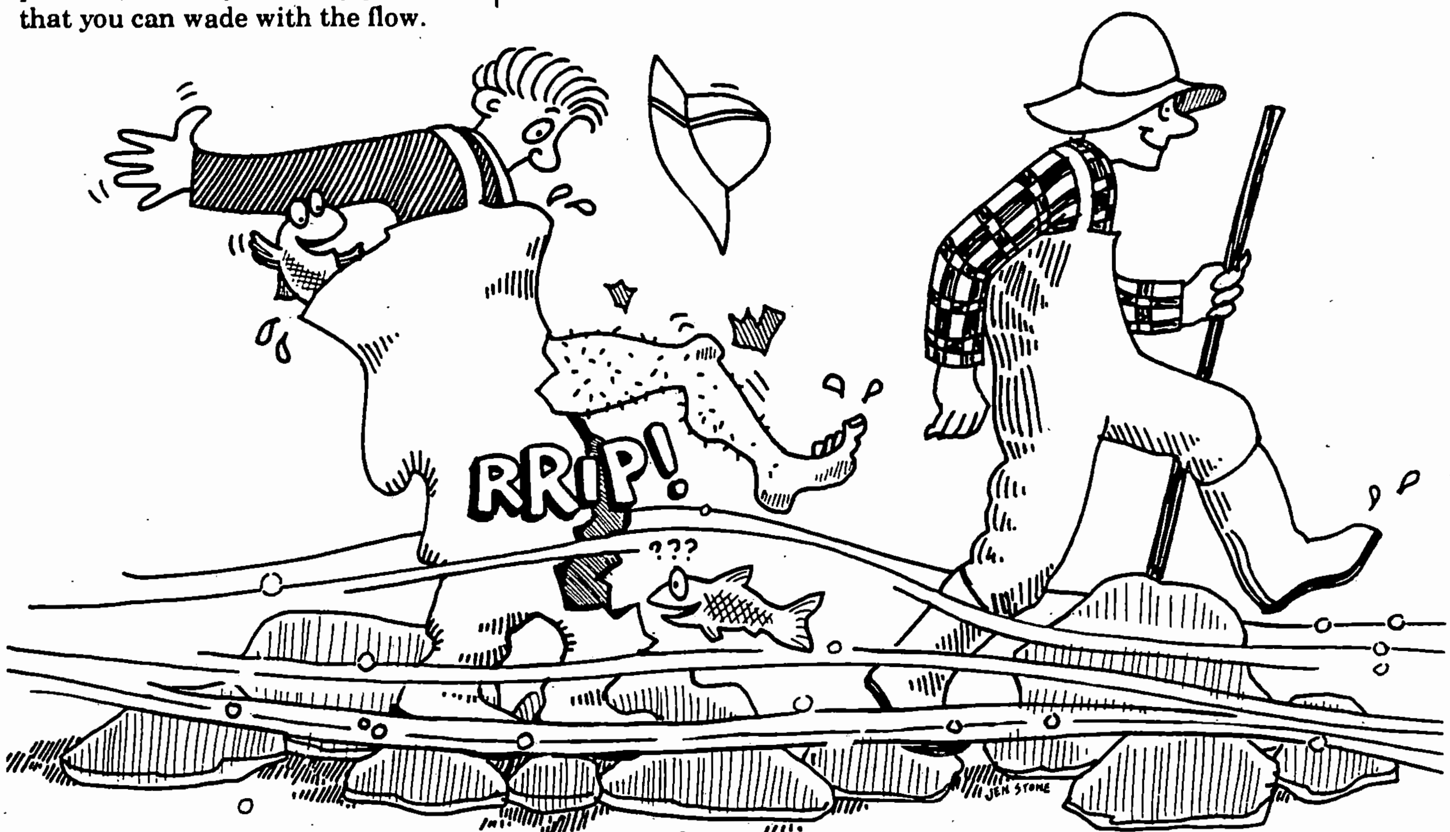
1. Always look an area over before you wade it; watch out for deep spots and fast water — areas to avoid.

2. Try to avoid wading upstream, against the current. If possible, choose your entry point so that you can wade with the flow. (If you slip, it is safest to sit down with your back to the current, so you can brace your legs to avoid being carried downstream.)

3. When crossing a stream, don't turn your back to the flow, turn sideways — you present a smaller profile to the water, you can see what is coming toward you, and you can see where you are going.

4. When crossing fast, deep water, use the buddy system; walk side by side with arms linked securely to provide each other with stability. Always communicate your stability to your partner — work as a team.

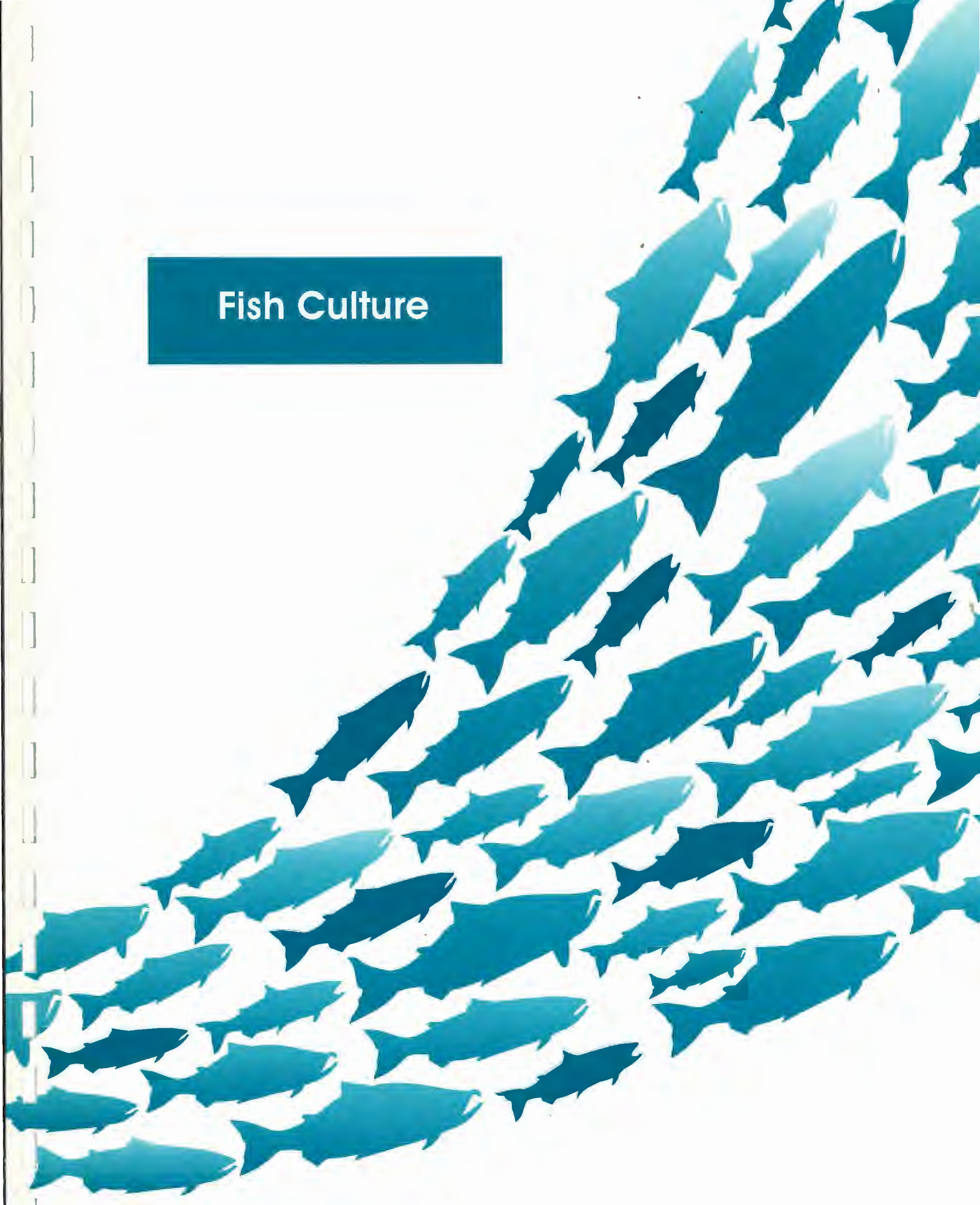
5. Take slow, deliberate steps. Always make sure your footing is secure before you take the next step.



"All work and no play..."

Wading in our streams and rivers is an essential part of any broodstock capture effort, but it offers some side benefits, too — don't miss them. Wading in a stream takes you away from the crowd. There are wonderful opportunities to see and experience wildlife along our rivers. Buy good quality, well-fitted waders and maintain them properly, wade safely, and you can enjoy it for many years to come.

Fish Culture



The anatomy of an ATU

Accumulated thermal units (ATUs) are a vital part of the fish culturist's knowledge base. Temperature affects everything from the rate at which eggs develop to the amount of feed that fry require and the amount of dissolved oxygen (DO) that water will hold. It is very important, therefore, that the culturist becomes familiar with the role of water temperature in various aspects of enhancement projects.

What is an ATU?

An ATU is defined as a measure of the sum of water temperatures over a period of time. That is, if the first day of incubation occurred in a water temperature of 8°C, the second in a temperature of 7°C and the third in a temperature of 9°C, then the ATU at the end of day three would be 24.

ATUs are used in B.C. hatcheries to determine the stage of egg development, and to predict the date of hatches. The method is quite accurately developed for most situations. Other factors, apart from temperature, do play a part in determining the speed of development as well. For this reason, when incubation takes place in particularly cold water, the fry will emerge at a lower than expected ATU reading. The time factor becomes so prolonged in such a case that emergence will occur at the lower reading. In general, the significance of other factors such as oxygen levels and water flows, which operate in nature, is minimal in fish culture operations. so temperature tends to become the major variable.

How to measure

The ATU reading is developed day by day, by charting the temperatures and adding each day's reading to the sum of the readings from the preceding days. The form shown (next page) is used to record the individual day's temperature reading *and* to add it to the preceding total so that an ongoing ATU chart is kept. (A computer and spreadsheet program can easily computerize the chart and operation.) The form allows a project to chart several different egg-takes (with different start dates) and more than one incubator for a given egg-take if necessary.

The procedure is as follows:

1. Take the temperature at the same time each day, and from the same part of the water flow. This will guard against readings being inaccurate due to localized or diurnal fluctuations.

2. Be sure to leave the thermometer submerged until the column of mercury has stabilized before reading the temperature. If possible, read the temperature with the bulb of the thermometer still submerged. If this cannot be done, be sure to read the temperature as soon as you take the bulb out of the water to avoid having air temperature alter the reading.

3. Enter the reading in the appropriate column of the accumulated thermal units chart. The chart should be kept posted close to the temperature taking site for both accuracy and convenience.

4. If there are several incubators to be charted, take and enter the temperature for each one before calculating the accumulated totals for the day.

5. Once all the temperatures are taken and recorded, add each day's new reading to the sum of those from before for that incubator. The resulting number is the ATU reading.

Abbreviated ATU Chart

Salmonid embryonic development predictions*

Species	Temp	Eyed		50% Hatch		Swim-up	
	°C	Days	ATUs	Days	ATUs	Days	ATUs
Chinook	5°	51.5	257.5	102.4	511.8	199.2	996.1
	10°	24.9	249.2	52.6	526.4	93.2	931.7
Chum	5°	50.1	250.3	99.6	498.2	168.9	844.4
	10°	22.9	229.0	54.4	544.5	104.9	1049.0
Coho	5°	46.1	230.6	93.6	467.8	155.3	776.6
	10°	22.8	227.8	45.9	459.5	81.4	813.9
Pink	5°	51.4	257.2	109.0	545.0	173.6	868.2
	10°	23.1	231.4	63.0	629.6	103.4	1033.9
Sockeye	5°	48.2	240.9	122.8	613.8	188.5	942.6
	10°	25.0	249.6	69.3	693.2	108.8	1088.2
Steelhead	5°	34.3	171.4	70.7	353.4	127.6	637.8
	10°	17.1	171.0	32.9	328.6	63.6	635.9

* These predictions were obtained by using the SIRP program described in the Can. Tahc. Rep. Can. Fish. Aquat. Sci. no. 1878 (Jensen et al. 1992)

What does the reading signify?

During the first days after incubation begins, the recording of these readings may seem boring work. The information that the record provides becomes much more interesting to the fish culturist, however, as the days pass and the ATU readings begin to near the totals at which hatchery fry can be predicted. The chart shows the ATU reading at which various species of fry can be expected to eye, hatch and emerge.

Unusually warm or cold water can cause some variations from this chart, but for most projects it will prove to be quite accurate.

What else does temperature affect?

Water temperature remains a significant factor after the fry emerge from the gravel. Fry will grow more quickly, and will require more feed in warmer water. The water will also contain less dissolved oxygen at higher temperatures. For these reasons, it is still important to keep a record of water temperatures during the rearing stage, even though the accumulated thermal unit reading is no longer significant. As the water warms in the spring, the fish culturist knows that the fish will be growing faster and may need considerably more feed. As well, if the temperature is rising, it is important to check the dissolved oxygen levels frequently (see **Tipsheet** on Dissolved oxygen).

While taking and recording temperatures each day may seem to be a lot of bother, the information that becomes available will help your project to incubate and rear a strong and healthy group of juveniles. When you consider all the work that goes into an enhancement project, the checking of temperatures is just a small amount of effort to achieve results.

ACCUMULATED THERMAL UNITS

PROJECT *Our Enhancement Project* SPECIES *Coho*

MONTH *September* BROOD YEAR *1994*

EGG TAKE NO.		1	2		3	4	5	6	7	8
INCUBATOR NO.			1	2						
DATE	TEMP.									
1										
2										
3	7	7								
4	8	15								
5	7	22	7	7						
6	7	29	14	14						
7	8	37	22	22						
8	8	45	30	30						
9	9	54	39	39						
10										
11										
12										
13										
14										
15										

Broodstock capture

Capturing broodstock can be an interesting and exciting part of an incubation project. On the surface, catching fish for their eggs or sperm seems simple enough, but mistakes can be wasteful. This **Tipsheet** offers a few pointers that may help you.

Correct species

Many times there will be two or more species of salmon and trout on the spawning grounds at once. Know what species you have permission to capture. Be sure that everyone involved can quickly and easily identify the fish you want.

Correct sex

It is very important to be able to tell the difference between male and female salmon. There is a sad story of one project that had permission to take 20 salmon. They did; 19 males and one female. This can be very embarrassing — and very wasteful.

Correct ripeness

If you have a holding facility where you can keep your broodstock live after capture, there is little problem. If, however, you are like many projects, and have to catch-and-carry, then you should know how to check a fish for ripeness before you kill it. (A firm, but gentle hand run down the belly will release eggs or sperm from a ripe fish.) This is not as easy as it sounds; learning to judge ripeness takes experience. Work with an experienced partner until you fully develop your skill.

Releasing fish

Whatever method you use to capture your broodstock; gillnet, seine, dip net, rod and line, traps, there are two important points to remember. First, don't create a poaching opportunity by leaving traps or nets unattended for others to use. Second, be prepared to release fish alive and unharmed. Many projects are working in areas where adult fish are scarce. Don't add to this problem by accidentally killing fish; check your traps or nets often; cut the gillnets if necessary to free unneeded fish. All fish that are not the right species, sex or ripeness should be set free as quickly — and carefully — as possible.

Fecundity

You should have a rough idea of how many eggs there are in a given fish. Egg numbers can vary from less than 1,000 to more than 12,000 per fish, depending on species and size. If you have permission to incubate 50,000 eggs, figure out in advance how many females you need to capture.

Be quick

The rule of every broodstock capture should be this; get in, take what you have permission to take, and get out. Most likely your broodstock capture will be from a natural stream, and you will be capturing from among the few fish that have made it past all the obstacles and perils. These are very valuable fish and every effort must be made to avoid disturbing the main spawning population in any way.

Beware of "half empties"

Unless it is absolutely necessary, don't take the fish that are half full of eggs or sperm. Many times the struggle of capturing them introduces water into the cavity and a high number of unfertilized eggs may result.

Select from throughout the run

Factors such as water levels may limit your options, but it is always best to try to select broodstock from throughout the run.

Don't pick only large fish

Don't choose all large fish for your broodstock. The size diversity of salmon is important. As in nature, you should aim for genetic diversity. When capturing, select a size and timing range similar to what you see in your creek. Also, don't be afraid to use sperm from jacks. Doing this crosses the genetics of a brood which is a year younger than the adult female.

Watch for poachers

Sadly, poachers do exist. They may wait for you to leave a fish in a holding tube or pen. Make sure that you have a secure or secret place to hold your fish for ripening and check them regularly.

Avoid stress

You are capturing and confining a wild animal. If it isn't ripe and you must hold it, you will have to make it comfortable and secure or it may die before becoming ripe. Keep your broodstock in a quiet place, away from disturbances. Watch them carefully and treat them for disease if it is warranted.

Keep a record

Record where you captured your fish, how many you took, how strong the run is, etc. That is valuable information for next year's egg-take.

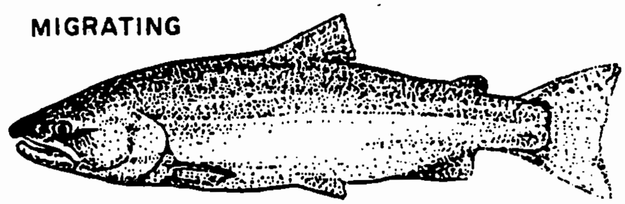
Also, contact both Fisheries and Oceans and the B.C. Fish and Wildlife Branch **before** you conduct a stream-side egg-take. You may have your permit, but if the authorities do not know where and when you will be operating, and get a call from someone who thinks you are poaching, they may waste time checking you out.

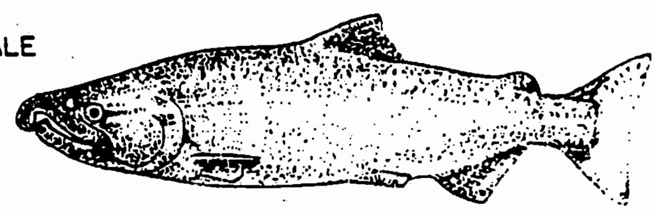
Finally, please cut all your broodstock in half (crossways) after you have used them. Long after you are gone, people may call the fishery officer and report finding "belly robbed" fish on the creek. Cutting the fish is a simple way to let them know if it is your carcass.

Species identification

Coho salmon

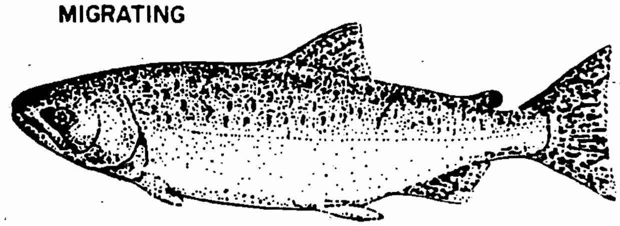
Migrating — nostrils white; black spots on back and upper lobe of caudal fin; dorsal surface a dark, metallic blue.
Male — nostrils white; body colour very dark; side of body with broad, red stripe; caudal fin spotted on upper lobe only.
Female — (not illustrated) resembles migrating form, but overall colour darker, with broad red lateral stripe.

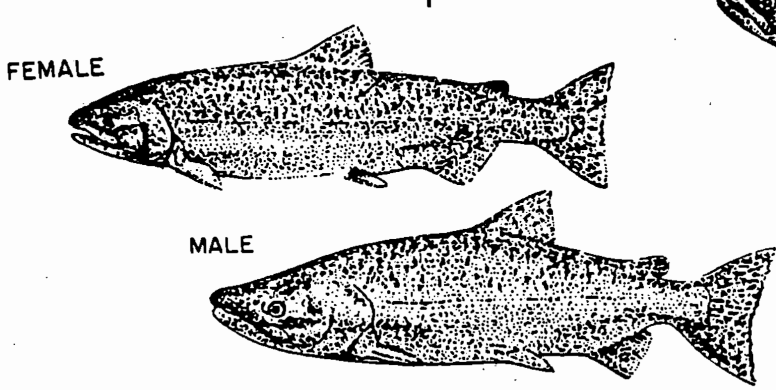




Chinook salmon

Migrating — dorsal fin greenish-blue to black; moderately large, irregular black spots on back, upper sides, dorsal fin and both lobes of caudal fin.
Male — forward part of body may deepen considerably; body spots present and caudal fin spotted on both lobes (as in migrating form).
Female — body dark; spots on body and caudal fin (as in migrating form).





For further species identification consult "Stream Enhancement Guide," available through your community advisor.

Broodstock care and egg-takes

A. Holding

Once you have obtained broodstock, you may need to hold them until they are ripe (ready to spawn). Following proper holding procedures is important.

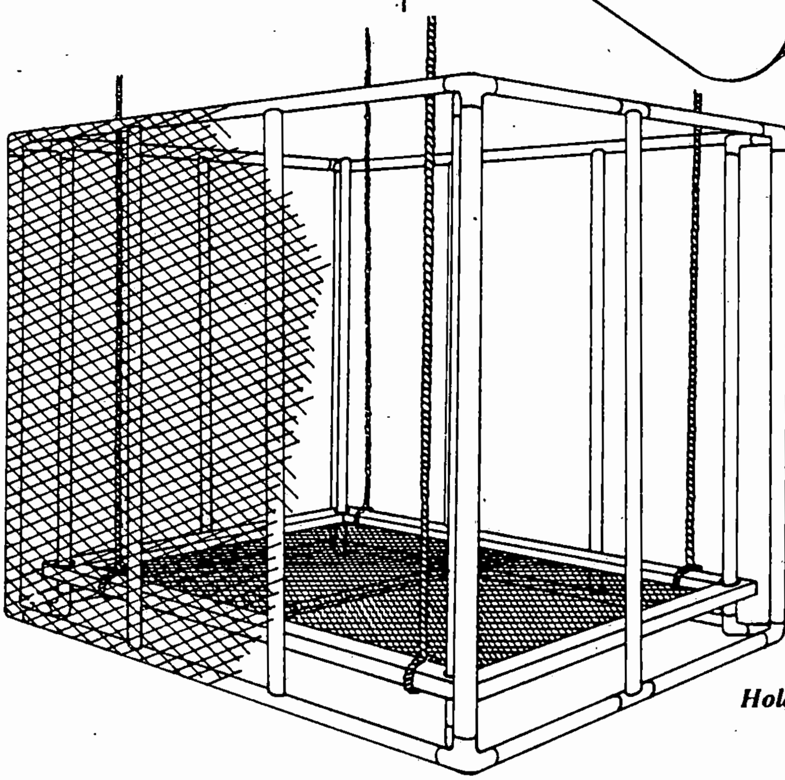
Net pens, PVC tubes, Capilano troughs with dividers or condominiums can be used to hold adult fish. Sufficient water flow is essential; if it is too low, the fish may die or fail to ripen. If possible, hold each adult in isolation to reduce frequent handling/sorting.

Holding pen

Adults can be held in standard net pens until they are ripe. This method does not allow for segregation of fish by ripeness unless you have two or three pens.

The pen illustrated has been fitted with a false bottom which can be raised to bring fish to the surface for handling and sorting.

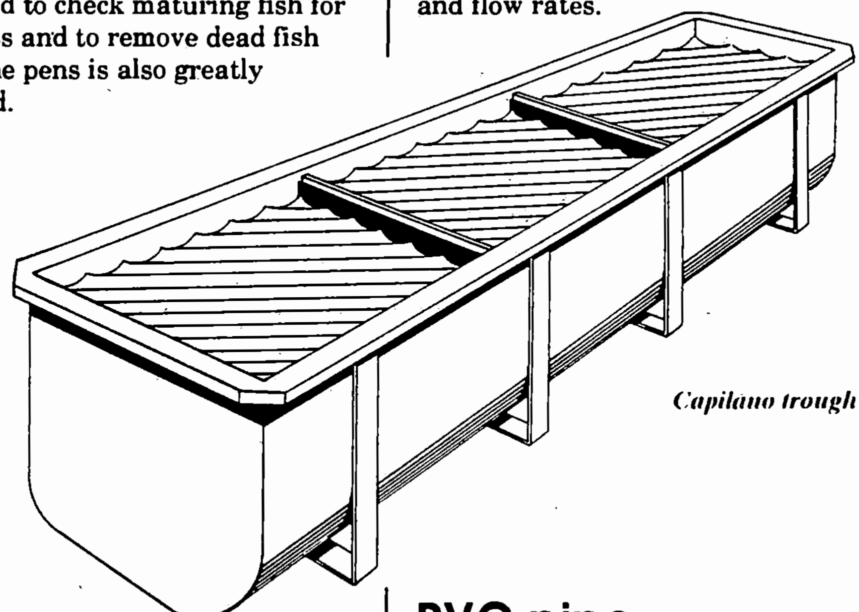
The false bottom is made of net-covered aluminum. This is fitted to guides which run up each of the 50 mm (2 inch) diameter galvanized corner posts, using rings on the false bottom. Ropes are attached to the bottom and used to raise it. This creates a shallow pen from which you can remove fish easily to check them. The fish are much calmer when handled this way. The effort required to check maturing fish for ripeness and to remove dead fish from the pens is also greatly reduced.



Holding pen

Capilano trough

Capilano trough dividers can be used to segregate green females by degree of ripeness. This cuts down on handling and sorting which stresses fish. Dividers may be positioned anywhere in the trough, and moved if the number of fish in each group changes. Watch for rough aluminum sides, which can cause injury and check loading and flow rates.



Capilano trough

PVC pipe

Capilano troughs can provide individualized holding for broodstock if PVC pipes are used.

Each fish is kept in a length of pipe. The pipes are tied in bundles and arranged in the troughs with perforated plywood dividers separating each bundle.

The pipe should be:

- black or white PVC
- 15 cm (6 in.) diameter for females
- 20 cm (8 in.) diameter for males
- cut just slightly longer than the fish; 75 cm (30 in.) for coho
- smooth on the inside.

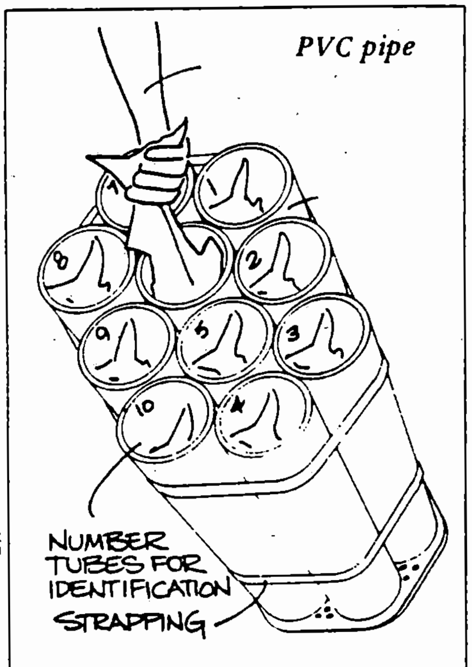
They are bundled as shown in the diagram. Because of the weight of fish, water and tubes during handling, the individual tubes must be drilled at both ends and lashed to their neighbours with codline.

Each tube is numbered and each bundle lettered for easy identification. Each bundle must also be lashed, all around the edges, to its perforated plywood sheet which should be 3/4 inch material.

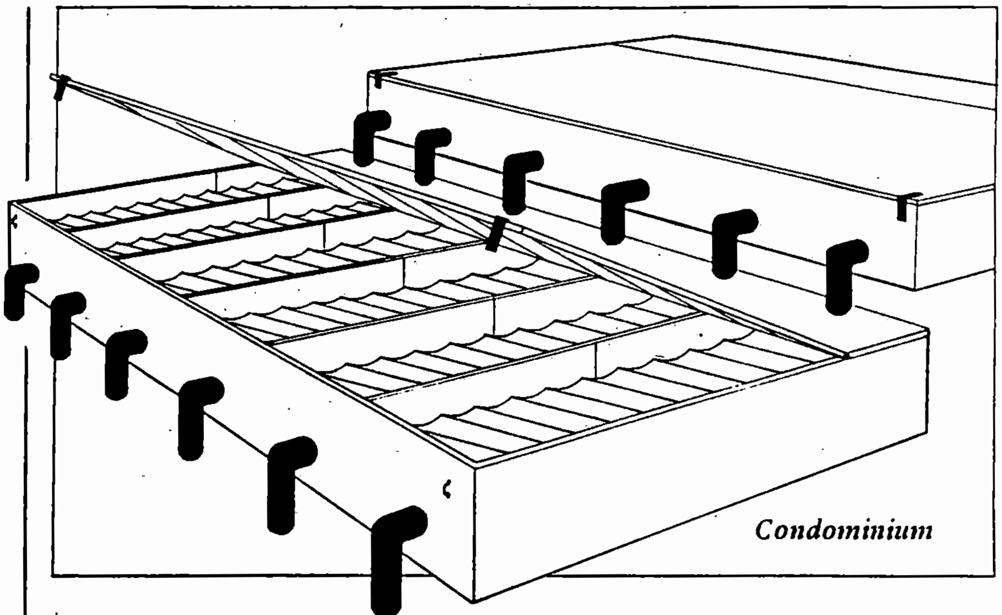
As each bundle is loaded with fish it must be tied with two lines to the downstream end of the Capilano trough. To prevent fish escapes, place 25 mm (1 inch) mesh anti-predator screens over the trough and weight them down.

When the last bundle is placed, close its end with a piece of plywood or a screen to prevent escape. Rocks or cement blocks will prevent floating.

Check that water flows are appropriate.



PVC pipe



Condominium

Condominium

Condominiums are waterproofed plywood boxes, each large enough to hold two fish. Two banks of these condominiums can be assembled as illustrated, allowing the water to flow from the first units into the second set. Because the fish can be handled individually there is less stress and it takes less time to check the broodstock.

Condominiums can be used effectively by placing a green female with a ripe male to speed her ripening. (Monitor this closely.) Flow load rate should be 1 to 1.2 kg/litre per minute. Volume load rate is 32 kg/m^3.

Staple waterproof paper onto the holding unit to identify each fish by species, sex, stream origin, capture date and condition of ripeness. Handle adults in holding as infrequently as possible to reduce stress and possible mortality.

B. Sorting

Before sorting your females (ripe versus green), and killing those which are ripe, you should be sure that there are ripe males available (either in holding or easily caught in the stream). Sperm is much more sensitive and loses its viability more quickly than eggs; therefore it should be taken last.

The following describes the general procedures to follow when sorting your fish. Always work with an experienced egg-taker your first few times.

Grasp the female fish by the tail, being prepared for a certain amount of thrashing. It's best to use a wool mitt on this hand. Do not allow the fish to bang against any hard surfaces. For chinook it may be necessary to anesthetize the fish in order to handle it.

There are several characteristics to look for. When a female ripens, the eggs detach from the skein and become loose inside the body cavity. When the fish is held up by the tail, the loose eggs will slump down towards the head end. In addition, if the fish is relaxed, the belly should be soft to the touch. You should use your bare, free hand to check for this.

If the fish is relaxed but still firm, return it to its holding container. Make a note of the date and condition of the fish. With experience, you will be able to predict when to check again. Watch for general health as well as ripeness when checking your fish..

If the fish feels soft and looks ripe you can confirm this by trying to express a few eggs from its vent. While grasping the fish by the tail with your mitted hand, tuck its head under your other arm and turn it to a horizontal position. When the fish relaxes, use your free hand to gently stroke its abdomen from the pectoral fins toward the vent. If the fish is ripe, light pressure should cause the ovipositor to extend slightly and eggs to be expelled.

Be very careful with this technique. If too firm a pressure is applied, eggs can be broken internally. The yolk from these eggs will coat surrounding eggs and greatly reduce the fertilization rate. It is also possible to expel a few loose eggs from a fish even though the majority are still bound to the skeins. If you rely solely on this technique, you may be misled into killing an occasional green female.
Check all the indicators, rather than relying on just one.

C. Egg-takes

With experience you should be able to easily recognize ripe fish by look and feel. If there is still any doubt about a fish being ripe, return it to the holding container for another day. Following proper procedures once your fish have ripened will ensure the success of your incubation project.

Killing

When you have determined that a female is ripe, suspend it by the tail with your mitted hand and kill it with a sharp blow between the eyes. Avoid any blows too high on the head towards the body cavity and do not have the fish resting against anything when you strike it. Either action could cause broken eggs and internal bleeding. It's also best to have a thong attached to the handle of the killing club and wrapped around your wrist. This will prevent the chance of a flying club injuring a co-worker.

Bleeding the broodstock

Hang the freshly killed fish by the tail (head down) on a bleeding rack. (See page13 for a safe design). Locate it in the shade. Use a knife to sever the artery in the throat area just below the gills.

Allow the blood to drain for three to five minutes. This reduces the chance of getting blood into the eggs while stripping. Although it has been shown recently that a moderate amount of blood mixed with eggs does not significantly reduce fertilization, it is still a good idea to avoid blood contamination.

The eggs should be stripped from each female within 10 minutes of killing, especially if the weather is hot or freezing. Depending on the size and experience of your egg-take crew, you will have to judge how many fish to kill at a time.

Stripping the fish

A minimum of two people are required for stripping eggs and milt. Protection from both sun and rain and a plentiful supply of paper towels are also essential.

• Females

One person (the fish holder) should remove the females from the bleeding rack in the same order they were killed (first to last). Use a dry, mitted hand to grasp the tail. Use your free hand to wipe the fish clean with paper towels.

Once the fish is clean and dry, grasp the head with your free hand. Place your thumb and forefinger in the eye sockets or under the gill plates to provide a good grip. Tip the fish upright over the spawning basin with the ventral side outwards. Do not tip the fish upright until it is over the basin or you could spill some eggs.

The second person (the fish stripper) should use a “Zak” spawning knife to slit the fish. The incision should be made from the vent, around the outside of the ventral fin and then up to the center of the abdomen to the top of the body cavity.

Keep the distance the eggs must drop to a minimum. Some eggs may remain attached to the skeins. Any that do not fall off with a gentle shaking should be discarded.

A small amount of blood mixed with the eggs may be unavoidable. Try to keep it to a minimum; dry paper towel can be used to blot up most of it. The stripper should check for water hardened eggs (particularly if the fish appears partially spawned). These will be translucent, as opposed to the opaque colouration of normal eggs, and the hardness will be easily distinguishable by touch. All of the eggs from such a fish may be in the process of water hardening and therefore unfertilizable. They should be discarded unless you are having serious trouble attaining your egg quota. If so, you could retain, fertilize and incubate them separately. This will prevent them from adversely affecting your good eggs.

Definitely discard the eggs from any female with cloudy ovarian fluid. These eggs could spread disease.

Once the stripper has checked the eggs, they can be poured into the appropriate containers (i.e., one for good eggs and another for questionable eggs). Slope the bucket so that the eggs roll gently down the side. Replace the lid on your egg bucket, then wipe the spawning bucket clean and dry with paper towels. While all this is going on the fish holder should be preparing the next fish. Keep an accurate record of the total number of females stripped.

- **Males**

Once all the eggs are taken, put the bucket in a cool, secure place. You can then proceed with stripping the males.

Depending upon the availability of male broodstock, you can either kill them prior to stripping (for ease of handling) or strip them live and return them to the holding containers (for re-use later).

Before killing the males, check to see if they are ripe. This is done by expressing a small amount of milt, by much the same procedure as for expressing eggs from the females.

Once you have a ripe male, wipe it dry with paper towels. Then one person holds the fish and the other holds the milt receptacle. Ziploc bags are ideal for this purpose.

When expressing the milt, the stream initially may appear watery. The person holding the container should wait until the milt is milky white before moving the receptacle to catch the stream. About 10 to 20 ml from each male is sufficient. Don't try for too much milt or you may contaminate it with blood or feces.

If the fish holder is using a wool mitt, make *certain* that water from the mitt doesn't run down the fish and mix with the stream of milt. Water activates the swimming motion of sperm. This lasts for only 10 to 15 seconds before they die.

You should strip at least as many males as females at each egg-take to maintain genetic variety. Strip each male into a separate container as it is thought that sperm from some males may dominate when pooled with others. These procedures are particularly important when dealing with small populations (fewer than 25 pairs).

Each container of milt is sealed (watertight) with at least an equal volume of air inside. Keep these cool along with the eggs (i.e., on ice in a cooler).

Fertilization and planting

Once you have collected an adequate supply of milt, you are almost ready for fertilization and planting at the hatchery. First, you may want to set aside some or all of your broodstock carcasses for sampling. This involves length measurements and scale sampling (to determine age). The sampling can be carried out later.

Next you must calculate approximately how many eggs you have. Take three 50 ml subsamples and count the number of eggs in each. From this, calculate the average number of eggs per 50 ml. Using a measure (as small as practical, for accuracy), determine how many ml of eggs you have in total. Now multiply these two figures to determine the total number of eggs as follows:

number of eggs/50 ml X total ml of eggs = total number of eggs

Knowing the number of eggs per ml allows you to divide your eggs up into convenient amounts for fertilization and planting (i.e., 5000 chinook or 8000 coho eggs for each Heath tray). Divide your bags of milt equally among the lots of eggs.

You are now finally ready for fertilization. Add several (two or more) bags of sperm to each lot of eggs. Never fertilize a group of eggs with milt from just one male (it might be sterile) or even with a single bag of pooled milt (it might be contaminated with water).

Once all the milt is added to a batch of eggs, pour in some water to activate the sperm. Gently mix by hand for 10 to 15 seconds. Wait a little longer (just to be sure) then rinse with clean water. Drain off the excess water, then plant the appropriate number of eggs in each incubator. Record the number of eggs in each incubator. Record the volume (in ml) and the number of eggs in each incubator along with the date and stream of origin.

If you follow these procedures carefully, you will greatly increase your chances for a successful egg-take and a high fertilization rate.

Choosing — and using — disinfectants

Disinfectants are essential in running a hatchery operation, large or small. This **Tipsheet** offers information from B.C. Ministry of Environment's Fish Health biologist Sally Goldes.

Before using *any* chemicals, consult your CA for up-to-date regulations and practises.

Introduction

Strategic and effective disinfection of eggs, equipment, rearing units and facilities is the best defense against disease, particularly viral and bacterial diseases. Too often, however, disinfectants are used improperly, thereby creating a false sense of security. The objective of this article is to describe the proper use of disinfectants commonly used in fish culture.

Overview

Detergents and hand soaps are suitable for cleaning hands and surfaces of organic matter prior to disinfection. In general they are very poor disinfectants and should not be used with this purpose in mind. Alcohol is used commonly to sterilize dissecting gear in combination with flaming. Bleach and iodophors are the chemicals of choice for routine disinfection of surfaces, rearing units and facility disinfection. Iodophors, when so labelled, are the disinfectant of choice for eggs.

Comparative efficacy

Disinfectants are used to rid (sterilize) surfaces of fungi (i.e. Saprolenga), bacteria (Furunculosis, BKD, ERM, BGD), viruses (IHN, IPN), protozoa (Itch, Trichodina, Costia, etc.) and monogenetic trematodes (Gyro). No given chemical is universally effective against all of the above pathogens. For example, iodophors are effective against fungi, bacteria, and viruses but *not* against protozoa and trematodes.

Chlorine, on the other hand, is effective against protozoa and trematodes. As well, it is critical that disinfectants be used at the correct concentration and for the right length of time to achieve their purpose.

Types of disinfectant

Common disinfectants for fish culture include:

Generic name	Common name
Detergent	Detergent, soap
Alcohol	Isopropyl alcohol
Sodium hypochlorite/ Calcium hypochlorite	Bleach, HTH
Iodophors	Wescodyne, Argentyne

Human safety

• Hands, face and eyes

Good quality rubber gloves should be worn when working with both stock and practical solutions. Some active ingredients (chlorine and alcohol) may cause skin irritation. *Always* wear protective glasses when working with disinfectants; many (particularly chlorine and alcohol) are capable of causing serious and irreversible eye damage and/or blindness.

• Ventilation

Chlorine bleach releases vapours which are harmful to eyes, nose, throat, and lungs. When exposed to high levels of gas, it is possible to be incapacitated. Ambient gaseous levels of chlorine should be *well* below one ppm (Workers' Compensation Board). Easy-to-use, on-site testing kits are available. When working in enclosed spaces and/or with stock solutions, a full face, nose and mouth respirator fitted with an "organic vapour, acid, gas" NIOSH approved cartridge *must* be worn. This cartridge will protect the wearer from levels of chlorine up to 25 ppm. If, during exposure to the gas (while wearing the respirator), the chemical is tasted and/or smelled, then:

i) the mask does not fit properly (one size does *not* fit all), **ii)** the cartridge is spent, or **iii)** the gas levels are higher than the protective capabilities of the cartridge. If possible, work with stock solutions out-of-doors unless you have access to a fume hood.

Environmental safety

Use disinfectants sparingly and neutralize them before discharge. Chlorine is easily dissipated by aeration (beware of gas release), or neutralized (5.6 grams sodium thiosulphate per 3.8 litres of water containing 200 ppm of chlorine). Neutralize iodine by adding sodium thiosulphate until the solution is clear and colourless.

Follow WIMIS regulations for storage, check restricted chemicals list before purchase or use.

Effective application

Disinfectants work *only* if used properly. The following procedures and factors must be heeded in their use.

Surface preparation

Surfaces must be *absolutely* free of organic and inorganic matter before you apply disinfectant. Organic matter binds the active ingredient, reducing the effective concentration, and it keeps disinfectant from contacting the surface. Scrub surfaces first (a mild detergent, hot water, and a scrub brush — *plus* elbow grease!). Rinse thoroughly with clean water. The simple rule — if it's not *clean,* it is a waste of time to disinfect it!

Factors

• **Water temperature:** lower water temperature requires longer contact times; higher temperatures increase efficiency by two to three times per 10° C increase.

• **Water hardness:** hardness in excess of 300 - 400 ppm destroys disinfecting ability.

• **Contact time:** insure adequate (preferably excessive) contact time. Disinfectants do not kill on contact. It may take minutes to hours for organisms to die. In general, use the following guidelines; exceed them if feasible.

Iodophor	100+ ppm	30 min.
Chlorine	200 ppm	60 min.
Chlorine	100 ppm	2 hrs.
Alcohol & flame	70-80 %	10 min.

Strategies for use

Disinfect properly, but only at selected points in fish culture practice, as allowed by the Bureau of Veterinary Drugs:

1. At egg-takes.
2. When eyed eggs and equipment are brought on-site,
3. After equipment has been used on diseased fish, and
4. On equipment and rearing units after a group of fish has been removed.

Specific tips

• **Isolation:** sanitation and isolation are as important as disinfection. Isolation should be practiced in the incubation room (separate boots, gloves, and equipment being left — and used — *only* in that room). It is easier to keep infection out than to remove or kill it!

• **Sanitation:** disinfection is no substitute for sanitation. Thorough cleaning of brushes and other equipment is essential. Never leave organic debris on equipment — it is an ideal medium for bacterial growth.

• **Foot baths:** foot baths don't work — organic matter on boots renders them ineffective and contact time is totally inadequate. Use separate boots for incubation room and high-risk area.

• **Floors:** consider the floor "hot." Discard any fish that fall on it and immediately disinfect any equipment that is dropped. Do not let hose nozzles rest on the floor.

• **Disinfectant stations:** be sure disinfactant is at proper strength before use; mix new batch if in doubt. Clean equipment with hot, soapy water before disinfecting it. Rinse equipment after disinfection. Keep the rinsing area clear of contaminated equipment. Be aware of proper disposal of contaminated rinse water.

Specific surfaces

• **Hands:** "germicidal" soaps are not effective. Use gloves if working in critical areas. In other areas, wash with scrub brush, soap and the hottest water that can be tolerated for 30 - 60 seconds.

• **Egg:** surface disinfection can be done at specific times (during and immediately after water-hardening; after eyeing). Use a buffered iodophor at 100 ppm for at least 10 minutes. Always disinfect eggs before bringing them on-site. (Be sure you have transport approvals for moving eggs.)

• **Equipment:** use iodophors at 400 ppm and discard when the colour turns from dark to light brown. Equipment must be *fully* submerged to be disinfected!

• **Small rearing units:** use iodophor. Fill the unit to over-flowing, add the iodophor to obtain 100 ppm, mix well and leave overnight. Paint exterior surfaces with full-strength iodophor.

• **Large rearing units:** chlorine is less expensive than iodophor. Apply chlorine so that at least 200 ppm is maintained for one hour and 100 ppm for at least two more hours. Observe safety precautions.

A final note

No one disinfectant kills everything, so follow disinfection with drying for as long as possible in a warm room and/or exposure to sunlight — nature's disinfectant!

Cold water incubation

Unusually cold weather during incubation can cause problems for fish culture projects. The following information from Frank Velson at the Pacific Biological Station in Nanaimo may help you during the next cold snap you encounter.

Water temperatures and salmonids

Pacific salmon spawn in British Columbia rivers from August until January. Steelhead, the sea-going form of rainbow trout, spawn from March till June. Thus spawning occurs over a great range of water temperatures, from 3.5° to 17° C.

Pink salmon, the species least tolerant of cold, spawn from July till near the end of October, the warmest period of the fall and winter.

Coho, the most cold-tolerant species, spawn from August until the end of January. In addition, all species have both cold- and warm-temperature adapted stocks such as the sockeye in the Stikine River on the Alaska-B.C. boundary and those in the Nimpkish River on Vancouver Island.

Information on tolerances

Information on lower lethal temperature limits (LLt), the temperatures at which mortalities occur, is sparse. The accompanying table shows the temperatures for a LLt at 10 percent (LL10) and at 50 percent (LL50) mortality. This temperature data is tentative as it was established with very few data points, and without information on incubation of cold-water adapted stocks.

Mortality table

Species	Mortality 10%	Mortality 50%
coho	2.0°C	0.5°C
chinook	4.2	3.0
steelhead	4.5	2.0
chum	5.0	2.5
sockeye	5.2	2.8
pink	5.0	3.8

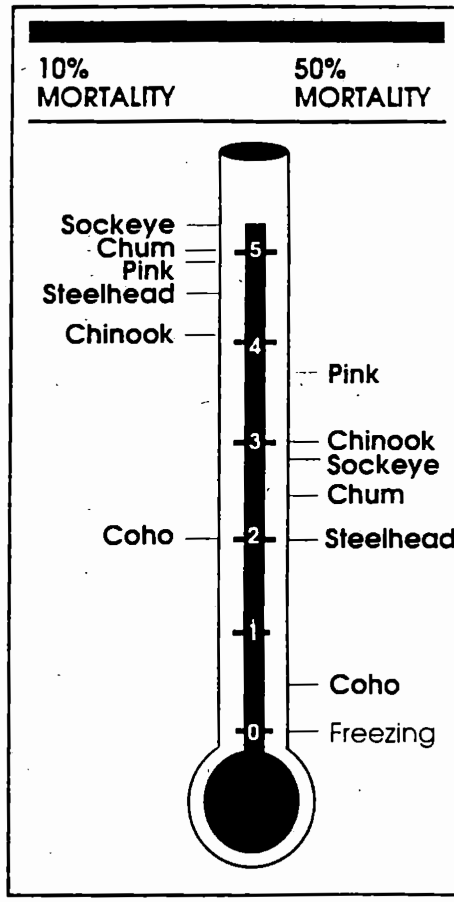
The body of this table refers to constant and ambient incubation temperatures; constant meaning that the range around the mean temperature was not greater than 2°C (that is, plus or minus 1°C). Ambient temperatures may cover quite a range starting at 12°C at fertilization and declining during incubation to about 4°C, depending on the time of the year. The initial "warm" period of 12°C is essential to the survival of the embryos of warm-water stocks.

This information suggests one incubation strategy.

A. Starting warm

If hatchery water temperature is low (4-5°C) when green eggs arrive for fertilization, mortality can be kept to a minimum by incubating these eggs for about three days or more in water at 6 to 8°C before dropping the temperature down to 4°C.

This will allow the early cell divisions to progress to a more low-temperature-tolerant stage (usually beyond the 128-cell stage). The lowest mortality can be



achieved if incubation in 6-8°C is carried through until the eggs are eyed. From the table it is clear that this initial low temperature does not form a problem for coho.

Sockeye experiment

An experiment carried out at the Pacific Biological Station with two sockeye stocks (Nimpkish and Stikine) provided, among other things, information on:

1. Stock differences in relation to incubation temperature,

2. Low mortality due to a higher initial incubation temperature for a few days, and

3. Insignificant temperature-related stock differences, at maximum alevin wet weight (MAWW).

The eggs of these two stocks started incubation at 6.5°C for 54 hours (until the 128-cell stage) after which temperatures were altered to 1,2,3,4 and 8°C. Eggs from the "cold water" Stikine River, when incubated at 3°C or lower, hatched about 20 days sooner than those of the "warm water" Nimpkish, thus showing their adaptation, as a stock, to lower temperature incubation.

At 1°C, mortality was high (92 percent) for the "warm water" Nimpkish eggs, but low (four percent) for the Stikine eggs. At ponding time (swim-up) there was no significant difference in MAWW between the two stocks. This indicates that initial differences between eggs of two stocks can even out by the time the fry start migrating.

Some further strategies for successful incubation have been developed. They require taking special precautions in very cold water.

B. Temperatures at fertilization

Initial low incubation temperatures can be damaging to incubating eggs. However, rapid transfer at fertilization, from a low temperature to a higher one, (and vica versa) does not cause mortality. **Eggs of all species mentioned may be fertilized at 4°C to be placed immediately in water of a higher non-lethal temperature for incubation.**

C. Cold water strategies

During an egg-take the air temperature may be well below freezing. It is then necessary to protect eggs and milt from freezing. Mortality from freezing is rapid and complete. Eggs may be safely kept at 6-8°C for up to 24 hours. Milt is more sensitive, however, and must be kept, as soon as possible after collection, at about 1-4°C in containers (whirlpacks) with lots of air space. Under those conditions milt may be kept for 100 hours and still give 90 percent fertilization success.

On warm days, it is necessary to strip the milt and place it in cold storage very shortly after capture of the fish.

A final note

Of the salmonids discussed here, pink salmon are the least tolerant of cold. Their eggs cannot be incubated at under 4°C until they are faintly eyed.

In general it is necessary to assure that hatchery water is about 6-8°C during the first 60 hours or so of incubation and, if at all possible, until the eggs are eyed.

Egg counting

If you are incubating eggs, you have to count them. This is the Von Bayer enumeration method, for use with eyed, water-hardened eggs. While not completely accurate, it is fast and requires relatively little handling of eggs.

Equipment

- a V-shaped trough, *exactly* 30.5 cm (12") long; it can be constructed from wood or plastic,
- a suitable, accurate device for bulk measuring eggs. A one-litre, drained, graduated cylinder is good; larger buckets produce inaccurate measurements because eggs in the bottom are compressed.

Procedure

1. You can use a quick volume count, a known, historic eggs-per-litre figure, or a weighed/counted sample (best) to estimate the number of eggs taken.
2. **After** the eggs are eyed; shock and pick. Count dead eggs, then take three random counts of number of live eggs which align in the V trough. (If there is a variation of more than five percent in three counts, repeat with three new random samples.)
3. Average all counts; round to nearest half egg. Convert to eggs per litre, using this table.
4. Measure out all eggs, using the same graduated cylinder. Be careful, accurate; do not to underestimate.
5. Calculate total number of eggs by multiplying the total number of litres by the eggs per litre figure from the table (right). This number plus the dead count will be more accurate than your green egg estimate.

Modified Von Bayer egg counting chart

Number of eggs in 30.5 cm trough	Number of eggs in one litre
34	1623
35	1758
36	**1927**
37	2096
38	2266
39	**2435**
40	2648
41	2842
42	**3057**
43	3293
44	3515
45	**3757**
46	4022
47	4312
48	**4577**
49	4864
50	5172
51	**5110**
52	5801
53	6194
54	**6536**
55	6901
56	7296
57	**7612**
58	8063
59	8548
60	**8939**
61	9353
62	9793
63	**10263**
64	10761
65	11294
66	**11861**
67	12468
68	12895
69	**13574**
70	14300
71	14815
72	**15353**
73	16211
74	16818
75	**17457**
76	18130
77	18839
78	**19578**
79	20362
80	21187
81	**22057**
82	22977
83	23455
84	**24452**
85	25508

Egg shocking and picking

Although the survival rates for incubation projects are much higher than in nature, you will have eggs that were never fertilized successfully, and others which die during incubation.

These dead eggs should not be left in your Heath trays or incubator as they will begin to decay and thus will provide a medium for fungus growth which may spread to healthy eggs.

Eggs that are dead will appear opaque, or nearly so, when compared with healthy eggs. They can be removed **carefully** as they appear, or you can identify and remove virtually all dead eggs in one operation by physically shocking them. Physical shock will rupture the yolk membrane of dead eggs and cause them to turn white due to protein coagulation. After shocking, dead eggs should become opaque in 24-48 hours.

There are some very specific ways to undertake egg shocking. Failure to observe the necessary precautions can result in high mortalities, so study the **Tipsheet** fully before you begin. If you have any questions, consult your community advisor.

When to shock

Until they reach the eyed stage (not below 220 ATUs for coho), your eggs will be **extremely** sensitive to any disturbance. It is therefore essential that the eyed stage be reached before you attempt to shock eggs. You should not wait too long after the eyed stage, however, or you will risk causing premature hatch. If the incubation is done in very cold water, the eyed stage may develop sooner. (Development is dependent on time as well as temperature.) If in doubt, leave the eggs a few more days; they still have a long way to go before hatch.

How to shock

Once the eggs have developed definite eyes, there are three methods that can be used to shock them.

1. Pour the eggs into a bucket of water. If you are using Heath trays, this is a simple egg shocking operation. Take one tray from the stack, remove the screen and pour the eggs, from a height of about 18 inches, into a bucket of incubation water.

Clean the tray then pour the eggs back into it and replace it in the stack. Move quickly and efficiently during this operation.

2. Siphon the eggs from an incubation box. You can siphon the eggs through a short length of garden hose and into a bucket about one-half full of incubation water. Once the batch has been transferred by siphon, you can pour them back into the incubation box.

3. Use a dipnet. If it is not possible to siphon the eggs from your incubation box (i.e., there is not enough head), you can use a dipnet to remove the eggs. The idea is simply to create enough of a physical disturbance to cause the eggs to change colour. Pour them from the dipnet into a bucket (again, from about 18 inches). Once the eggs are all removed in this manner, you can return them to the incubation box.

Egg picking

After shocking the eggs, leave them for 24-48 hours. By then, all the dead eggs should have changed colour. Remove them.

It is important that the dead eggs be removed without damaging the others. You can use a siphon-tube turkey baster to carefully pick up each dead egg and remove it. You can also mount a paperclip on each side of a forceps or bent metal strapping tool to make an egg-picker that will do the job safely.

Dead egg count

You will want to keep track of the number of mortalities so you can calculate survival rates for your project to each development stage. During any counting or calculating procedure, keep eggs in moving water, *or* keep them cold and moist at all times.

The easiest way to count dead eggs is to use a hand tally counter as the dead eggs are picked. Subtract that number from the number of eggs you started with to get the survival figure.

Taking inventory

By volume

Rather than counting individual eggs, you may want to make a volumetric calculation of the number of eggs you have when you are carrying out the shocking and picking operation. If you made a volumetric calculation of the number of eggs you took before water-hardening, you will have to recalculate your eggs per millilitre figure because the eggs will have swollen during water-hardening. To do this, use the following method:

1. Use a small graduated cylinder or measure (e.g., 50 ml).
2. Take a scoop from the eggs being inventoried. Use a dipnet so the excess water is removed.
3. Gently add the eggs to the graduated cylinder.
4. Count the number of eggs in this sub-sample. Do at least two sub-samples for each group of eggs being inventoried.
5. Calculate the total number of eggs by multiplying the number of eggs in the average 50 ml sub-sample by the total ml of eggs in that incubator.

For example, if the average number of eggs in the sample is 200 eggs per 50 ml, and the total volume of eggs in the group is one litre (1000 ml), then 200 divided by 50 X 1000 = 4000 eggs. (See formula in Figure 1)
6. Subtract the number of dead eggs from the number of live to get the live total and the percent survival to the eyed stage (see formulas in Figure 2). Be sure to record all data accurately. The number of fry to be released can be calculated from this inventory.

Figure 1

Formula for total number of eggs if using 50 ml cylinder:

$$\frac{\text{number of eggs in sub-sample}}{\text{volume of eggs}} \times \text{total volume of eggs (ml)} = \text{total number of eggs}$$

For example:

$$\frac{\text{200 eggs}}{\text{50 ml}} \times \text{5000 ml of eggs} = \text{20,000 eggs}$$

Figure 2

Formula for percent survival:

$$\frac{\text{total number of live eggs}}{\text{number of eggs taken}} \times 100 = \text{percent survival to eyed stage}$$

For example:

$$\frac{47{,}200}{58{,}000} \times 100 = 81.4\%$$

Be accurate

Bear in mind that estimating by volume is not nearly as accurate as by weight. If you *must* use the volume method, keep the containers in which you measure as small as is practical. The weight of eggs in a large container will compress the eggs near the bottom and will produce a greater number of eggs per litre than in your counted sample, taken from a smaller container.

Feeding and pond cleaning

Feeding

For those of you engaged in hatchery operations, spring is fry emergence time. If you plan to feed your fry prior to release, there are a few things to consider that will ensure a healthy crop of fish.

Getting started

The first few weeks after initial ponding are critical. Water temperatures are usually cold and the fry are learning feeding behavior. Like human babies, young salmon must be fed small amounts of feed frequently throughout the day.

Newly ponded fry may be skittish and hesitant to feed. If the fish appear nervous despite your best attempts to move slowly and quietly, you may want to try providing cover for the rearing containers to reduce levels of stress. It is quite possible that feathered and/or four legged predators are harassing them when you are not around.

Patience must be exercised to ensure that all of the fish are learning the feeding response. If care is not taken, a variation in size will develop and a large number of fry may eventually starve to death because of their inability to compete.

Feeding rate

As time goes by, and fry grow, the amount of food consumed at each feeding will increase while the frequency of feedings will decrease. Warmer water temperatures also cause an increase in the amount of food your fish require.

In order to determine the proper feeding rate we must know the average weight of the fry (see **Tipsheet** titled "Sampling fry", page 79), the number of fry, and the average daily water temperature in each rearing container.

With this information, we can determine the feeding rate, using "Staufer's Feeding Guide." (If you do not have a copy, consult your community advisor.)

The accompanying table can be used as a guide to determine the frequency of feedings and the pellet size to feed.

Automatic feeders

Some projects may be using, or may anticipate acquiring automatic feeders. These are useful tools for cutting down on time demands, which is important in a volunteer operation.

Do not, however, be lured into a false sense of security and forget to observe the fish frequently to see how they're doing. The fish feeder is the person closest to the fish and is usually the first to recognize any subtle changes in behavior or appearance. And, in all likelihood, he or she would be the "firefighter" in the case of a sudden emergency.

An experienced fish feeder will quickly recognize a small problem and take action before it becomes a big one. If close scrutiny of the fish is neglected, "Murphy's Law" (what can go wrong, will go wrong) will eventually prevail.

Feed Rate Chart

Food Size		Fish Size	Feeding Frequency
No. 4 starter	mash	until fish feed aggressively (1 - 2 weeks)	as often as possible during daylight hours
1.0 mm	1/32	up to 0.9 grams	6 - 8 times a day
1.3 mm	3/64	0.9 to 1.8 grams	4 - 6 times a day
1.5 mm	1/16	1.8 to 3.0 grams	2 - 4 times a day
2.5	3/32	3.0 to 9.0 grams	2 - 4 times a day
3.0	1/8	0.9 and up	2 - 4 times a day

Oxygen consumption

As fish digest and metabolize their food, oxygen is consumed. The more food they eat, the more oxygen they consume. Monitor the situation or low dissolved oxygen levels may become a problem. In an emergency, oxygen demand can be reduced by cutting down feed rations (growth rate will also be reduced).

Feed storage

Storage of food is extremely important, as salmonids are very susceptible to nutritional deficiencies. Improper storage of feed can lead to loss of its nutritional value and may result in fish of poor quality and increased disease susceptibility.

Since most PIP hatcheries don't have large freezer facilities, they are supplied with Bio-diet fish food. This semi-dry food can be stored, unopened, for up to three months without freezing if kept at cool temperatures. The following are storage guidelines for Bio-diet:

❍ Store in a cool, dry place.

❍ Shelf-life for *unopened* bags of starter is 60 days.

❍ Shelf-life for *unopened* bags of pellets is 90 days.

❍ *Shelf-life for opened bags of starter or pellets is four days.*

Pond cleaning

Sanitary conditions are of utmost importance in any rearing operation where salmonids are unnaturally crowded in a confined living space.

Before fry are ponded, the rearing container should be cleaned and disinfected (See **Tipsheet** on Disinfectants) to rid it of any disease organisms which may be left from a previous batch of fish. If possible, allow the rearing tank to air dry and bake in the sun (this can be difficult in our West Coast climate!). Ultraviolet light from the sun is an excellent disinfectant.

Once the fry have been ponded, it will be necessary to clean the container periodically. The frequency of cleaning is left to the operator's discretion, bearing the following in mind:

A. Feces and waste food will build up quickly in containers with low velocity flows. If this organic sludge is allowed to accumulate for very long it may become a breeding ground for certain disease-causing organisms. On the other hand, every time you clean the container, the fish are being stressed and you are not encouraged to become overzealous. There is a happy medium somewhere, and each operator must determine what is appropriate for his or her project. Your community advisor can help you decide this.

B. Each rearing tank should have its own set of equipment (nets, brushes, etc.) and a separate bucket of disinfectant for soaking its implements. This will help to prevent transmission of disease from one rearing container to another. Consult your CA for advice on appropriate disinfectants.

C. Dead or sick fish can be a source of infectious agents and should be removed and tallied daily. Keeping daily mortality records will alert you to any developing problem.

Tools

Brushes or suction devices are the two most common tools for cleaning rearing containers. Brushing the container is the quickest method, but is probably the most stressful to the fish. Care must be taken that the sediment is stirred up as little as possible during cleaning. Suspended particles can cause gill irritation and further problems may develop later.

Suction devices can be purchased or fabricated. They use either a pump or siphon action to suck organic material from the bottom of the rearing container. This method is more time-consuming, but it's easier on the fish.

Fish culturists are good at developing innovative ideas for rearing containers and cleaning devices which help to reduce the time spent doing this mundane, but very necessary chore. You may want to try putting your ingenuity to the test.

Stress

Finally, the word "stress" has been used frequently in this **Tipsheet**. The importance of minimizing stress cannot be over emphasized Although fish may not exhibit immediate symptoms of stress from handling or overcrowding, their resistance is necessarily weakened and delayed outbreaks of disease may result. Even if you manage to avoid a disease outbreak, the marginal condition of the fish will make them an easy mark once they are released to the wild.

By keeping these tips in mind and exercising care and common sense, you should be able to release a healthy group of fish with greatly enhanced chances for survival in the wild.

Spring chore list:

- Mend nets
- Patch waders
- Clean buckets
- Repair rain gear
- Wash floor
- Weigh fish food
- Flush aeration tower
- Make dip-nets
- Painting
- Plumbing

Feeds and feeding

Fish feeds have a long and interesting history. Years ago, in England, fish culturists filled wire cages with slaughterhouse offal and hung the baskets over their ponds. In warm weather, maggots would develop in the material and, as they fell into the pond, the fish were fed! This rather primitive automatic feeder had another feature; when the weather got cold, the maggots stopped forming and, since the fish also stopped feeding in cold water, the whole process was self-regulating.

In early fish culture on the west coast, items like liver and fish eggs were commonly used as feed for salmon — not surprisingly, disease was a common problem.

Feed manufacture is now an exact science. The ingredients include ground fish scraps, liver and krill. Feeds are pasteurized to eliminate disease-producing organisms. Various formulas are available for feeding every hatchery-raised species from salmon to catfish. There are also medicated feeds for disease prevention and/or control.

Today, two types of feed are commonly used at SEP projects; semi-moist and dry. Several factors should be considered in feed selection; your Community Advisor will help you decide what is best for your project.

Once a feed product has been selected, you want to get the best value for the dollars you spend on it. As with anything you buy, you will generally get the best price by buying in volume, but you must also consider your total seasonal requirement for each size of feed and your storage facilities. It may be possible to coordinate your purchases with those for a nearby SEP hatchery.

Fish feed has storage requirements and a limited shelf life. If you cannot provide the recommended storage condition, or if you exceed the manufacturer's suggested storage time, the feed may go bad. There is a more subtle concern, too; outdated or improperly stored feed may seem fine, but it may have lost some of its nutrients.

You can tell if feed has gone "off" by a changed odour or colour, or by spots of mold or fungus. You cannot easily tell that it has lost nutrients — a chemical analysis would be required — but your fish will certainly feel the effects. If you are in doubt about the condition of a package of feed — don't feed it. You have invested a lot of time and effort in your fish and there is the danger that a suspect batch of feed may have long-lasting detrimental effects.

The table offers some facts about fish feeds that may be useful for your project.

Project specific choices

The information in this **Tipsheet** is general. Each SEP project is different and questions about which feed to buy, how much to purchase at a time, how much to feed and how often are complex.

Many elements have to be considered. Always consult your CA before deciding on a feed and a feeding program.

Miscellaneous feed tips:

Light is the enemy; it can deplete nutrients and cause breakdown of feeds.

Air can draw off nutrients and cause loss of moisture. Keep feeds in the most airtight container available.

Other creatures may take a fancy to fish feeds; protect them from insects and animals.

Don't feed more than the fish will eat in a short time; food on the bottom of rearing containers can breed disease.

FEED PACKAGE & STORAGE TABLE

Product	Package Sizes	Shelf Life	Storage Requirements
BioDiet	5, 10, 20 kg	60-90 days	20°C or cooler Shelf life can be extended; refrigerate or freeze unopened bags
Ewos Dry	25 kg	6 months	Cool (18°C), dry; no sunlight

Nutritional Analysis (Approximate percentages)

Feed	Protein	Fat	Moisture
BioDiet Starter	43.0	14.5	20.0
Ewos Starter	50.0	15.0	9.0

Fry and smolt survival factors

All fish culture is geared to increasing survival rates during the early stages of the salmonid life cycle. During incubation, controlled water quality and temperature can ensure maximum survival to hatch; alevins are kept in a protected environment to ensure that as many as possible will become fry and the resulting fry are fed to promote growth so that strong, healthy smolts will be released. At all stages, protection from predators and natural disasters produces the desired result — a survival rate far in excess of what nature allows. Once our fish leave our care, however, they must fend for themselves — the only advantage we can give them as individuals is to rear and release them under optimum conditions so that they will be well equipped for life on the wild side.

Over the years, SEP has studied the factors that affect survivals. Although most of the work has been done in the major facilities, the knowledge gained is applicable to all projects. The following information, ideas and suggestions came from Brian Anderson (support biologist, Coast Operations Unit) and Dr. Craig Clarke (head, Fish Culture Research Station, P.B.S.).

Water is the key

From the first moment you put eggs into an incubator, water quality is the most significant factor affecting survival.

Dissolved Oxygen:

See also "Monitoring DO" page 91.

1. Source: water from a stream probably contains sufficient oxygen, but groundwater is often low in dissolved oxygen and will require aeration.

2. Barometric pressure: as pressure drops, so does the amount of oxygen that water can hold.

3. Temperature: when water temperature rises, oxygen levels drop. It is also the time when air bubbles can form in the water supply and, if large, can block water flow, leading to short circuiting in the incubator.

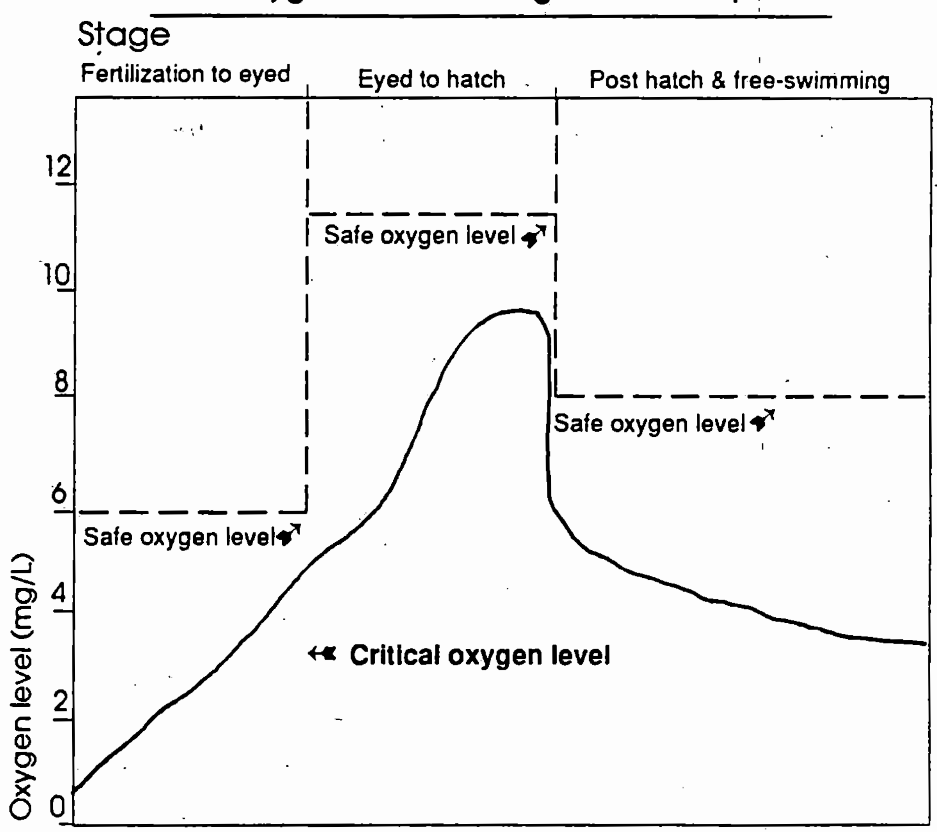
During warmer weather, monitor oxygen levels carefully. This is especially critical just prior to hatch, when highest oxygen levels are required — water at above 10° C cannot hold enough oxygen for eggs near hatch.

4. Desired levels: dissolved oxygen levels must *exceed* 6 mg/L (to eyed), 11 mg/L (during hatch) and 8 mg/L thereafter.

Water Purity:

Clean, clear water is essential for health at every stage of development. Silt-covered eggs cannot obtain sufficient oxygen, even if it is available in the water. Poor quality water can lead to gill damage in developing fish. Many chemicals and minerals (man-made or natural) are found in water and may be toxic to eggs, alevins and fry. Before you start a new project, test your water supply. If you have an existing project, test periodically — things may happen upstream that can cause changes.

Safe oxygen levels during fish development



Temperature:

Salmonids require water that is cold (by human standards). You can speed up egg development by using warmer water than is seasonal in your area (for example, groundwater), but this may produce other problems. If your fry emerge, and are released, earlier than fish in the natural environment, they may find little if any food in the stream. As well, if released into cold water (5° C), the fish will grow very slowly, making them available to predators for a longer period of time.

They are what they eat

Once you have provided good, oxygen-rich water, the next important factor affecting the health of your fish is diet. Of course it is necessary to buy high-quality feed, but it is also important that you store it properly and feed the right amount. (See **Tipsheet** on Feeds and Feeding.)

If feed is not stored under ideal conditions, a substantial portion of the nutrients it contains may be dissipated. Although you are feeding the fish, and they appear healthy, a lack of some nutrients may affect them later — long after release.

If you are using frozen feed, thaw only enough for a day at a time. If you are using a semi-dry (BioDiet) feed, store it in a cool, dry place, out of direct sunlight. Shelf life, under ideal storage conditions, for unopened bags of starter is 60 days; for unopened pellets, 90 days; for open bags — 4 days.

Time it right

Release strategies:

There are many factors to consider when releasing juveniles. Should it be under cover of darkness? All at once or in small groups? "Voluntary" or by an arbitrary date? Optimum release strategies are still being studied, but we do know something about the factors involved.

Light:

It seems that an increasing water temperature, coupled with increased hours of daylight, may be nature's trigger for downstream migration. If so, unnaturally warm rearing water may not "match" with light cues and may put the juveniles out of phase with appropriate migration timing for the area, possibly causing serious repercussions for survival rates.

Species:

Each species, and stock, has its own requirements in terms of appropriate time and size for release. There are, for example, at least two strains of chinook; one is the familiar "90-day" fish, common to coastal streams. The other, found more frequently on the upper Fraser system and on some northern rivers, rears for about 14 months — much like coho. Find out what is normal for your species in your area. As nearly as possible, try to duplicate nature's pattern for timing of downstream migrations for the appropriate life stage.

Habitat:

One of the most important things you can do to improve survival odds for your fish is to select the best possible environment for their release. Good fish habitat, with riffles and deep pools, will offer the best food supply and predator cover for your fish while they adapt to life in the stream. If you are not dealing with too many fish, and there is easy access to the release stream at several sites, you may want to release some fish to each of several good sites. (Don't put all your eggs...).

Brian Anderson offers another suggestion that might not have occurred to you. There is probably an advantage, especially with smaller streams, in releasing fish (assuming they are otherwise ready for release) when a heavy rainfall is due. Although it will tend to sweep the fish downstream, this strategy gives them the advantage of deeper water and higher silt content — protection from predators. It is also best to release toward evening (twilight) so the fish can become oriented to their new environment while getting some protection from predators due to the low light levels.

Don't teach your fish bad habits

One thing that has always concerned those who raise salmonids in artificial environments in the fact that they may not learn to avoid predators. Indeed, a shadow passing by probably signals food, not danger, to pond-reared fish!

In fact, it appears that they learn avoidance quickly once introduced into the natural environment. Still, do try to avoid casting your shadow over the water when you are feeding. There's no point in teaching them to rise to the surface when a shadow appears — the next time, it could be a heron!

Forget chemical dependency

Traditionally, there have been several reasons to use chemicals in fish culture; to disinfect equipment and work surfaces, anaesthetize adult fish being prepared for egg takes and juveniles prior to tagging and fin clipping, and to disinfect eggs prior tobringing them on site.

During incubation, when fungus growth can be a threat, malachite green was the chosen solution. Buffered iodophor was commonly used for surface disinfection of eggs. These procedures are changing.

Today, there are serious concerns about malachite green. Test on rats in Germany revealed abnormalities through 12 generations after exposure to malachite, which has been found to cause mutations, genetic changes and to be a carcinogen.

Phil Edgell and Bill McLean (Robertson Creek) sought alternatives to malachite; they found salt.

Information about chemicals and their use is updated frequently; **always** check with your CA for current information.

Why not use chemicals?

There are several reasons to try to avoid use of any potentially dangerous chemical in a fish culture operation:

1. It may be harmful, over the long term, to the very fish you are treating,
2. In the normal course of events, the chemical may be discharged into the stream or river whichputs it into the natural environment and,
3. Despite proper precautions, some of a chemical solution being used may be splashed around where people can come in contact with it.

Robertson Creek hatchery tested treatment of coho and chinook eggs with a salt water solution over four years. Early results indicated success.

The salt solution:

Marine mix, sold for use in tropical fish aquariums, is suitable for treating eggs.

Alternatively, you can prepare a solution yourself:

Salt Water Bath

sodium chloride 26 parts
calcium chloride 1 part

Mix with water to produce a solution of 20 parts per thousand; use a static bath.

Treatment:

1. Handle eggs just as you would if treating with malachite.
2. Treat with salt water solution three times per week, from green to eyed.
3. Turn off water flow to Heath trays, pour static bath solution into trays.
4. Leave eggs in static bath for one hour.
5. Restore normal water flow to Heath trays.

Cost factors:

Because the salt solution is used at greater concentrations (20 parts per thousand compared to malachite at 1 part per million), the salt water treatment is more expensive. It is also more time-consuming because it must be administered as a static bath. Phil Edgell at Robertson Creek suggests that this could be overcome by creating a salt solution holding tank, plumbed to the Heath trays with an alternate, recirculating system. Then it would be possible to simply switch over to the salt solution for one hour three times per week.

What to look for:

If you adopt the salt water bath treatment, you will notice some differences:

1. Visibly, there will appear to be slightly more fungus on salt water treated eggs than you have seen when using malachite. Tests at Robertson Creek, however, indicate that the mortality rate (the real measure of success) is within one percent.
2. You may see reduced incidence of coagulated yolk (white spot disease). Tests at Robertson Creek showed a 50 percent less coagulated yolk when compared with malachite-treated eggs.

An alternative anaesthetic:

It is sometimes necessary to anaesthetize fish. At Robertson Creek, as part of the effort to limit chemical use, carbon dioxide is now used for this purpose.

Bottled Co2 is fed to the holding tank through hoses and introduced into the water with airstones (just as oxygen would be). A level of 200-400 ppm is required for anaesthetic use.

The presence of CO_2 in the water causes the pH level to drop. By the time anaesthetic level is reached, the pH will be at slightly over 4. The water must be buffered with sodium bicarbonate to bring the pH back to a bit above 6. These levels are site specific; depending on the initial pH at your site, adjust accordingly.

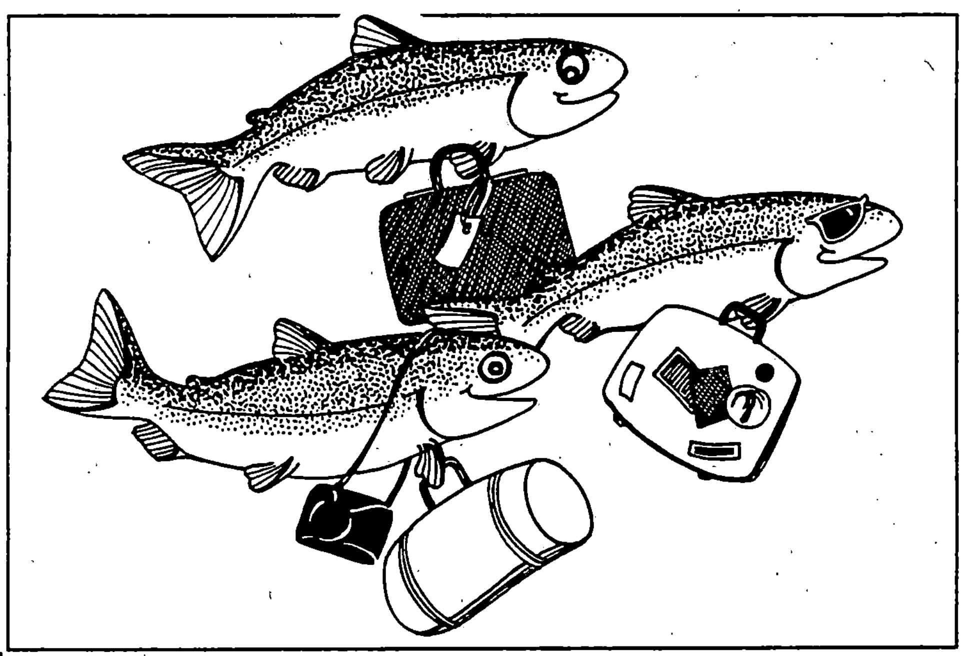
Transport and release of hatchery juveniles

With all the effort given to fish production, from broodstock capture to feeding, the importance of transport and release can be overshadowed. It shouldn't be — much of what you have achieved can be undone by transport and release problems. Handling and changes in environment stress fish. Predators, from which the juveniles have been protected, enter the picture. A sound plan, developed with or reviewed by your community advisor, can minimize losses.

The following guidelines will help you plan a successful release.

Pre-transport

1. Avoid major handling of fish for at least seven days prior to release date.
2. Starve your fish for at least 48 hours prior to transport. Digestion of food increases oxygen requirements for your fish, so they will withstand moving best on empty stomachs.
3. Healthy fish are essential for a successful transport. The release of sick fish may cause release and post release mortalities, lowering the expected adult return. If you suspect a disease prior to release, consult your community advisor. Be aware that some treatments can cause more harm than good, especially if used on smolts immediately prior to releases. A disease treatment recovery time of four to seven days often is recommended.
4. Disinfect all equipment which will come in contact with the transport water. Rinse thoroughly before using.
5. Scout for access to your release site(s) immediately prior to release — things may have changed since you saw it last. If you are gaining access to the site through private property, be sure to obtain permission in advance.
6. Plan your release strategy in advance with your community advisor. Scatter plantings at several sites throughout the river or lake system can yield better early survivals than one-site releases. Planting strategies depend upon the size and species of fish. The abundance and concentration of predators should be considered in your release strategy, too. Predators can, over a few years, clue into your release site. They may bring along a few more friends to share dinner each year — at your expense.
7. Compare water temperatures at the release site and the hatchery. If there is a difference of more than 4°C (plus or minus), the fish may suffer temperature shock. It is best to acclimatize the fish to the release site temperature gradually (over a few days) while they are still in the hatchery.



Transport loading rates

A loading rate is the total amount (by weight) of fish you can transport in a given amount of water. Usually, it is expressed as grams/litre (the total weight of fish which can be carried in a litre of water). Loading rates are variable and depend upon several factors.

1. Size of fish: a large fish has a lower metabolism (energy requirement) than a small fish. Larger fish, therefore, use less dissolved oxygen by weight so a larger weight per litre figure can be used when loading larger fish in a transport tank.
2. Water temperature: in warm water, a fish's metabolism is higher than in cool water — the higher the temperature, the more

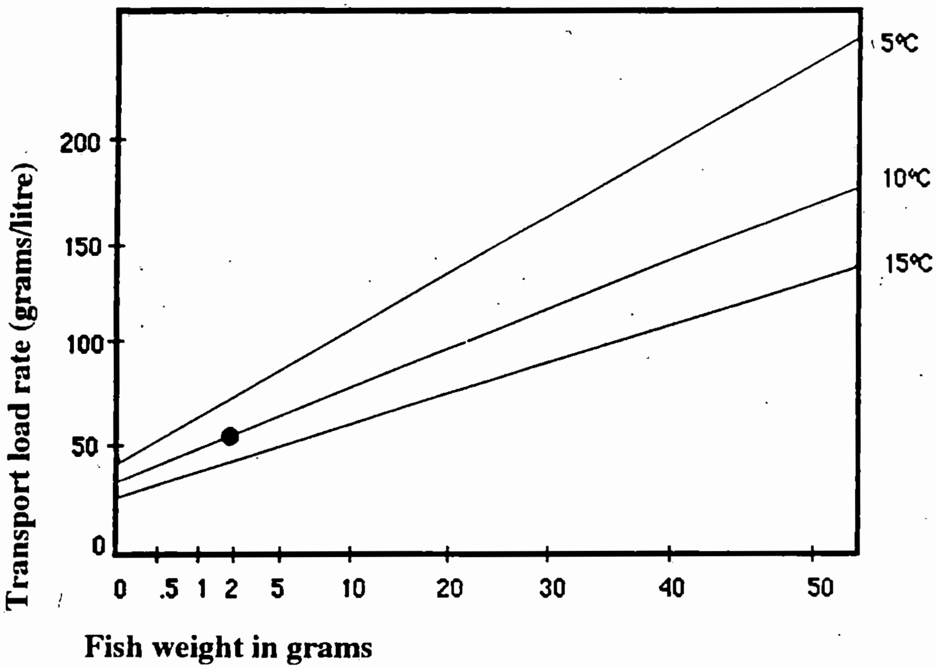


Table A

Transport tank load rates (Continuous aeration) (Webster, 1981)

This table describes *conservative* transport loading rates for juvenile salmonids. If millions of fish must be moved quickly, or if expensive helicopter transport is required, ask your community advisor's assistance to determine *maximum* loading rates. In *all* other cases, conservative rates should be followed.

These loading rates assume a continuous supply of oxygen at 80 percent saturation or a minimum of 9.0 ppm dissolved oxygen for up to 3 hours.

Example:

2 gram average fish weight

10° C transport water

* chart shows 50 grams of fish per litre of water (50 g/l) loading rate.

Calculation:

At half full your transport tank holds 250 litres of water so:

250 l X 50 g/l = 12,500 grams of fish

$\frac{\text{12,500 grams of fish (12.5 kilos)}}{\text{2 grams average weight of fish}}$ = 6,250 fish

dissolved oxygen a fish needs to survive. Also, as temperature *increases*, the total amount of dissolved oxygen in the water *decreases*, making transport at higher temperatures even more dangerous.

3. Oxygen distribution systems: these are critical to a successful transport system. Both static oxygenation (eg: plastic bag transport) and continuous flow oxygenation (eg: transport tank) systems affect loading rates. A continuous flow of oxygen to the transport water permits higher loading rates, but do not super-saturate — more oxygen is not necessarily better. Improvements in the quality of ceramic oxygen distribution air stones allows for better oxygen delivery.

4. Transport time: loading rates must be lowered for a longer transport time. In lengthy transports (more than three hours), there is the additional problem of fish wastes building up in the water and creating an unhealthy environment.

Set-up and procedures

A. Continuous aeration (common in transport tanks)

This is the most widely-used and desirable system for transport of small and large numbers of fish.

Materials:

✓ container: from a 100 litre garbage bucket to a 1,000 litre insulated transport tank with a tight or locking lid.

✓ oxygen distribution system:

✓ oxygen bottle plus spare

✓ regulator displaying total oxygen bottle pressure and flow in litres/minute

✓ length of oxygen hose; airstones or micropore tubing

✓ maintained transport vehicle (one litre of water weighs one kilogram — make sure your vehicle can take the weight!)

Methods:

1. Load the tank about half full of water and place a small mark at the water level.

2. Aerate the water at a high oxygen level (3 - 6 litres/minute) while adding appropriate weight of fish without additional water (use a dipnet, not a bucket).

3. When maximum number of fish have been loaded, place another small mark at the new water level. For subsequent loadings, you can use the two marks to load instead of weighing each batch of fish.

4. Handle the fish gently and carefully; care is more important than speed. Scale loss is detrimental at this time, especially if releasing to salt water.

B. Static aeration (plastic bag transport): mainly used for the transport of smaller numbers of fry or for scatter planting throughout a system.

Materials:

✓ Doubled 4 ml plastic bags — clean, unpunctured fish food bags are great!

✓ Sturdy frame backpack or five gallon plastic bucket.

✓ Dipnet with 3 - 6 inch opening.

✓ Supply of sturdy twine.

✓ Small oxygen bottle, regulator, one-metre length of aeration (aquarium) hose and an airstone.

Methods:

1. Place doubled plastic bags into backpack or bucket and add 10 - 15 litres of clean water.

2. Cube ice can be added between the bags in the backpack at this point. An 8 cm layer of ice can be frozen onto the bottom of the bucket in advance. If ice is added directly to the water, be sure it is **not chlorinated.**

3. Place connected airstone into water and aerate while using the dipnet to add fish.

4. Remove the airstone and fill the remainder of the bags with oxygen. Twist and fold the end of the bags and **seal** with twine. At least 50 percent of the bag should hold oxygen; the rest, water. During transport the sloshing of the water into the dome of oxygen will supply aeration. Carry one or more spare bags; check on fish every hour.

Transport and monitoring

❏ Make sure the tank lid is secure. The force of water sloshing inside can easily pop the lid off, spilling water and fish.

❏ During transport, oxygen flow can be reduced to maintain dissolved oxygen level at 80 percent saturation or 9 ppm.

❏ Dissolved oxygen and fish condition should be visually inspected every 30 to 60 minutes. If available, a constant readout oxygen probe can be suspended into the transport tank, with the meter carried in the vehicle cab.

Table B

Plastic bag loading rates (static aeration)

A safe loading rate for up to three hours at a water temperature of 10° C is 50 grams per litre. Loading rates of 150 grams per litre have been used successfully for up to one hour at water temperatures below 8° C. Transport water should be kept below 10° C with ice throughout transport.

Tips and warnings

❍ The use of anesthetics in transport water can be harmful and is **not recommended.** Fish will become sedated over time with the build-up of carbon dioxide produced by their breathing.

❍ Ice can be added to the transport water on long transports to help cool it. Remember to use only **unchlorinated water** to make the ice; chlorine is deadly to fish.

❍ Over-oxygenating (greater than 100 percent saturation) transport water is a serious threat and harmful to fish. Constant monitoring and/or the use of compressed air through a separate airstone in the transport water will minimize the problem.

❍ Always have someone else check your loading rate calculations before transport — mathematical errors can be fatal. Better safe than sorry!

❍ Have a fall-back position or crisis plan in case of problems with transport equipment. Spare oxygen bottles, hand aeration equipment or access to a second truck can save an operation — and a lot of fish.

At the release site

Release fish by carefully pushing buckets or bags underwater at an angle, allowing water to flow in and fish to swim out. Use of dipnets, while possible, should be minimized.

Transport tanks often have long hoses on valved outlets at the base of the tank. Use with care; improperly designed systems can seriously damage fish. Ask your community advisor for advice.

After long or aircraft transports, it may be best to hold fish for one to 24 hours for observation; use portable raceways or small holding pens in deep, quiet areas of the river. Be sure fish are in good health before release.

Temperature acclimatization at the release site itself is not recommended. The time is too short to provide any benefit — adjust temperature slowly at the hatchery instead.

Release in areas with natural cover. Logs, cutbanks and boulders provide cover to minimize predation during the first few critical hours after release.

Take the last step

When it's all done, review your release program while the recollections are fresh. Identify any problems you had and note any improvements that could be made. Next year you'll be glad you did it.

Keeping fry healthy

Problems and solutions

Early rearing is one of the most critical stages in the life of a fish. In the wild, egg to fry survivals of 15 to 25 percent are considered normal for salmonids. In hatcheries, mortality problems are frequently encountered following hatch, through ponding, to the three- to four-gram size. Fry are quite susceptible to some infectious disease agents, such as bacteria gill infections, parasitic invasions and fungal diseases, which do not pose a threat to larger fish. Despite these problems, with the appropriate rearing strategies and care, hatchery egg to fry survivals of 80 percent can easily be achieved with Pacific salmon. In later life, especially as immature adults, salmon are more resistant to most fish health problems.

Gill problems

Gills are delicate structures and young fish are especially likely to suffer from a variety of gill problems. Because the gills are in immediate contact with water and due to their large surface area (necessary to facilitate the exchange of gases), they are easily damaged by water-borne irritants such as silt. The gills form safe havens, complete with nutrient supplies, for a variety of microorganisms; bacteria, parasites and fungi.

Bacterial gill disease probably kills more young salmon in fish culture facilities than any other fish health problem. In fact, it is probably the leading cause of mortalities among young cultured fish world-wide. The most frequent bacterial gill disease is caused by gliding bacteria, commonly known as myxobacteria, but a number of other bacteria, such as *Pseudomonas sp.* are involved.

Another gill problem frequently encountered by the Fish Pathology Laboratory is caused by dusty food or by the use of fine mash for too long. Food particles become lodged between the lamellae and irritate the gills. The gill tissues respond by excess mucus production and sometimes cell proliferation. Bacteria and fungi then become entrapped and multiply in the area, causing further irritation. Eventually most of the oxygen exchange area may be occluded causing the fish to suffocate.

Prevention of fish health problems in fry

1. Strong healthy fish are less prone to have problems with disease agents. Poor egg and sac-fry incubation conditions that cause small swim-up size, coagulated yolk, elongated yolk sacs, fungus infections, etc. usually result in unacceptably high fry losses and invasion of the fish by infectious diseases.
2. Avoid transferring disease agents from one group of fish to another by having separate equipment, e.g. dipnets, brushes, etc.
3. Keep young fish upstream of older fish to avoid transferring disease agents to the more susceptible group.
4. Poor ponding and feeding techniques can lead to gill disease problems, e.g. allowing swim-up fry to remain in high waste levels on the trough bottom.
5. In most cases, a fish-free water source will avoid infestations of parasites and viral agents. Where possible, avoid the use of surface water.
6. Silty water or high temperatures are other hazards to avoid.

Gill damage caused by bacterial gill disease

Normal gill structure. Note the separation of the lamellae.

Severe bacterial gill disease. Note the clubbed appearanceof the filaments and lack of separation of the lamellae.

Prevention and treatment of gill problems in fry

Because many gill problems originate with water quality problems, it is essential to start with good quality water and it regularly and to ensure optimum flow loadings. High ammonia levels, silt, and food fines are major culprits in gill deterioration.

Bacterial gill disease can cause heavy losses in a very short time, but early treatment can avoid a major outbreak. When fish are high in the water column, have flared gill covers, and appear to be gasping, make arrangements to obtain a diagnosis; treatment can usually alleviate the problem rapidly.

❍ Don't feed dusty foods; do reduce the length of time of feeding mash to a minimum to avoid food particles becoming a gill irritant.

❍ Examine your fish carefully each day for the early signs of a gill problem: increasing losses, drifting in the current, fish collecting near the outlet screen, lack of feeding response, collecting near the surface of the water, or slow (sluggish) to respond to hand movement.

Treatment of external parasites and fungal infections of fry

Many external parasite problems and fungal infections can be combated by bath treatments in the rearing containers. However, if chemical treatments are to be used, they must be approved and thought must be given to the proper discharge of the spent treatment solution. In most cases, it is a tight-rope walk in which it is hoped that the chemical is more toxic to the parasite than to the fry. For instance, formalin treatments to correct gill parasite problems or fungal invasions not only kill the disease agent, but also damage the gills to some extent. **Currently, there are no effective treatments for external parasites and fungal infections of fry that the fish culturist can lawfully use.** All chemical treatments, including formalin, can only be used if an Emergency Drug Release (EDR) has been obtained from the Bureau of Veterinary Drugs, Health and Welfare Canada, Ottawa.

Supersaturation

One of the hardest problems to diagnose in fry is gas bubble disease caused by supersaturation. Look for fish that have popeye, gas bubbles in the yolk sacs and fins, or that drift to the surface after diving. More difficult to pinpoint is low level, sublethal supersaturation that does not result in bubbles forming in the fish. Always check for supersaturation using a reliable method of measurement — at many sites, aeration towers are a must.

Common bacterial diseases

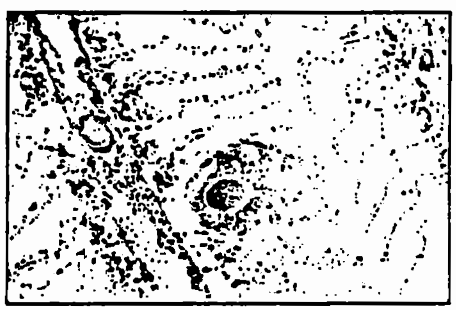
The most common bacterial disease problems in salmon fry are those caused by the organisms of the Flexibacter group, such as coldwater disease and columnaris disease. Look for open lesions on the fish; often on the nose or on the ridge of the back. Because the causative bacteria have a yellow pigment, the lesions will often have a slight yellow colour. In severe cases, the bacteria can eat deep craters in the fish; it looks as if the fish was bitten or suffered a mechanical injury. Many Flexibacter infections can only be controlled with an antibiotic.

The Fish Pathology Program (756-7069), Pacific Biological Station can help diagnose fish health problems and suggest or help with corrective measures.

— Gary Hoskins, Dorothee Kieser, Fish Health and Parasitology Section, P.B.S.

Common external parasites encountered among cultured fry in B.C.

***Trichodina* (above). A protozoan parasite of the skin.**



***Ichthyophthirius multifiliis* (above). A protozoan parasite often found in the gills of fry at warm water sites. The tongue-twisting scientific name is usually shortened to "ich."**

***Gyrodactylus* (left). An external trematode parasite that is barely visible to the naked eye. This small worm can cause extensive damage and flashing when the fry are heavily infected.**

Salt Treatments Control Fungus on Eggs

In 1993, SEP adopted a policy on use of drugs and chemicals in all fish culture operations:

"The use of all chemicals, including drugs, used on fish... must be in compliance with the Food and Drugs Act, administered by Health and Welfare Canada and the Pest Control Products Act, administered by Agriculture Canada."

Robertson Creek hatchery developed salt treatments to replace malachite green (now **prohibited**) for control of fungus on eggs. A 20 parts per thousand (PPT) salt solution was used

The salt solution consists of 26 parts sodium chloride and one part calcium chloride. The salts are available from Van Waters and Rogers in Richmond (273-1441). The sodium chloride is called Sifto Fine Evaporated Salt. The calcium chloride is food grade, dehydrate calcium chloride.

The calcium chloride will absorb moisture once the bag is opened so all of the calcium chloride should be weighed into lots immediately. For example, you may want to weigh the calcium chloride into two kilogram lots and store them in Ziploc bags.

Mixing salt solution

Some of the CEDP hatcheries have constructed salt containers that sit on a stand. A header pipe runs from the salt solution container to the incubation area. Outlets run off the header so that each Heath stack and Atkins line can be fed with the salt solution. The salt container sits high enough so that there is sufficient head to operate the system as gravity feed.

The salt solution container can be fabricated with a built-in mixing system or you can use a small, plastic submersible pump to mix the salt solution.

EXAMPLE:

The volume of the container is two cubic metres which equals 2,000 litres.

We want to make a 20 PPT salt solution: 20 PPT = 20 grams of salt per litre of water.

The weight of salt required is 2,000 litres water times 20 grams salt per litre:

FORMULA:

2,000 L X 20 g/l = 40,000 g (40 kg)

The salt solution must be made from **one part** calcium chloride and **26 parts** sodium chloride.
40 kg/27 = 1.48 kg per part
(Round this off to 1.5 kg)
So:
26 parts of sodium chloride = 1.5 kg/part X 26 parts = 39 kg
1 part calcium chloride = 1.5 kg

RECIPE:

1.5 kg calcium chloride
+ 39 kg sodium chloride
+ 2 cubic metres water
= a 20 PPT salt solution.

To mix up the salt solution, weigh the appropriate amounts of sodium chloride and calcium chloride into a container. Add the appropriate amount of water. (To make it easy, you can draw a line at the correct depth of water on the inside of the container and just fill to the line each time you mix the solution).

Put a plastic submersible pump into the container and mix the solution for an hour or two. Be careful about how long you allow the pump to run in the solution. The pump will heat up and this may cause the temperature of the salt solution to rise. Measure the salinity of the solution, it should be 20 PPT. Add more salt if necessary to bring it to that.

NOTE: The salt solution must be allowed to sit for 24 hours before being used to treat eggs.

See next page for treatment instructions.

How to treat eggs with salt

STEP 1. Check the water temperature in the incubators and the temperature of the salt solution. There should be no more than a three degree difference in temperature. Check the salinity of the salt solution, it must be 20 PPT.

STEP 2. Have your salt dispensing system set up and ready to go. (Also have your salinity meter or refractometer ready to go.)

STEP 3. Have a stop watch or clock available to time the treatment.

STEP 4. Turn off the freshwater flow to the incubators you are going to treat with salt solution.

STEP 5. Add the salt solution to the incubators being treated. The salt solution will displace the freshwater in the incubators until there is only salt solution in the incubators. You must monitor the salinity in the incubator. When the salinity in the incubator reaches 20 PPT, turn off the flow of salt solution and start timing. The eggs should sit in the salt solution bath for exactly one hour.

STEP 6. At the end of one hour, turn the freshwater flow back on.

Salt treatments can be done twice a week (for example, every Tuesday and Friday) until the eggs are eyed. Once the eggs have eyed, you can use dead egg picking as the fungus control.

CAUTION: Do not treat alevins with the salt solution.

Equipment required:

✓ Container for salt solution
✓ Sodium chloride salt
✓ Calcium chloride salt
✓ Small submersible pump for mixing the salt solution
✓ Refractometer or salinity meter to measure the salt concentration
✓ A dispensing system to administer the salt solution to the incubators.

Try these on predators

Ducks, mink, otters, kingfishers and a host of other creatures endorse the nutritional value of salmon, but that does not make it any less frustrating when your salmon are the featured main course. From the largest hatchery to the smallest streamside incubation box, predators are a problem for most enhancement projects.

Keeping them from their chosen snacks is made more difficult by the fact that the predators are, like our fish, part of the natural environment. Obviously, while we do want to keep them away from the fish, we do not want to harm them.

Many things have been tried, and there are no sure-fire answers; but what follows is a brief overview of some of the methods that work (at least some of the time). Much of this information was provided by Quinsam hatchery on Vancouver Island.

Netting works, but be careful

Netting, arranged over rearing ponds, tubs and channels, is an old stand-by predator control.

It is effective (60 to 80 percent), but labour-intensive and it may pose hazards to predators and to people working nearby.

Install and maintain it carefully.

One problem with netting is that if birds do get inside (ducks will actually sit on the netting, then drop through to get to the pond!) they are trapped. Then they are likely to hurt themselves — or stress the fish — when they try to get out.

Some precautions will help you to get the best performance from netting.

Choose the right size of mesh (it's a barrier, not a trap).

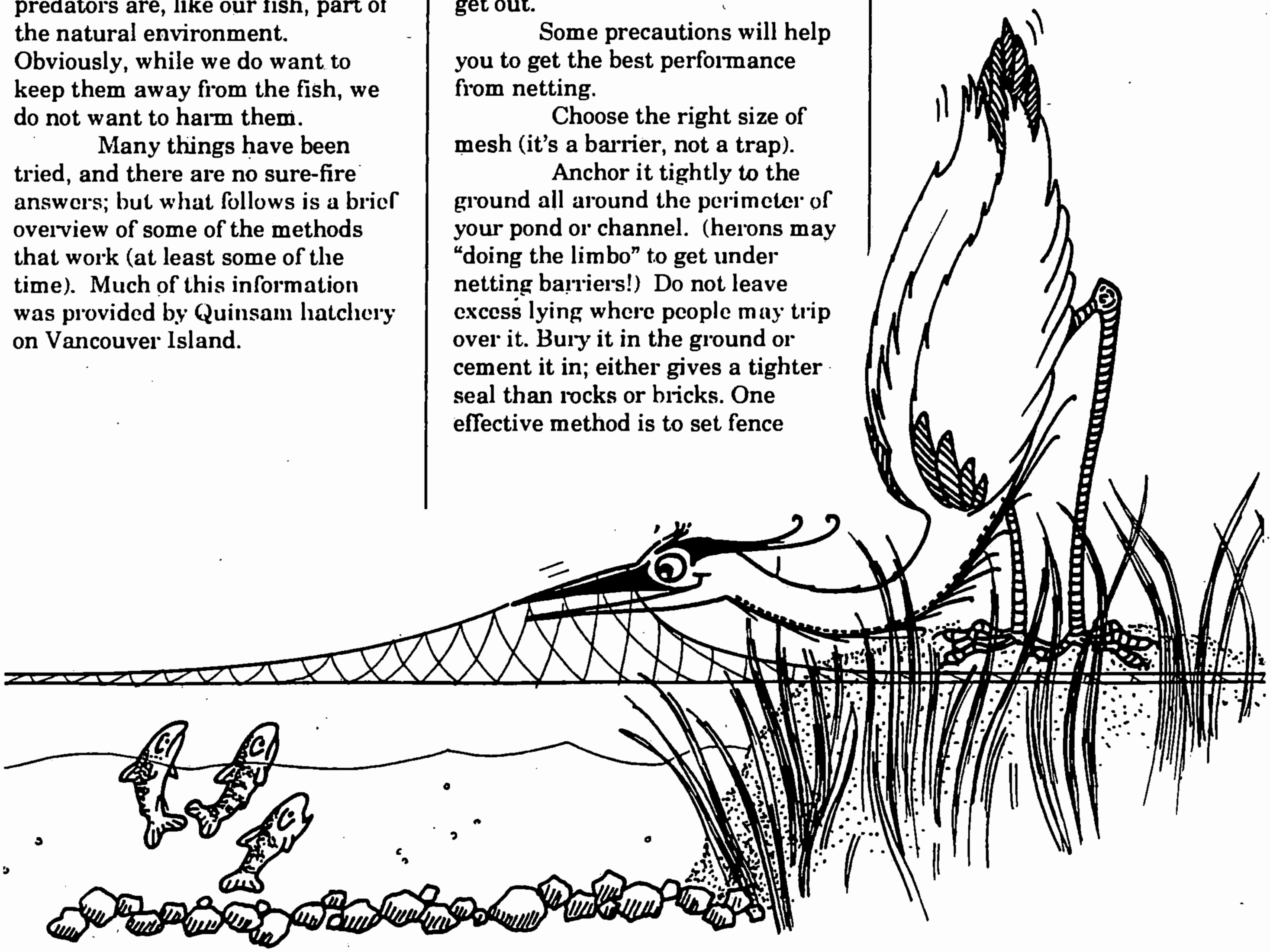
Anchor it tightly to the ground all around the perimeter of your pond or channel. (herons may "doing the limbo" to get under netting barriers!) Do not leave excess lying where people may trip over it. Bury it in the ground or cement it in; either gives a tighter seal than rocks or bricks. One effective method is to set fence posts around the perimeter of your pond or channel. Nail two by six boards all around, set tight to the ground, and secure your netting to these with nails or good strong staples.

When you have to join two pieces of netting, make sure you don't leave any gaps.

Many people "mark" netting with bits of ribbon or surveyor's tape so birds will see it and not fly into it.

A series of vertically-strung nets often works for ducks, such as mergansers, that have a long take-off path.

Netting can get in the way and slow down jobs like fish



sampling or filling feeders. At Quinsam, a net is anchored to sliders that let it run along stretched cables (one on each side of the channel). Two people, one to a side, can slide the netting back for access, and pull itback easily.

Fright methods

Quinsam has investigated other methods of predator control, particularly for birds. The biggest problem with most of them is that birds are very adaptable and soon get used to the device (gardeners know that, eventually, the birds roost on the scarecrow!). Changing from one method to another helps.

Strobe lights, flares and rockets:

These all work, until the birds get used to them.

Air cannon, other noisemakers:

These devices also work, until the birds grow blasé; and, for obvious reasons, they are not the "weapon of choice" in populated areas.

Motion-triggered lights or buzzers:

More sophisticated; a motion sensor, triggered by an approaching bird or animal, turns on security lights or a noisemaker. It only triggers in response to an intrusion, so it may take longer for creatures to get used to it than if noise or strobe lights are used on a constant cycle. One problem; it is hard to evaluate the results.

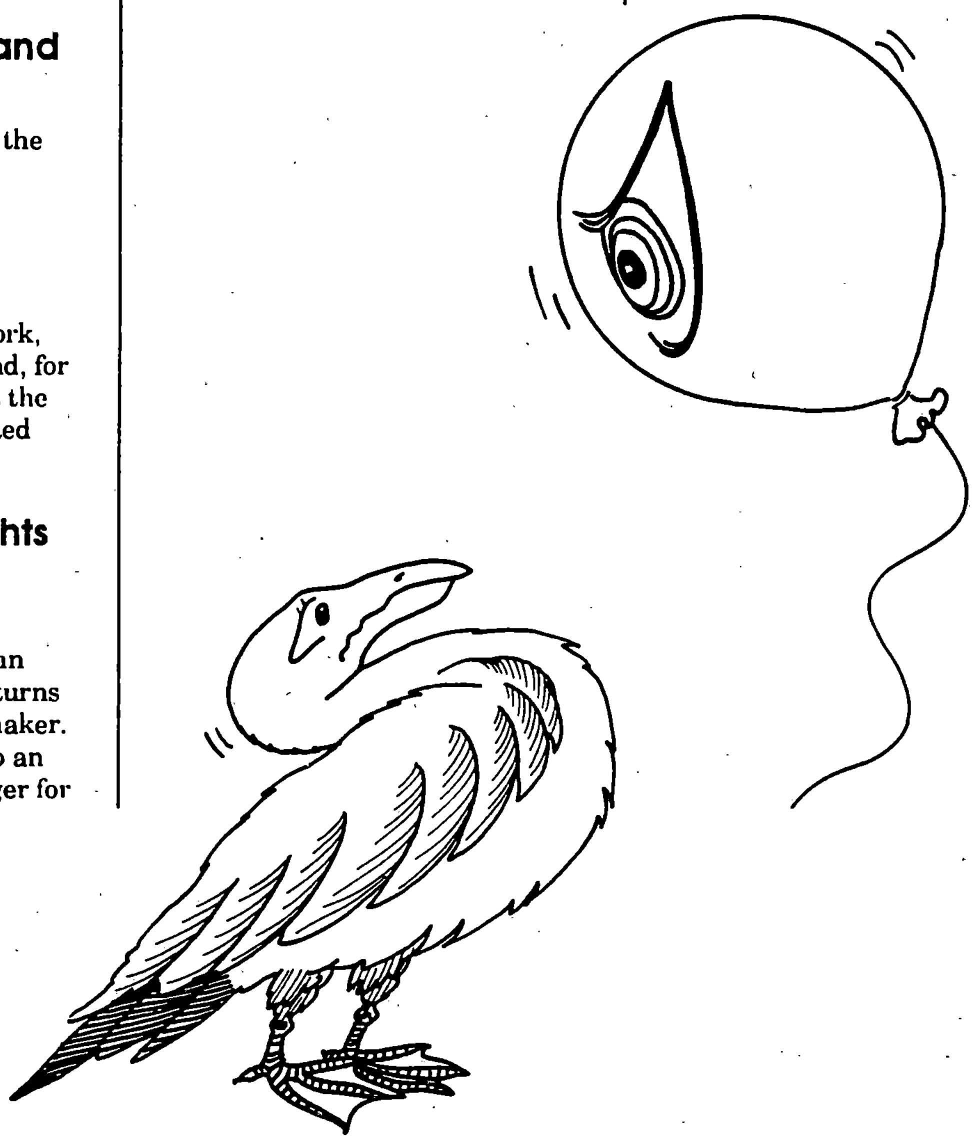
Balloons:

One winter, when severe weather made birds a serious problem at Quinsam, the hatchery tried balloons. About the size of a beachball, they were painted with a specifically engineered eyeball, designed to simulate a bird of prey.

This seemed to work but it was necessary to change the colour of the balloons regularly.

The one-on-one approach

Here is a final idea, but it is probably too expensive. Dave did get information about what airports do to keep birds out of jet engines. The Canadian Wildlife Service says many airports have someone on staff who patrols with falcons, hawks or radio-controlled devices to scare the birds off as soon as they approach. Apparently, that is very effective. It is also very costly, so unless you have a benefactor (or a friend who is training falcons), it may not be for you.



Vibriosis

Vibriosis is a bacterial disease that can cause extensive mortality in salmon reared in estuarine or salt water netpens. Two species of Vibrio bacteria commonly affect salmon here, *Vibrio anguillarum* and *Vibrio ordalii*.

Vibriosis usually affects juveniles in water above 13°C. but has occurred at lower temperatures, depending on other environmental factors and stress levels. All salmon species reared in salt water are subject to infection.

Affected fish often show bright red inflamed areas in the skin and musculature and bloody fluid in the body cavity. There may be hemorrhaging in the eye and popeye.

If the disease hits suddenly, there may be no external signs prior to significant mortalities.

Prevention:

1. Vaccinate fry prior to transfer to salt water pens.
2. Reduce stress: maintain high oxygen, minimize handling, and keep densities well within recommended limits.
3. Locate pens where adequate flushing occurs; avoid brackish (low salinity) water.
4. Check with other projects or aquaculture facilities in your area to see if, where, and when Vibrio has caused mortalities — and what techniques they have used to minimize losses.

Guidelines:

There are three ways to vaccinate fish: by immersion (short bath for fish < 10 grams), by spraying (10+ grams size), and by injection (usually adults or captive broodstock). The method we describe here is the most one most commonly used — the immersion method for fry/fingerlings.

In general:

- ✓ follow the vaccine manufacturer's instructions for use
- ✓ treat only healthy fish
- ✓ minimum size for effective vaccination varies with species; generally larger than 2.0 grams
- ✓ once mixed with water, vaccine should be used immediately; it cannot be stored; unused bottles of vaccine should be stored in a cool, dark place at four to seven degrees Celsius.
- ✓ try not to handle the fish for at least one week after treatment
- ✓ vaccinated fish should be kept in fresh water for a period (usually about 200 ATU's — 20 days at 10 degrees C.) before being transferred to salt water
- ✓ if the transfer to sea water is delayed for a long period (greater than 100 days for chinook), a booster vaccination would be advisable because immunity gained by initial vaccination diminishes with time.

A. Vaccine

Vibrio vaccines are prepared from the inactivated Vibrio organisms, as with many vaccines for human and domestic animal medicine. The goal is to have the fry take up enough vaccine so the immune system learns to recognize and destroy the "bad guys" when the live bacteria strike.

To ensure efficiency and safety, use only vaccines that have been licensed for use in Canada. Vaccines come in a combined formula (both types of Vibrio) or in separate formulas for each type (which can be combined when mixing up the immersion solution). Containers are usually one litre in size and are mixed with water (1 litre solution and 9 litres water) just prior to treatment. **Specific instructions will come with the vaccine and should be read and followed carefully!**

B. Equipment

- ✓ floor type weighing scale with
- ✓ large container of water
- ✓ oxygen bottle with regulator, hose, and small air stone
- ✓ oxygen meter
- ✓ thermometer
- ✓ crowder net or screens for trough or pond
- ✓ post-treatment container nearby
- ✓ pencil and paper to record dips
- ✓ stopwatch (time immersions)
- ✓ dipnet or screened container for fish: fits inside weighing bucket/box. Ensure: A) if it is a dipnet, the bag is long and large enough so fry are not squished and can spread out in the vaccine so all are immersed and, B) that mesh size permits easy draining of excess water/vaccine.
- ✓ container (small coolers work well) for vaccine solution which: A) dipnet or screened container fits into easily and, B) is of the right dimensions so solution is deep enough to immerse all fry when net or box is placed in it.

C. Set-up

a) Site: try to set up so:

1. Vaccination takes place close to both the pond and the recovery container — if you can only be close to one, make it the recovery container — after you weigh out the correct amount of fry, carry the entire weighing bucket to vaccine site before taking the dipnet or fish box out of the bucket; drain water from fish and place them in vaccine.

2. You have shade and use the cooler time of day (air and water temperature).

3. You have easy access to water for mixing vaccine and adding to weighing bucket.

4. Scale is level, easy to read, and you don't have to step over it to get to the vaccine solution or recovery pond.

5. The oxygen bottle/ regulator is in a stable and secure stand where it will not be disturbed during treatments.

b) Preparation:

1. Plan so treated fry will be of the right size to be transferred to seapens within the specified time noted in the vaccine instructions.

2. Purchase sufficient vaccine for the entire group of fish, allowing for 15 to 20 percent inventory discrepancies (too much is better that too little).

3. Do a bulk weight sample the day before to confirm how much vaccine you need and number of dips required (e.g.: you may only have 80 kilograms of fish to do so you could make each dip four kilograms instead of five).

4. Starve fish for at least 12 hours prior to treatment.

D. Procedure

1. Check temperature of vaccine and water to make sure they are within five degrees of each other.

2. Set up equipment; mix vaccine.

3. Turn on oxygen — monitor to keep level at 10 to 12 ppm.

4. Fill weighing bucket to a pre-determined weight with water; place the fry net or box into it.

5. Crowd enough fry in rearing unit for 20 vaccine dips.

6. Dipnet fry out; allow excess water to drain off before pouring into fry net or box. Add fry until the desired weight is reached (five kilograms for 10 litres of vaccine/water solution)

7. If solution is near both "from" and "to" containers, simply take fry net out of the weighing bucket, drain slightly, and immerse it in the vaccine solution for a full 20 seconds or *for the period prescribed for the type of vaccine you are using*. Make sure that *all* fry are immersed.

8. Lift fry net from solution; allow excess vaccine to go back into the container; gently dump fry into the recovery container.

9. Check oxygen levels, water weight on scale, and rate of recovery of first load before continuing.

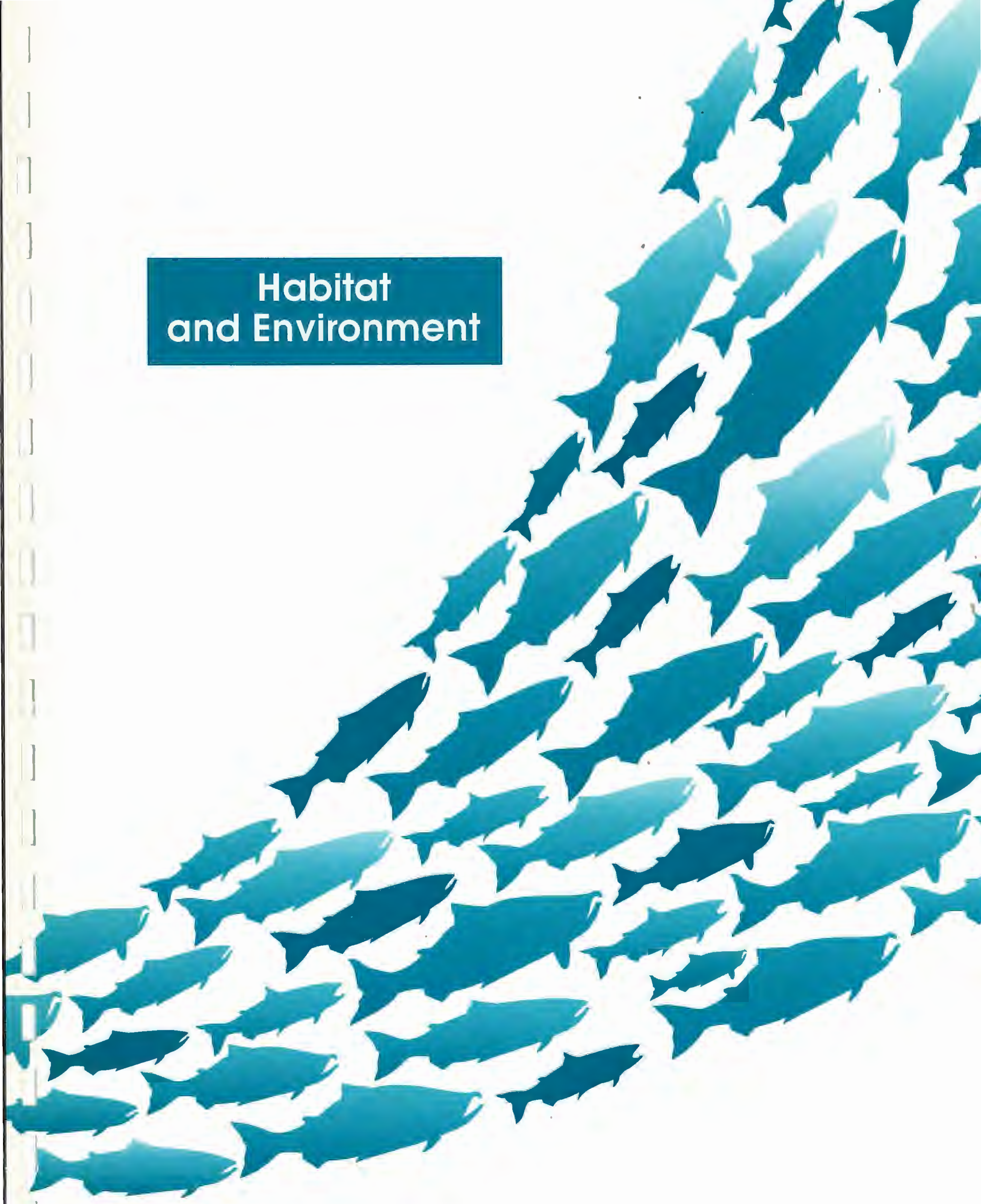
Additional Note:

Many aquaculture companies give their fish a vaccination in fresh water then, 10 days after transfer to salt water, give a booster. Results have been excellent according to Brenda Donas (CA, Smithers) and the amount of time and money to treat Vibrio outbreaks has been greatly reduced. *Be sure to check with your CA and vaccine supplier before considering the booster vaccination.*

Suppliers (1993)

Supplier	Vaccine Type	Approx. cost/litre
Micrologix Ltd. Sidney, B.C. Tel: (604) 652-4482 Fax: (604) 4802	Combined MicrovaX (anguillarum) MicrovoX(ordalii)	$75.00 75.00 75.00
Biomed Inc. Bellvue, WA TeL (206) 882-0448 Fax: (206) 882-2678	Combined	($U.S.) 42.40
Aqua Health Ltd. Charlottetown, N.S. Tel: (902) 566-4966 Fax: (902) 566-3573 (B.C. contact: G. Seaton: 756-0543)	Combined	75.00

Habitat and Environment



Fish need a good neighbourhood

All enhancement efforts are intended to increase the number of salmonids in B.C. streams and rivers. All the incubation efforts of government hatcheries, contracted operations and volunteer projects are doomed, however, if our rivers and streams become inhospitable to fish. With this in mind, SEP began development, in 1993, if a StreamKeepers program to encourage stewardship of the streams and rivers all salmonid species depend upon. Even earlier, some Public Involvement projects increased the scope of their activities to try to ensure the future of their watersheds through the basic principals of stewardship; education and awareness, planning, and coordination of private and public goals.

Tynehead plan for watershed management

Protection of our waterways is a growing concern. Whether the damage is as spectacular as a chemical spill or as subtle as a denuded stream bank, the growing feeling is that it just shouldn't happen. The question is, How to stop it?

The Tynehead Enhancement Society in Surrey started a program intended to answer that question — and make things better for the entire Serpentine River watershed. What follows is a description of what they did, how and why. If you live near an endangered stream, this "envirotip" may give you some useful ideas.

1. Define the problem.

Surrey is an area of rapid growth. As a result, there are more people living, working and playing near the Serpentine River and its tributaries. More people near a stream means greater risk of damage.

Tynehead Enhancement Society members worked from the premis that, while there are some cases of people deliberately damaging the environment, ignorance is more often the cause. So, they reasoned, if they could make people better informed, there would be less damage.

They also reasoned that, if more people knew about the dangers threatening the streams in their neighbourhood, more people would be on the look-out for those whose deliberate actions cause damage.

2. Plan, plan, plan.

Once the problem is defined, a plan is necessary. The plan that Tynehead devised was to enlist the interest and support of all property owners on the Serpentine system.

The group hoped to use the environmental awareness that is growing these days and couple it with informed self interest — after all, if a creek is flowing beside your property, you have a vested interest in keeping it healthy.

The Tynehead plan called for establishing direct, personal contact with each stream-side property owner. It called for offering them information, inducements and a chance to meet their neighbours. And, because the goal was long-term, it also called for establishing an on-going relationship with these property owners.

The plan also involved working through the area's SEP community advisor to be sure that all affected authorities were aware of the program before it started.

3. Name your targets.

It is easy to say, "We need to send a direct, personal letter to each property owner." It is much harder to do that.

Tynehead volunteer Lynn Price knows about that; she undertook compiling the mailing list. (See next page for mechanics of mailing.)

4. Deliver the message — with a punch.

Once there is a mailing list, you have to deliver a message — and you don't want it to go the way of "junk mail." That means you need to make the message an attention-getter.

Tynehead sent a letter, with some information about the Serpentine River and stream care, to each property owner. They also decided to try a couple of attention-getting devices.

The first device was an invitation. The group timed the initial mailing to reach the households shortly before the hatchery's Open House and fish release in May. Each property owner was invited to come out to enjoy the event. As a second attention-getter, coupons were enclosed in the letters. Each coupon entitled the bearer to two free coho fry for release into his or her own section of the stream.

5. Keep track of how you're doing.

When the Open House event was in progress, each of the stream-side property owners who attended had his or her property marked with a dot on the master map at the hatchery. This refined the basic mailing list; letting the society know who had demonstrated an interest.

In Tynehead's case, the Open House drew about 500 people from the stream-side residents mailing. Assuming that each of the 800 homes identified is occupied by three to four people, that would be approximately 20 to 25 percent. Area-by-area, response rates varied; on one crescent, representatives from all eight homes attended the event.

For an Open House to be successful, it should offer a variety of ways to draw attendees into the issues. Some things to consider:

- Displays with photos that show good and bad habitat, with short explanations of why.
- Maps of the area, with streams highlighted.
- Something for the children: a tide pool for touching sea creatures, a tank of salmon fry, SEP's inflatable salmon, complete with a story-teller inside, or a group leader to organize salmon and habitat games or art activities.

6. How you continue is more important than how you start.

A watershed is in a constant state of renewal, so trying to make it healthy is an ongoing job. Tynehead planned to keep up the relationships it established and to expand on them.

Regular mailings to all the households were planned. These included a newsletter and information pamphlets (available from Fisheries and Oceans or the B.C. Ministry of Environment) about streams, fish and what both need to stay healthy. The society also planned to invite the householders to other events, with speakers to offer information on streambank care and other environmental topics.

As well, the Tynehead Society planned a committee for those who, while not interested in working at the hatchery, were interested in being part of the public information program.

The Tynehead model offers a good approach that could be adapted to other neighbourhoods.

Mailing list mechanics

For those who want to make up a neighbourhood mailing list, the method Lynn Price uses is:

1. Use municipal land title maps (at city hall) to locate each individual piece of land along the river and on its tributaries.
2. Make a list of the street addresses from these records.
3. Use the postal code directory (available at Canada Post or in your library) to get the postal code for each street address.
4. Also in library, use criss-cross directory to find names of owner for each address on your list.
5. Now it gets easier; compile the list using a computerized mailing label program.
6. Prepare your letter, stuff envelopes, stamp and mail.

The general stream survey

Stream surveys can be carried out to count adult spawners, to evaluate habitat, to identify juveniles by species and determine their relative populations, or just to get an overall feeling for the general productivity of a stream.

The degree of difficulty in carrying out surveys varies. Some surveys require trained personnel and specialized equipment.

This **Tipsheet** gives information on how to conduct a very simple survey to discover and record basic characteristics and population levels in a section of stream. It is not capable of producing a detailed evaluation of a stream's carrying capacity, but could provide a starting point for such work.

The data can be of value for habitat and fisheries management people and to various government agencies.

This project may be of particular interest to teachers who are planning future incubation of salmonid eggs. It will help students become more aware of the type of habitat their fry will need when they are released.

Tools and equipment

Most is readily available:

1. Maps

A large-scale map of the stream is essential. The best are on a scale of 1:50,000. These often show building sites which can be used as landmarks in sparsely populated areas. They may be obtained from stationary stores carrying government publications.

You also need a ruler or map measuring wheel.

2. Recording material

You need a good supply of pencils and notepads or survey forms on which to record what you observe. A portable tape recorder may be useful if you are forced to work in wet or windy weather and writing is difficult, but be sure to record your exact position before recording each set of observations. When transcribing the information later, your will need to relate it to positions on the map.

Stream cards are available from federal and provincial agencies to help those conducting a more thorough survey.

3. Other equipment

✓ **Polarized glasses:** help to reduce glare and make it easier to see (and therefore count) fish.

✓ **Compass:** for locating your position with reference to the map. (Also of obvious value for any activity that takes place in remote areas.)

✓ **Tape measure:** (or survey chain) optional for a general survey; essential for advanced work.

✓ **Walking stick:** for safety and to measure stream depth; marked in 10 or 20 cm sections.

✓ **Timing device:** a watch with a sweep second hand or a stop watch to calculate water velocity.

✓ **Floating objects:** pieces of wood or oranges for measuring velocity (oranges are best as they are partially submerged and produce a more accurate measure of velocity in water column).

✓ **Thermometer:** in a carrying case. For air and water temperatures.

✓ **Identification materials:** the diagrams from this **Tipsheet** will aid in fish identification. Booklets that identify insects, plants and trees are also useful. Some of these can be obtained from government agencies.

Warmth and safety

It is important that you also equip yourself with warm, waterproof clothing. It is essential that your footwear be suitable for damp and slippery conditions. Teachers taking school classes on such outings should have blankets, warm drinks and basic first aid equipment as well.

If you are working in a remote area it is essential to work in pairs — even a minor mishap can become serious if you are alone in the bush.

Getting started

Always be sure that you get permission if you will be working on private land.

Mark your map with your starting position. Mark the stream off from that position in 0.25 km (about 1/4 mile) sections and number each section. Be sure that you check each item on the survey form at each location.

You will need to use a fresh sheet of paper or survey form (or make a note in your tape recording) as you pass the boundary of each of your map sections.

The survey form

The following information will help you to fill out each form. The first section asks for general information on the stream, time and who did the survey.

Habitat and Environment

A. Stream and water

1. Stream width and depth: with a tape measure, check both the width at current depth and that indicated for high-water flows. Also measure today's depth. Take readings at each of three or more spots and average them.

2. Flow: measure off a length of stream (about 10 meters) with a fairly uniform cross-section and no obstructions. Best done at a riffle with relatively smooth bottom, or at a culvert or bridge crossing. Time how many seconds it takes a floating stick or orange to cover it. Repeat five times and take an average. Divide by 10 to get meters per second. This will give you water velocity. The following formula will help you calculate water flow:

average width X average depth X velocity (metres/second) X roughness coefficient (0.8 for rough bottom or 0.9 for smooth bottom) = cubic metres/second

For more accurate results, measure stream depth at one-meter intervals. Calculate water area as below:

section 1 = 1mX .2m deep = .2m²
section 2 = 1mX .3m deep = .3m²
section 3 = 1mX .3m deep = .3m²
section 4 = 1mX .2m deep = .2m²
Total 1.0m²

Flow = velocity X area

3. Stream gradient: note whether streambed is nearly flat, moderately or steeply sloped.

4. Stream bottom: note whether sand, dirt, small gravels, stones, boulders or bedrock.

5. Stream profile: note the shape which most closely resembles a cross-section of the stream.

6. Water: note water and air temperatures. Express the clarity in terms of depths to which you can see clearly and note any evidence of colouration.

B. Land and surroundings

Pictures provide additional information when correlated with your map points. Always take photos facing upstream.

7. Surrounding vegetation: note the density and type for both streamside and nearby areas.

8. Obstructions: note logjams, waterfalls, dams or other obstructions.

9. Areas of cover: (for both juveniles and adult spawners); be sure to include the underwater covers — rocks, undercuts, submerged logs, etc.

10. Shade and cover: note the percentage of water that is shaded. Also estimate (based on compass readings, direction of flow and the height of vegetation) the amount likely to be shaded at different times of the day.

11. Streambanks: note height, whether they are steep or gently sloping, undercut or eroded, and whether of rock or soil.

12. Surrounding land use: note the type of nearby land use. This is especially complex in urban areas; try to note as many different activities as possible. Provide an estimate of the width of the vegetation strip between the bank and any developments.

13. Pollution sources: note as silt, sewage outfalls or storm drain; areas which may carry livestock wastes into the steam; irrigation returns which may carry pesticides; land fills, industrial drainage and other drains or ditches.

C. Living organisms

14. Plants: note number of water-rooted plants and species in a square metre. If you don't know the species, note whether broad-leafed or narrow-leafed.

15. Insects: try to give a rough estimate of the abundance of aquatic and land-based insect life and identify as many species as possible. If there is very little evidence of insects it may be useful to note the amount of decaying vegetative material in the stream. Such information aids biologists in estimating steam productivity.

16. Fish: measure off (in your mind's eye if necessary) an area equal to about one cubic metre of water volume. Note by species and size the number of fish you can see in that cubic metre. Make observations on several such "blocks" of water in each section that you survey. You may also wish to note specific characteristics of these blocks of water, such as nearness to banks or pools.

A final note

This type of survey is only a general or preliminary study of a stream. It can be very useful in spite of its limitations since it can give general stream catalogue information to be kept on file and some idea of the potential of a given stream. Such information may guide other groups looking for the most advantageous site for a fry release and may also provide a starting point for planning a habitat improvement project.

Please be sure that all your notes and findings are turned in to your community advisor to turn over to regional inventory coordinators. That way others will be able to benefit from your efforts.

The general stream survey

Stream.. River system.. Section no. from map........................

Date........................ Time........................ Starting location.. Surveyor ....

Landmarks..

A Stream and water

Stream width: .... metres today
(use for flow calculation)
.... high water mark

Stream depth: .... cm today
(use for flow calculation)

Flow: .... m/sec (velocity) X .... stream width X .... stream depth X .... bottom factor = ... cubic metres per second flow

Stream gradient: ☐ flat ☐ moderate ☐ steep

Stream bottom: ....%dirt/sand ....%small gravel ....%stones ....%boulders ....%bedrock

Stream profile:

☐ ☐ ☐ ☐ ☐

Water: Water temperature .... °C
Air temperature .... °C

Water clarity ☐ less than 5cm ☐ 0.5m to 1m ☐ over 1m

Colouration ....

B Land and surroundings

Surrounding vegetation:

Type	Abundant	Moderate	Sparse	None
Coniferous Trees				
Deciduous Trees				
Grass/shrubs				

Obstructions:

Type	Height(m)	Location
Dam		
Falls		
Culvert		
Logjam		
Other		

Areas of cover:

Type	Abundant	Moderate	Sparse	None
Logs				
Root wads				
Rocks				
Undercuts				

Shade and cover:

Time	0	10	20	30	40	50	60	70	80	90	100

Stream banks: ☐ steep ☐ sloping ☐ undercut ☐ eroded ☐ rock ☐ soil

Surrounding land use: ☐ forest ☐ farmland ☐ rangeland ☐ suburban ☐ industrial

Pollution sources: ☐ silt ☐ sewage ☐ animal waste ☐ irrigation ☐ industrial ☐ other............

C Living organisms

Plants:

Type	Abundant	Moderate	Sparse

Insects:

Aquatic	Abundant	Moderate	Sparse
Land-based	Abundant	Moderate	Sparse

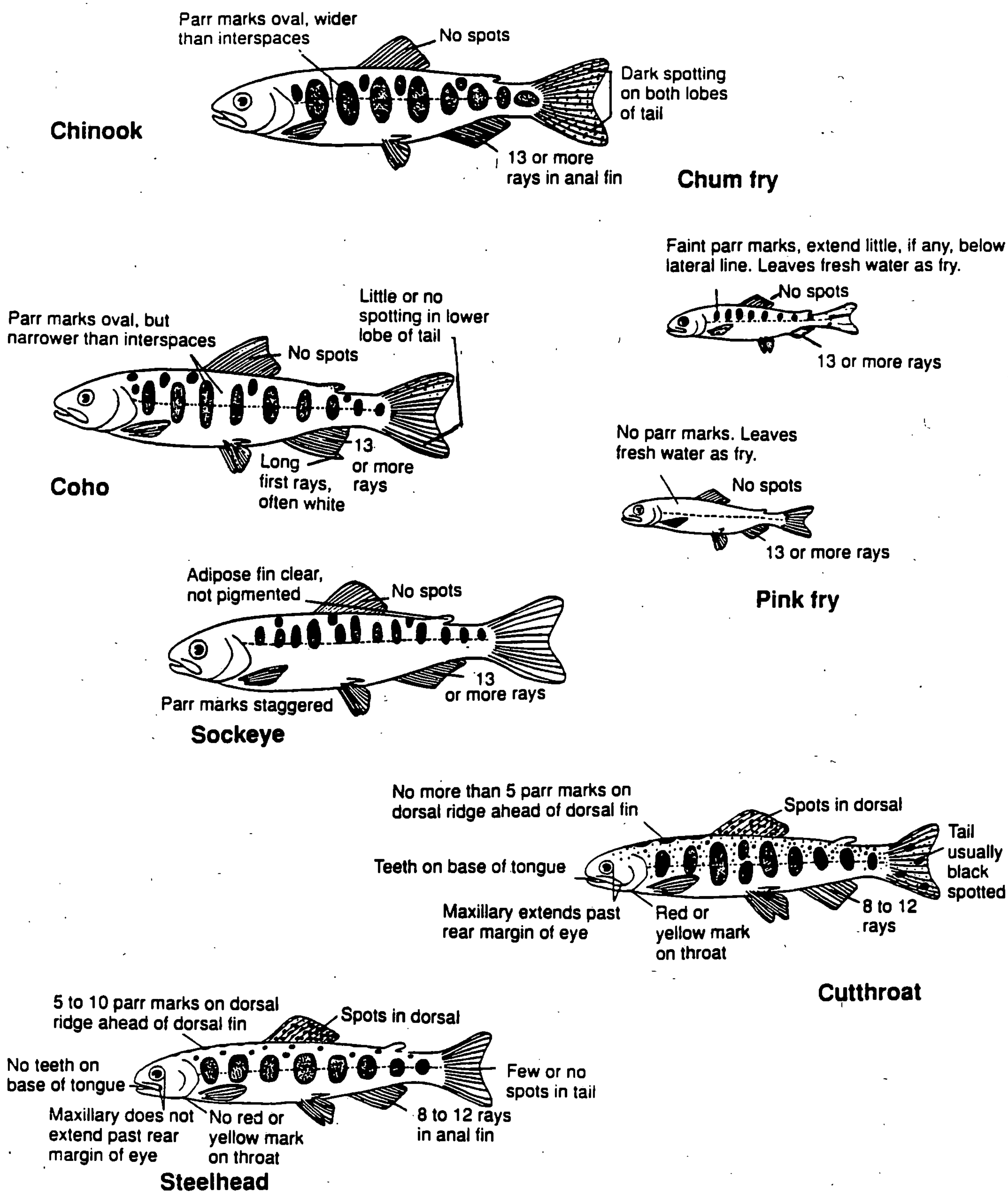
Fish:

Species	Number per cubic metre			
	0.5 cm	5-20 cm	20+ cm	Adult
Chinook				
Coho				
Chum				
Pink				
Sockeye				
Steelhead				
Cutthroat				
Other				

Additional comments...

Identification features of juvenile salmonids

Drawings show approximate relative sizes at migration



Storm Drain Marking program

If you ask most people what happens to water that goes down the storm drains, chances are they will respond "It goes into the sewer," or "I really don't know." In fact, it usually goes right into the closest stream. So, of course, whatever is in it goes there, too.

Many B.C. youngsters are working to remind people of that fact, and of the danger of putting gasoline, antifreeze, garden chemicals and paint thinners down those handy storm drains.

The Storm Drain Marking Program is sponsored jointly by Fisheries and Oceans Canada and the B.C. Ministry of Environment and Parks; funding is from the Ministry's Habitat Conservation Fund.

The Mark of the Yellow Fish

The idea is simple, sensible and appealing. First, use pamphlets and the media to make people aware that harmful substances that go down these drains end up in fish and wildlife habitat. There they kill fish, birds and animals. Second, mark the curb-side drains as a constant reminder. That is where the kids come in. Schools and youth organizations provide the painting power needed to tackle the job of locating and marking all those drains.

The mark chosen is a fish, stenciled onto the street or curb with bright yellow, long-lasting highway paint.

For the kids, it's a double-play; they get to have the fun of painting on the roads and of doing something real, personal and immediate to help the environment.

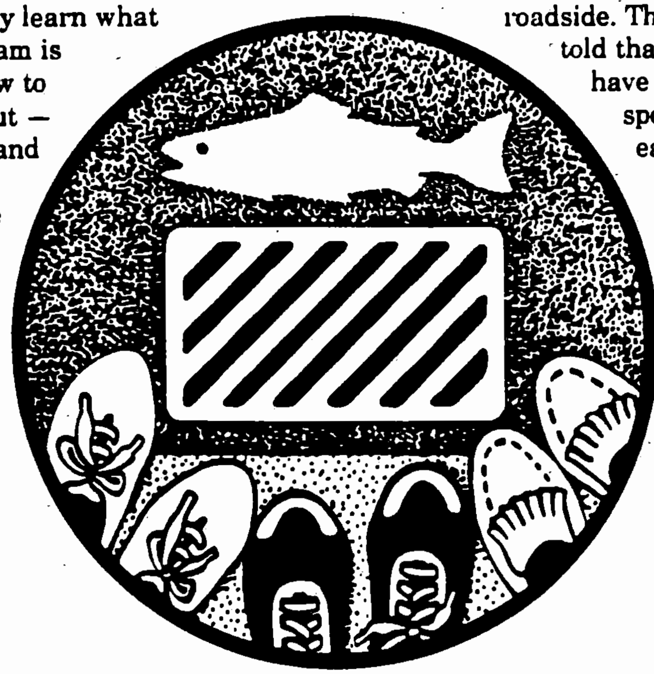
To start on art

Of course, you can't just send groups of children out to paint on the public streets. First, permission from the local government must be obtained. Second, maps of the area are needed so that the municipal or city officials will be able to keep track of what areas have been marked. Third, someone has to coordinate the effort. Fourth, painting supplies have to be obtained. Fifth, the actual work crews have to be given instructions.

Areas wanting to start their own marking program should contact their local community advisor or the Ministry of Environment and Parks for information and assistance.

How it works

Once the paperwork is done, children are selected, through classes or youth groups, and put through a workshop. There they learn what the program is about, how to carry it out — safely — and how to distribute materials that let the neighbourhood know about the program and its purpose.



Teach the teachers

At the workshop, the first order of business is to teach the children about storm drains and their link to fish and wildlife habitat. They learn that water from storm drains flows straight into streams, rivers or tidal waters without being subjected to any kind of treatment. They are encouraged to discuss the needs of fish that live in the water and other creatures that drink it. Then the leader asks them to consider the kinds of materials that can get into the drains and how that can happen (deliberate dumping or washing in from gardens and driveways).

This teaches the children but also equips them to answer questions from people they meet when they are out marking drains.

Safety first

The leader then moves onto a vital topic, the safety of the marking crew. They are shown safety vests and told they must wear them when at the roadside. They are also told that they must have a traffic spotter with each crew; someone to warn them when there is traffic approaching.

As well, the teams are warned that the highway paint is not good for human skin. They are told that those actually working with the paint must wear rubber gloves to protect their hands.

Check out the kit

Each team goes out with a marking kit, outfitted with everything needed to carry out the program; vests, paint, brushes, gloves, and a master stencil. During the workshop, a sample kit is used and the contents are examined and discussed. Care of kits, tools, and equipment is explained.

Public relations experts

Each team is given a lesson in good public relations; how to give polite responses to questions, and how to explain the importance of keeping chemicals out of the storm drains. They are also shown the pamphlets that are to be distributed around the area when they are marking. These pamphlets, ***Are You Killing Your Fish?*** and ***Home Tips for Clean Streams,*** help to explain the water quality issue to the residents.

The art part

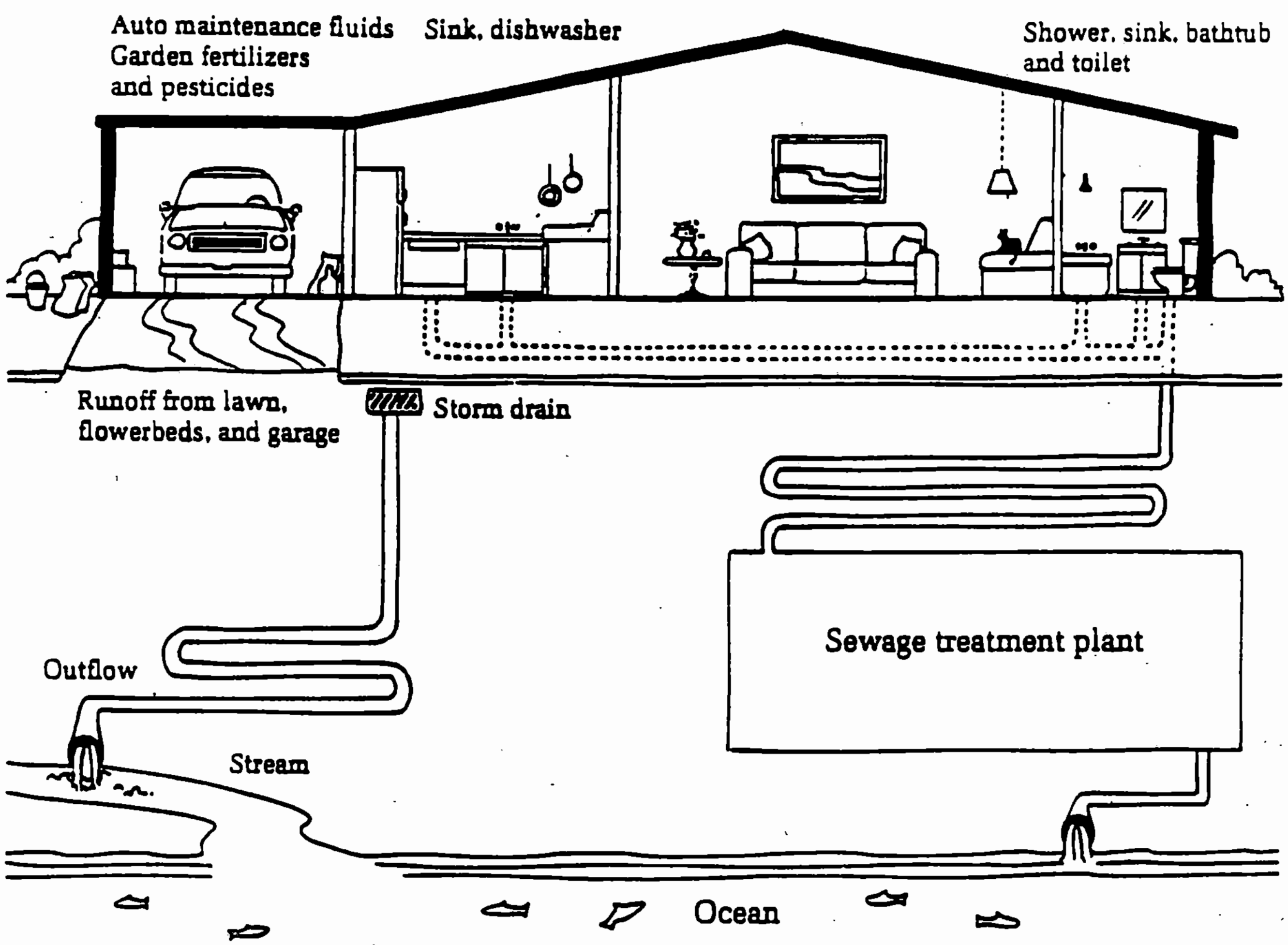
After the children know about these aspects of the program, there is a session on how to conduct the actual painting. That, of course, is the fun part.

Yellow fish are appearing in many communities. It's a program that seems to satisfy everyone involved.

Information

For information on this program, call Fisheries and Oceans, B.C. Ministry of Environment, or B.C. Conservation Foundation.

Where the water goes



Stream work: cover

Some problems commonly affect salmonid-bearing streams, limiting their productivity. Many such problems can be solved.

It is essential to start with a stream habitat assessment, with your CA's assistance, to determine the major factor(s) that keep the stream from being an ideal home for fish. This can be the most important work done, because what you discover from your assessment will have a direct bearing on the rehabilitative direction you take for your stream. If you miss the problem identification process, there is a good chance of using a technique that has no application to the problems of the stream.

Also be aware that no work should ever be undertaken in any stream without professional advice and assistance. Streams are complex environments, affected by interconnected factors and it is possible that the "solution" to one problem will create another.

Juvenile rearing needs

Salmonid fry are considered a delicacy by a variety of other creatures; birds, larger fish and small animals feed on them. As well, young fry are not strong enough swimmers to withstand the force of currents that may flow during freshets. Both these factors can lead to very high losses during this stage of the life cycle. These losses cannot be eliminated, but they can sometimes be reduced. Proper placement of cover in a stream can considerably increase the safe rearing area available to fry.

Before beginning any habitat improvement project, there are some essential points to remember.

1. No two streams are identical, so all work must be planned and approved for a specific site.

2. Different salmonid species have somewhat different requirements, so expert advice is needed on what improvements should be undertaken.

3. There are restrictions on what work can be done in a stream and on when it can be done — your community advisor can help with planning and with obtaining the necessary authorizations.

This **Tipsheet** offers information on some of the techniques that are used to increase rearing capacities. While no printed sheet can presume to offer a solid analysis of what might work in a particular location, the following notes should help you to become familiar with the techniques so that you will be in a better position to plan and execute the work if one or more is approved for a stream in your community.

The best course may be "do nothing"

Running water obeys certain laws of nature and it can exert considerable force. Therefore, any alteration made to a stream may produce secondary results — either at the site or at some point downstream. For this reason, it is always safer to err on the side of no action, at least until a thorough assessment has been made. This may require watching and keeping a diary of the stream's flow patterns over a period of a year or two so that any work undertaken will be planned with all likely conditions in mind. Professional advice is essential.

Vegetation

Some of the best cover for juvenile fish is provided by streamside vegetation. This may already exist or be starting to take root at your site. Conservation measures — keeping track of development plans, making sure private landowners understand the need for an "unsightly" bank, restricting access by animals and people, and planting a few more trees or bushes may be all that is needed. This does not seem like a very dramatic effort — but the results can be very rewarding.

Stream banks

There are three sections to a stream bank; one is always submerged, one is only under water in high-flow seasons, and one is always (or almost always) above high water. Each section contributes to the environment which supports juvenile fish.

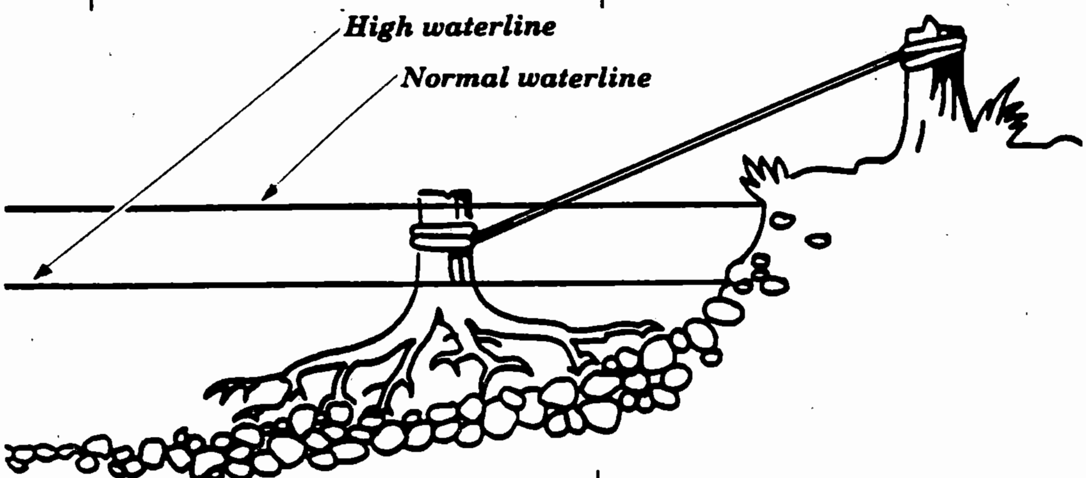
The submerged portion of the bank is frequently a source of protection. If the bank is undercut, fry may hide beneath it to escape predators approaching from the land. If there are large rocks and boulders along the bank, the crevices between them provide cover from both land-based predators and other fish species. Such cracks can also provide safe nooks for fry to wait out a period of higher water flows which might otherwise wash the small creatures downstream,

The section of the bank that is submerged at high water is frequently undercut to a sizable degree. If it can be left that way (by restricting foot traffic that might crumble it), it provides a margin between the land and water. This makes access for small animals very difficult and greatly reduces their chance to prey on young fish. Such undercut banks also increase the amount of shade, offering a cool summer environment for rearing fry.

The section of the bank that is rarely, if ever, submerged is of vital importance for this is where grasses, shrubs and trees take root.

The value of this stream side vegetation cannot be overstated. It provides nutrients, cover, a storage area for water, and stream bank stability, resisting erosion and assisting in the formation of pools and undercut banks favoured by juvenile salmonids. Vegetation also moderates temperatures and provides a source of food. While most of the fry diet is made up of water-dwelling insects, those which fall from the branches overhead are a good food source.

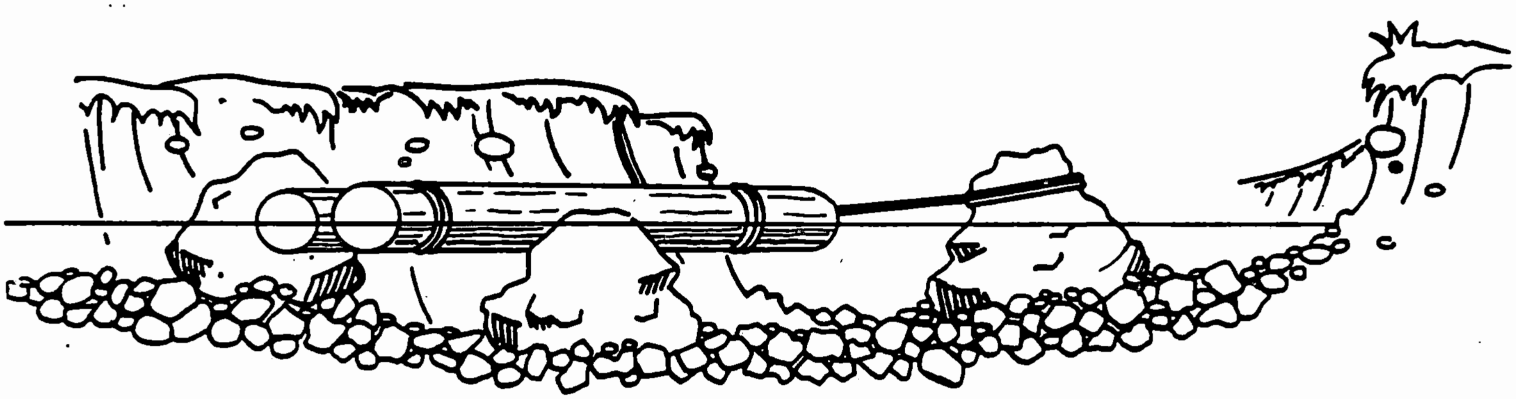
Planting suitable stream side vegetation is one excellent improvement for many streams. The best results will be obtained if expert advice is sought on what to plant, where to plant it, and at what time of year the planting should be done. Consult your community advisor who will be able to tell you what to plant by your stream or who can direct you to another information source.

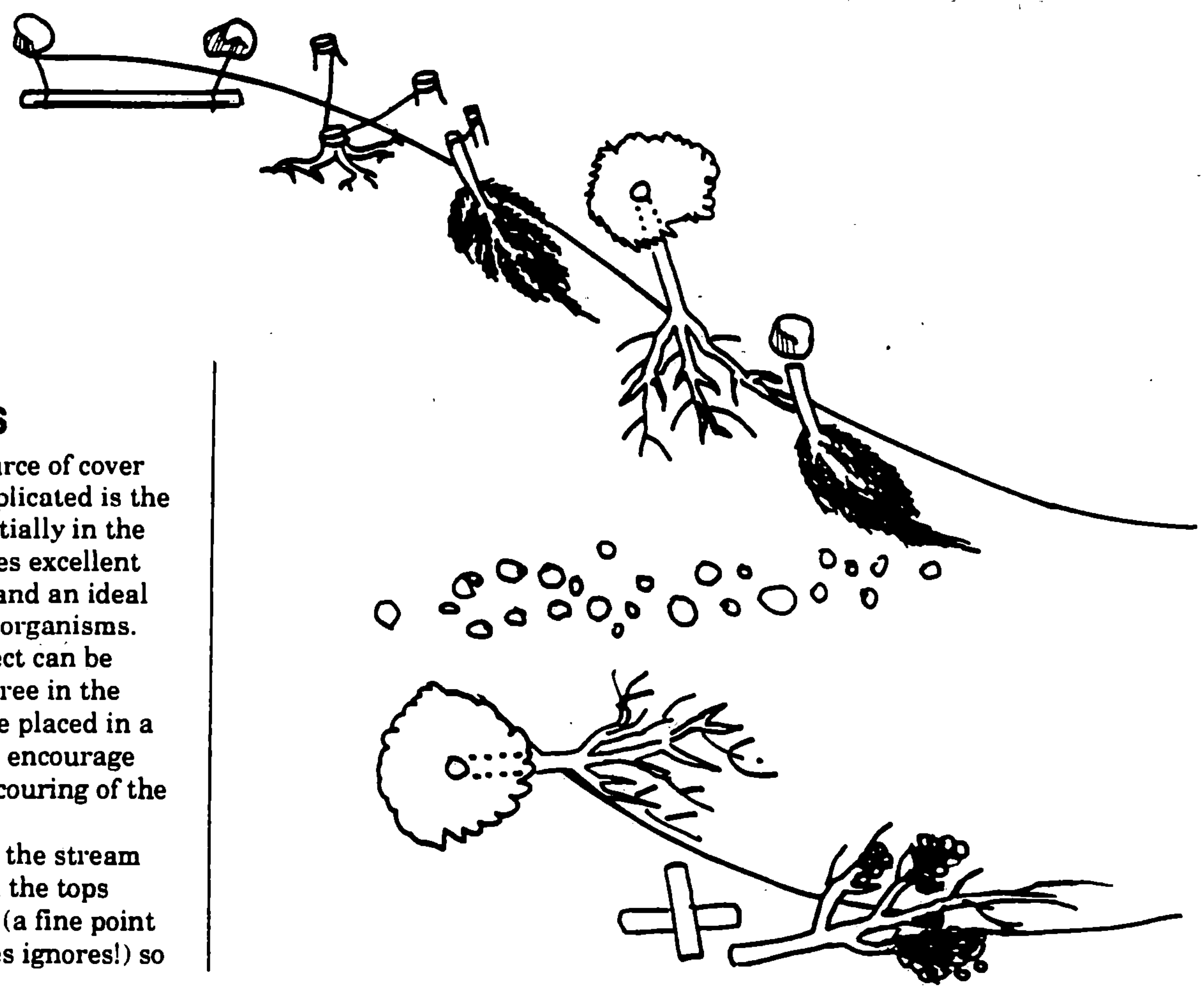


Logs in the stream

Floating cover, which rises and falls with the water level, can be provided by floating cedar logs in the stream. Logs can be whole or split, and several can be lashed together to form a raft. These should be placed adjacent to a steep bank, in an area with some depth so lower water levels will not leave them high and dry. The upstream ends of the logs must be securely lashed to the downstream side of a large boulder or a substantial tree at the edge of the stream. Float logs parallel to the current.

It is important to remember that wood will rot in the stream, so cedar is the best choice for this purpose.



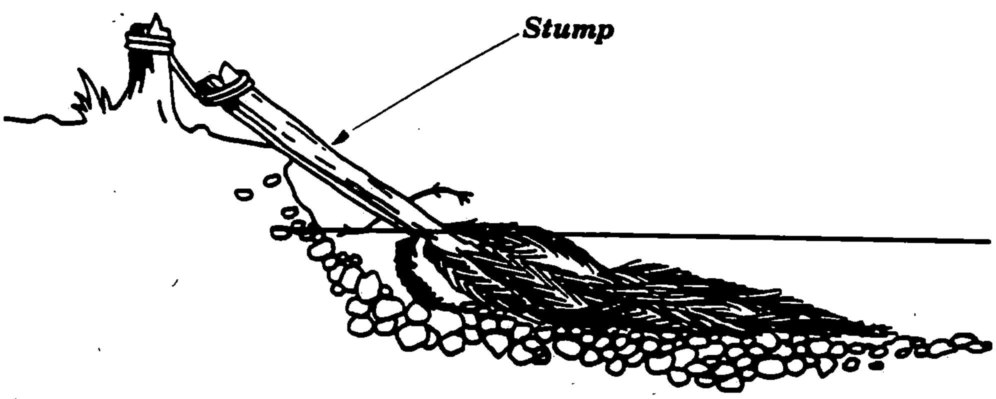


Whole trees

A natural source of cover that can easily be duplicated is the fallen tree. Lying partially in the stream, a tree provides excellent cover for young fish, and an ideal substrate for aquatic organisms.

The same effect can be created by placing a tree in the stream, but it must be placed in a manner that does not encourage buildup of debris or scouring of the bank behind it.

Trees set into the stream should be placed with the tops pointing downstream (a fine point that nature sometimes ignores!) so the branches



will be self-cleaning. The upstream (butt) end of the tree must be solidly anchored above the high water mark so it will not collect debris. This cover probably realizes the greatest benefits in wide, shallow streams with a sand or gravel bottom.

Remember to check with the landowner or the B.C. Forest Service for permission to fell trees.

Root wads

Root wads form superior cover for rearing fish, offering many nooks and crannies that will be used as hiding spaces. They must be handled with care, however, since their complex structure can pick up heavy concentrations of debris.

Place root wads so that the entire root structure will remain submerged during the lowest water levels. If any of the tangled root structure is left exposed, it will soon begin to collect small bits of waterborne debris. As it builds, it offers a resting place for larger bits of wood and a major water blockage can result. Such an obstruction may remain, and continue to build, through successive floods and receding water levels. Alterations to the water flow patterns, and severe erosion problems nearby may be the unintended end result.

Root wads must be securely anchored to the stream bank — lashed to a solid tree, stump or rock — or securely pinned into the stream bed with lengths of rebar.

Log and brush shelter

A log structure filled with brush is an alternative to root wads or trees, and provides both instream and overhead coverage. A main log (parallel to current) is set into the stream bank over an open pool. Three or more abutment logs (perpendicular to current) are also dug into the bank and pinned to the main log with a length of rebar. This structure will last longest if it is fully submerged. Brush or logging slash is then anchored into this framework. The brush should be partially submerged so that it will harbour both aquatic and terrestrial insects. This device is most suitable for use in low gradient stream beds; consult your community advisor.

Avoiding the unplanned

The dynamics of a flowing stream are complex. If cover is being provided, all likely results must be taken into consideration. Expert advice, from your CA and others, must be sought before work begins. Once the work is completed, follow-up inspections should be done on a regular basis. Prompt repair work is especially critical during the first few years following installation of structures.

Summary Guide of Stream Rehabilitation Strategies

	Streamside fencing	Terracing	Planting streamside vegetation	Rock rip-rap	Log rip-rap	Log crib structure	Wing deflectors	Half log structure	Instream log cover	Pallet cover structure	Tree and brush shelters	Log jam structure	Submerged log bank cover	Boulder placement for instream cover	Floating cover structure	Riffle building	Spawning riffle creation	Spawning channel creation	Streamside upwelling incubation box	Obstruction removal & fish passage
Eroded stream bank	●		●	●	●	●								●						
Lack of fish food production			●														●			
Spawning substrate lacking																	●	●	●	
Cover for adult fish lacking	●				●	●		●	●	●	●	●	●	●	●					
Cover for juvenile fish lacking	●		●	●	●	●		●	●	●	●	●	●	●						
Lack of riffles and pools							●						●	●		●				
Streamside vegetation lacking	●		●																	
Stream temperatures warm	●		●									●								●
Excessive silt deposition	●	●	●	●	●		●													●
Livestock access to watercourse	●																			
Natural meandering of watercourse lacking							●													
Fish migration interrupted																				●

Stream work: obstructions

Habitat improvements can be a simple and economical way to aid the enhancement effort. If a stream can be made more productive and a sufficient number of spawners either exist or can be introduced, then the population should become self-perpetuating.

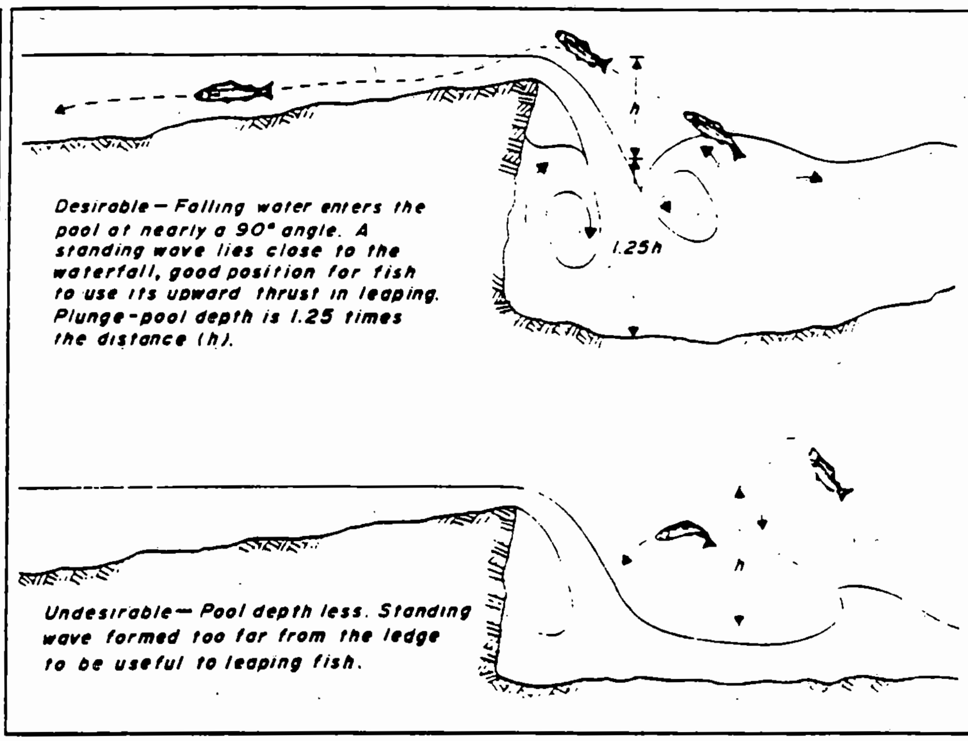
There are, however, problems associated with stream improvement work. The physical and ecological balances are highly complex and it can be very difficult to decide on appropriate alterations. **It is essential that stream work be thoroughly evaluated by your community advisor, fishery officers, habitat biologists, and the provincial Fisheries Branch authorities before anything is done.**

Stream improvements may concentrate on producing better conditions for juvenile rearing, upstream migration or spawning.

This **Tipsheet** will provide some information on types of obstacles which interfere with upstream migration and will provide some general tips on selecting appropriate improvements.

Before work is undertaken, the hydraulics of the stream should be thoroughly examined. Gradients, bottom composition, stream-bank and pool-riffle relationships and available cover are essential factors.

Waterfalls and rapids



The ability of salmonids to pass these obstructions depends upon a complex combination of height, water velocity and the position of standing waves. The impact will vary also according to the species of salmonids, since they have differing swimming and leaping capabilities. If alterations to such natural obstructions are necessary, your community advisor will be able to provide the essential information.

The work needed to improve fish passage may be as little as moving a few rocks or as major as blasting away large outcroppings of bedrock. A few approaches are outlined below:

1. Widen the gap between rocks where the velocity of the flows is too high for fish by removing all or portions of boulders. Use pry bars, slings and winches or rock-splitting tools. The rock removed in the process may be useful elsewhere as riprap or as shelter for juveniles.

2. Rearrange the boulders in very swift rapids to create a series of step-like pools; the fish will then be able to jump from one pool to the next. The same tools are needed as for widening gaps.

3. Deepen the plunge pool under a waterfall so that the standing wave will be nearer to the falls, and of greater aid to leaping fish. Depending upon individual circumstances, this might be done be making the pool itself deeper, or by lowering the top of the falls. The most desirable configuration is one where the water enters the pool at an angle of 90 degrees and where the plunge pool is 1.25 times the height of the falls.

Dams

Often, streams are obstructed by dams, either man-made or the work of beavers. The net result of both is the same; water flows are restricted and ponds exist behind the dam. Upstream migration may be partially or totally blocked.

Dams may produce benefits as well as problems. They may control fluctuating runoffs and the ponds they provide are used often by juvenile salmonids as rearing areas.

Small dams may be broken up and removed with rock chisels, rock drills and sledgehammers. Careful planning is needed regarding the impact of released water on the stream below the dam. The time of year for such work should be chosen with care and it may be necessary to remove the dam in stages to prevent flooding and scouring of the stream.

If a dam is too large for removal with hand tools, it may be necessary to call in a professional blaster. Again, care should be taken to minimize the damage caused to the bank while hauling material from the stream.

Beaver dams present a problem not associated with man-made dams; the beaver will probably repair the dam as soon as you take it down. If a beaver dam is obstructing upstream migrations the best solution may be to tear away a section of the top every day or two to lower the dam and let fish pass. Be sure you undercut the dam to create a vertical jump and place a polyurethane apron over the area to create a smooth surface. Sticks and twigs can trap fish trying to ascend if no protection is provided. Passage only needs to be provided during the spawning season.

Another alternative may be to run a culvert through the dam to provide a fish passage.

If a beaver dam must be removed completely, there are several factors to remember:

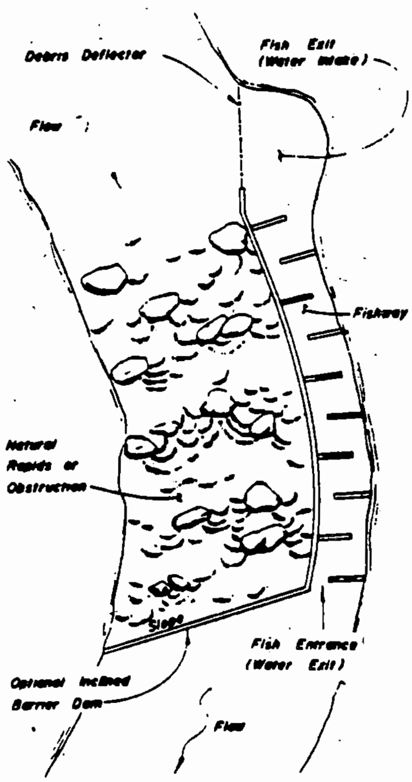
- Be sure you remove all elements, including the anchor sticks embedded in the stream bottom.
- Heavy siltation may occur downstream; check with your community advisor on when and how to carry out the removal.
- A permanent solution may include trapping and removing the beaver; if so, you **must obtain approval** from the Wildlife Branch for the project.

Fishways

Fishways allow fish to bypass otherwise impassable barriers. It is essential that any planned fishway be studied to be sure it is not also creating an opportunity for predators and/or poachers. Signs, covers and fences may be needed.

Fishways vary from simple stepped pools to elaborate concrete structures. Those most often undertaken by volunteer groups are short and simple in design (see illustration). Some characteristics apply to all fishway projects:

- Consider the species of salmonid which will be using the installations; each has its own swimming capabilities.
- Be sure that the fishway will carry adequate water flows during the migration season, in low as well as high-water years.
- Locate the fishway entrance as close as possible to the area where fish congregate below the obstruction. Be sure that the flow through the fishway is sufficient to attract fish to it.



- Minimize direction changes for fish swimming through areas of high water velocity.
- Flow patterns must be stable, not subject to surges; the energy of the moving water should be completely dissipated at each pool, not carried from pool to pool.
- Locate upstream exits so that there is no danger that emerging fish will be carried back over the area to be bypassed.

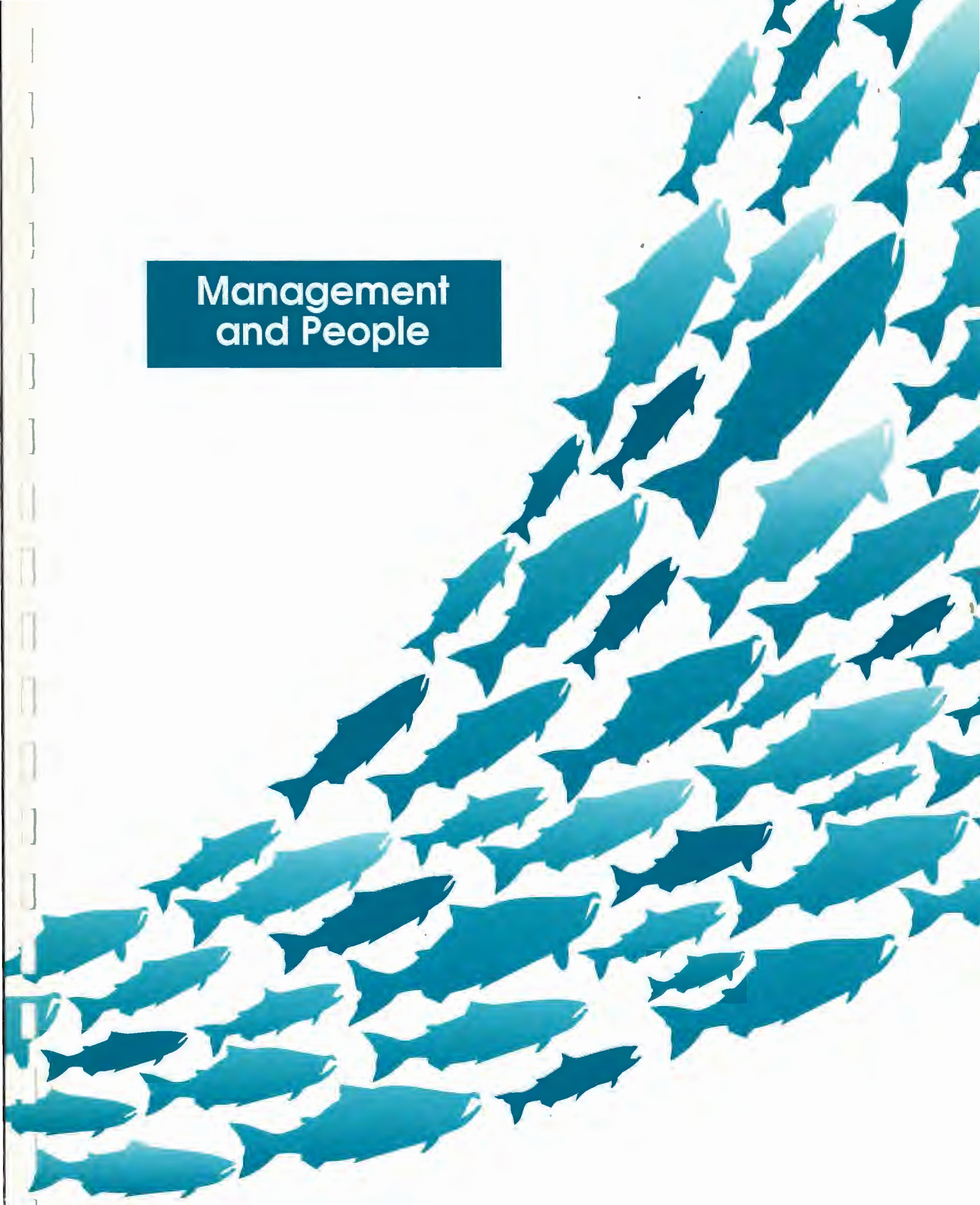
Logjams

Logjams can affect streams and fish populations by obstructing fish passage or by causing water to back up during high flows. Some types of logjams, however, are not a hazard; they even may be an advantage. If there is ample clearance for both water and fish beneath the logs, their presence may provide cover for adults in low water and for juveniles.

If removal is indicated, the size of the logs and of the overall jam will determine the best methods. Sometimes, sawing the logs into sections to haul out by hand is the answer. For a major jam, especially one involving large logs, you may need to use logging machinery. **Heavy equipment must be operated by experienced individuals.**

Whether using heavy equipment or hand tools, try to confine hauling activity to the most stable area of the bank. This will prevent erosion problems later. Special care should be taken in removing logs which restrain muddy deposits on the bank — you could release silt which would settle on spawning beds downstream. Your community advisor can help you determine the best methods for such work.

Management and People



Set volunteers on fire, just don't burn them out

Community advisor Joe Kambeitz, provided this Tipsheet on the care and feeding of volunteers — the lifeblood of every Public Involvement project.

Working for almost a decade with volunteers has given me an appreciation for their special qualities; their spirit and drive. On many projects, I've seen beginnings and endings and everything in between. Within the ebb and flow of these projects, one gets glimpses of what influences enthusiasm; what makes it endure and what stifles it.

How you are treated as a volunteer and, of course, how you treat other volunteers makes a real difference to your project; how it will grow, how many people will share the work (and satisfaction) and, ultimately, how successful it will be.

Elements of success

1. **Leadership:** if you are given the opportunity to guide other volunteers, to be the "old hand" so to speak, it's important to know the difference between being a leader and being a boss. Our work places, financial institutions and governments can supply a lifetime of orders and regulations. Volunteers need leadership, not more orders. This is an important point that should never be overlooked in our volunteer relationships.

(Note: Joe's point is supported by numerous surveys in the workplace which have shown that leading, not ordering, is more effective there, too.)

2. **Sharing the load:** when you become a veteran of several years on a project, and understand what makes it tick, for goodness sake share your experience. New, and initially eager volunteers can easily be soured by individuals or cliques who are "in the know" and just won't share information.

When someone volunteers what little time they have, it's not much fun to be left on the outside, looking in. They need to be included. Helping them to understand the things they need to know really is better than doing the job yourself. Don't fall into the trap of thinking that you don't have time for training — that the job must be done right and it will be faster to just do it yourself. Commit yourself to taking on an apprentice, or several. That way, the load is shared and more people are involved in meaningful ways.

When that happens, your project and your volunteer base will grow.

(Note: Thomas J. Watson, Jr. of IBM once said, "I want to begin with what I think is most important: our respect for the individual. This is a simple concept, but at IBM it occupies a major portion of management time.")

3. **Giving credit:** the grandaddys of Public Involvement projects, those that flourished, are the projects that give credit to *everyone* for a job well done. Leaders or followers, whether they drive nails, pick eggs or beg donations, they all like to be recognized for their efforts. So try giving a round of applause for the person who provides the coffee and muffins for your meetings. Encourage youngsters for their efforts. Salute seniors for their expertise. Each will return again and again.

This credit and appreciation should extend — enthusiastically — to donors and supporters outside your organization. Invite them to your meetings, put their names on signs or plaques, write a story for the local newspaper to recognize their help. See that someone they would like to impress knows what they did for you. Step aside for a moment to let the spotlight shine on them. You will certainly see a ten-fold return for your effort.

Do it because it's right. Do it, too, because you are not just working for today, Next year that backhoe time, lumber, concrete or free welding will be needed again. Insure yourself by giving credit.

(Note: Joe has documented support for this point of view. The book **In Search of Excellence** makes the following observation, "The volume of contrived opportunities for showering pins, buttons, badges, and medals on people is staggering at McDonald's, Tupperware, IBM or many of the other top performers.")

4. **Social aspects:** we form groups for all manner of reasons; to get a playground built or participate in a sport or enhance salmonids. The attraction that holds us together in these groups is our common goal. But we are also social animals and seeing one another only while working can be pretty boring. It allows us a one-sided view of our fellow volunteers. So, take the time (or make the time) for social occasions. A shared supper allows time for talk of plans, exchange of views and ideas; it allows time for friendships and relationships to form.

Social events are the times when families turn out and wives, husbands and children are introduced to the "miracle project" and to the "fellow crazies" who share the dream. The understanding and bonding that follows is the lasting cement that holds a group together for the long haul. It's also possible that some of the "outsiders" will catch the spirit and get involved along with you.

Try an "After-the-log-jam-removal" hot dog roast, or an "All-the-eggs-are-in" pot luck supper and see what happens.

A successful project is more than just having your fish survive; your volunteers must also survive. Neglect the human element and your project will be sterile, impersonal (and unpaid) drudgery. No one wants that. All the people who work on your project must feel involved, wanted, successful and that they have something worthwhile to contribute. Our common goal is to help salmonids, yes, but let's not forget about ourselves in the process.

— Joe Kambeitz

The volunteer life-cycle

Most organizations that deal with volunteers know that they pass through stages, beginning with enthusiasm, moving through learning plus commitment to knowledge and dedication. Near the latter stage, however, there is a real danger of "burn-out," a loss of interest and energy that can cause the best qualified of your volunteers to drop out of the project. Some of the ways to avoid this have been suggested by various experts in human behaviour.

Initially, volunteers are motivated by the goal, but if you want to keep them, be sure there is something in it for them, too.

1. The motivation can be a chance to learn new skills — so don't keep the same people at the same old task just because they have learned to do it; shift them around. Variety, as we all know, is the spice of life.

2. Motivation may be a chance to do something they don't do at work — so don't just assume that the accountant in the group wants to take over the books. Match people to their interests as well as to their known skills.

3. People get tired if they are asked (or forced by circumstances) to do an unfair share — so keep the group large and get lots of workers to carry a bit of the load. Be especially careful of the "Tom's always willing" scenario — if you keep leaning on Tom, he'll break.

4. Don't overlook the skill and willingness of the "silent majority." Many people are hesitant to volunteer — but will accept a job that's offered. They gain a sense of involvement and help spread the load, too.

5. Recognition is a motivator — for the people "behind the scenes" as much as for the "stars." At an International Association of Business Communicators conference a few years ago, one speaker pointed out that, from time to time, *everyone* needs a standing ovation; "Whenever you need one, just say so, and we'll all give it," she told her audience. It was probably the best-remembered statement from the entire three days — because it is so true!

6. Don't wait for someone to burn out. Offer them a "sabbatical" instead; but, if they take a month or more off, remember to keep them on your phone call and mailing lists or they may think you don't care if they ever return!

Dollars make the difference

Sooner or later (usually sooner) any project finds its ambitions exceed its current resources. when that happens, fundraising becomes a priority. Donald Lowen, SEP's education coordinator for southern Vancouver Island, prepared this **Tipsheet** to help you get started (or keep going!).

Choosing a fundraising event

When you are considering various fundraising events, keep your group's needs and desires in mind. Ask yourself these questions:

1. Can this type of event meet the group's needs (financial, social, etc.)?
2. Am I excited about doing this project?
3. Will other people in the group be enthusiastic about it?
4. Do the members have the time, skills and special talents needed to bring it all off?
5. Does the group have the resources (time, number of people, capital to invest) needed for the project?

If you've answered "yes" to all these questions, then consider your audience and whether or not it will "buy" the event you have in mind.

In addition to helping a worthy cause, a fundraising event should be something special, something that can stand on its own, something people want.

With special event fundraising, you promote your project and its objectives, but you must promote the event even more. For example, if you decide to hold a salmon bake, the first emphasis should be on the merchandise — its quality, uniqueness, price, freshness. Your secondary emphasis should be on the cause. Your organization's name or activities may draw people to your event, but the main reason they'll come is to buy a great meal.

Ethics and fundraising

Give some thought to ethical considerations when choosing and planning a special event. Your group has a reputation worthy of protection.

Keep fundraising costs to a minimum: Special events can be costly operations — aim to get most of the services and supplies donated.

Community standards must be respected: Avoid anything that smacks of sexism, racism or age-ism. Bachelor auctions, beer-drinking and food-eating contests, wild-west shows and circuses may not be for everybody.

Alcohol is a problem area: Aside from the ethics of encouraging people to drink, lawsuits have shown that the organization serving the drinks is responsible if a drunk driver is involved in an accident. If drinks are served, stress moderation.

Gambling presents cause for concern: Many religions prohibit it; people criticize lotteries and bingos as a tax on the poor. Consider carefully before involving your group in any gambling activities — including raffles, casinos and 50-50 draws. Check local, provincial and federal laws, too.

Low overhead equals high profit

Often, ticket sales do not produce a great deal of money; the income (or profit) results from the savings you realize when donors provide free goods and services.

The best way to increase event income is to lower costs by getting in-kind donations.

Almost anything you might pay for also can be had for free. For example:

$ **Foods** — several restaurants may give one dish each to a gourmet dinner. Look for restaurants that are new or about to open. Bagel shops, bakeries and deli's are often happy to give their day-old goods to charity. Soft drink bottlers can donate cases of pop.

$ **Printing** — Look for businesses that own an in-house printing plant. Chain stores, major corporations, schools and newspapers will often help. If you have to buy your printing, allow extra time so that your job can be run when the press isn't busy — it might be cheaper.

$ **Promotion** — radio and TV stations, newspapers and local magazines can help promote your event at no charge. PSAs, community bulletin boards and even "co-presentations" are possible.

$ **Raffle and door prizes** — hotel rooms (especially off-season), restaurant dinners, and last year's coffee table books are all popular prize items and are relatively easy to get donated.

$ **Give as well as take** — make sure your thanks to all sponsors are conspicuous. Keep the worth of donations in perspective. Time is valuable — don't spend all day trying to get "free" goods worth $25!

Measuring success

Any fundraising activity should have a financial goal. Obviously, one measure of success is whether or not you met this goal. But making a profit is not the only important consideration:

Was the event enjoyable? It's almost a rule of thumb that the best fundraising events are those in which the participants come away feeling that they got something for their money. Did they have fun? Were they entertained? Did they buy something they will cherish? Enjoy the satisfaction of helping a worthy cause? Feel appreciated? Would they do it again next year?

Did the volunteers enjoy themselves? The success or failure of a benefit event is determined by the dedication, enthusiasm, and energy of the volunteer workers who plan and organize it and who do the work. The event must be a happy one for both guests and workers. Some elements which contribute to volunteer satisfaction include:

$ plan as a group: let everyone participate in the process,

$ allow workers to choose the tasks that fit their interests and talents; make it fun; include a social aspect in the planning meetings,

$ share the public credit for the effort that goes into the event.

More than money

(from Ken Wyman's *A Guidebook for Fundraising for Disabled Person's Groups*)

Good fundraising provides an opportunity to gain more than just funds. In fact, if money is all an event raises, it may not truly be a success in the long term. Here are opportunities in three categories. Try to build as many as possible into any campaign.

1. **Cold cash** (once you spend it, it's gone)
   - cash
   - cheques
   - pledges
   - money orders
   - post-dated cheques
   - donations of goods or services

2. **Warm fuzzies** (good feelings that can open doors)
   - image
   - publicity
   - education
   - credibility
   - motivation
   - contact with people
   - increased commitment
   - good community relations

3. **Hot flashes** (help to raise more in the long run)
   - training
   - leadership
   - new volunteers
   - re-invigorated volunteers
   - repeat-ability of good ideas
   - names and addresses (new donors, diversified sources of funding)

Things to remember

Repeat special events annually. The first time is for learning from your mistakes, the second for making money.

Always collect the names and addresses of those attending. How? Try having a door prize where all guests must fill in a coupon.

Always give guests an opportunity to donate.

Never aim to break even.

Have early bird draws to encourage ticket sales, both for sellers and for buyers.

Never sell tickets only at the door. Inclement weather on the day could kill your income (and you'll have expenses anyway!).

Offer a three-tiered price strategy — regular, low-income (including students and "golden agers"), and "supporter" (at double or triple the regular price).

Attractive display tables sell. Display your merchandise, etc. in an organized and attractive manner. One priced sample of each item is all that is required on the table.

Watch your costs!

Thanks to Ken Wyman and to David Southern and the Canadian Section of Amnesty International, who provided material for this **Tipsheet.**

Public relations

We can clean up streams, incubate eggs, raise fish and undertake all kinds of enhancement projects but, in the final analysis, if our neighbours don't know about and support our objectives, they may all come to naught. Unless we have public understanding and support, our streams may be polluted, re-routed or captured in culverts. Local governments may permit clearing of streambank vegetation. Children (and adults) may damage our incubation boxes, disturb redds or harass returning spawners. Like any other organization, an enhancement project seek to establish good relations with its community and to gain public understanding and support.

Newspaper, radio and television stories indicates that many PIP and CEDP projects are highly skilled in this area. For those projects which are not experienced in this area, but would like to gain more publicity, this **Tipsheet** offers some basic public relations information.

Get to know your media

The first step in any publicity campaign should be to become familiar with the media outlets in your area. Make a list of newspapers, television and radio stations. Try to identify all of them — large and small. Consider business publications, too — companies in your community may publish employee or customer newsletters and could be interested in your project, especially if an employee (or employee's family) is involved.

Remember that your story can reach the same number of people through ten papers that have 1,000 readers each as through one that has 10,000 readers — but the small papers may be more interested in you. The same goes for community television.

Finding the names and addresses of all the outlets is only the first step. Research what kind of audience each has and what their content is like. You *might* get a fashion news magazine to use your mini hatchery as a backdrop for a photo spread, but it won't be easy! Concentrate your efforts on outlets that already cover things that apply — volunteerism, environmental issues, school activities or the outdoors.

Once the most likely outlets have been identified, find out *who* you should target information to at each one. It may be the editor, radio or television news director or an individual writer or reporter. Free-lance writers, who sell their work to a variety of outlets, are also worth locating — they may be able to "plant" a story where you could not. Make an effort to personally meet with editors, news directors and/or reporters — especially any who regularly report on activities similar to yours.

Don't be shy

It is easy to self-censor, thinking "that publication would never be interested in our little story," but you could be missing a good bet. Look at all the pages in a paper or magazine; think of the number of minutes of air time in a day's television or radio schedule. Then imagine what it is like to have to *fill* all that time or space. Information is raw material for the media — without it, they are out of business. Obviously, not every outlet will want your story — but offer it and let them decide.

Don't be pushy

The other side of the coin is that media people are busy and they get swamped with press releases, tips and requests. Offer information, but don't make the same approach over and over — if you get a reputation for pestering, you may get an automatic rejection even when you have a story that they normally would want.

Do be professional

Most successful relations with the media are built by taking a professional approach. Know the various media, be aware of story ideas that will work for each, then present appropriate information in a professional way. Don't waste people's time — do type all media releases, do provide accurate, useful information.

Writing the media release:

Be clear; label it "MEDIA RELEASE" or "FOR IMMEDIATE RELEASE" and date it.

Make good use of your headline. If the headline does not get someone's attention, they will never get to the rest of what you have written, no matter how exciting it may be. Remember that reporters and editors get from dozens to thousands of releases each day. Make yours interesting, but accurate. (There are few things as off-putting as a headline that has nothing to do with the story that follows!) Really take time wording a headline — get help from others in the group. Try for maximum impact with very few words. If you're stuck, study paper and magazine headlines for a few minutes, then try again.

Keep it short. A release should not run more than one page in length. If the information that you want to convey really is too much for that, split it. Do a short release (essentials) and add a "backgrounder" on an attached sheet(s) giving the details.

Style counts, too. A release must be well-written; it will be read by someone who is a professional writer and has a low tolerance for spelling errors, poor grammar and bad style. It is not, however, a literary effort. Avoid purple prose, poetic flights of fancy and exaggeration. Keep it clean, clear and simple. Get a second person to proof read it before you send it out. Few people are good at proof reading their own work. It's too easy to "read" what you meant instead of what you actually wrote.

Provide a contact. Media spokespersons say that one of the most significant oversights made in sending out releases is to forget to put a name and phone number at the bottom of the page so that a reporter can get more information. Equally frustrating; a release that has the name and number of someone who's never there! Reporters have deadlines. Respect their time constraints by making it easy for them to reach your spokesperson. List two or more contacts if necessary (just be sure they know that you are listing them, so they will be ready with answers if they get a call!)

Account for deadlines

Various outlets have different deadlines. A radio news department may be able to get your information on-air within the hour, but a magazine sets its line-up weeks or even months in advance. In between are a number of different deadline/lead time possibilities. Television stations have to book their camera crews and will want (except for *hot* news) at least 24 hours notice. Weekly papers will have deadlines a day or two prior to publication date.

Learn what deadlines apply to outlets you may deal with and respect them. Whenever possible, give people more advance notice than they need — they will appreciate your consideration for the realities of their job.

Phone... fax... mail?

Getting the word to a media outlet can be done by mailing a release, faxing it and/or phoning the appropriate person. If you are using mail or fax, be sure you address the release to an individual, by name. A release that is just sent to "the editor" or "the news director" may not reach the person who is most likely to see the possibilities in your story.

If you have an idea that has real merit, and if time is short, a phone call is appropriate. Be sure you have your facts straight before you place the call so you can convey the information in a professional, efficient manner. Common sense (and courtesy) indicate that you should avoid placing a phone query when the paper is about to go to press or the show to air — no one has time then for anything but the job at hand.

Tailor for the outlet

Although you may be sending one basic release to several outlets, try to offer each a suitable slant or angle. If, for example, you have a class of students coming to your project to release fry, offer each outlet (by note or phone call) specific aspects of the event. Each gets an "exclusive" (and you avoid every-one wanting to interview the same person at the same time.)

Become an expert

One way to raise public awareness of your project, is for someone in your group to become an expert — one of those the media turn to for comment when there is a fish-related issue to comment on.

An articulate, well-informed expert finds publicity opportunities come to them. There are some provisos, however. Be sure you don't get trapped into commenting on a topic or situation you don't know enough about. Someone will read or hear what you said and respond — you can end up leaving a bad impression of yourself and your group. Be fair — never give in to the temptation to disseminate dubious information or paint a picture that unduly favours you or your cause. You will lose all credibility if you do. Offer information of real value — answers rather than accusations, perspectives that others may have missed, how your group's work fits into a larger picture. Learn to answer questions clearly, but briefly — if you ramble on, the media will stop calling you.

Keep your perspective

If there is a controversy in the community, some members of the media may try to push you into a confrontational stance. Stay with the facts and keep your cool. Words uttered in anger can lead to libel court and, in general, they don't look good in cold type. As for getting dragged into a shouting match in front of the television camera — in most cases, it makes everyone involved look bad. When the topic is touchy, make your mind up in advance about what to say. Then say it, and say no more.

River safety

River anatomy

Within a river, there are numerous currents, each with varying speeds and directions. Currents are largely influenced by water speed and obstacles. Faster, deeper water is generally found in the middle of a channel, while slower currents tend to be located nearer the banks. Due to the presence of rocks and boulders, the water is slower along the shoreline.

Water flows more slowly along the bottom of a river because of the obstacles encountered there as well. Deeper water is generally darker than shallow water but, depending on its location, may or may not be swifter flowing. For example, water on the outside of a corner (bend) in the stream is always deeper and faster moving than on the inside. In comparison, while a deep pool may be very dark, its current may be negligible.

Ccurrents reshape the river's banks and bed. Faster water on the *outside* of a curve erodes the banks, exposing large boulders and roots, while sand and gravel are deposited by the slower water along the *inside* of the bend.

Obstacles both slow the speed of moving water and redirect its flow. An obstacle can be any size, from a point of land to a single boulder. Each will influence the current in its own unique way. A boulder on the river bottom forces water around and over it, creating a wave on the surface.

Standing waves

The size and shape of a surface wave depends on the speed and depth of the water as well as the size and location of the rock. Generally, the deeper the water, the smoother the wave. Tall, smooth waves down the center of a channel are called standing waves or "haystacks."

Diagonal waves

If a wave originates near the bank and extends toward the main current, it is called a diagonal wave. Diagonal waves coming from both shores create a "V" with the tip pointing downstream. These downstream Vs are usually composed of deeper, darker water and are usually the safe route for travel by boat.

Pillow waves

If an obstacle is close to the surface and the water "bulges" over the top without showing any white, the wave is called a pillow. Avoid boating over these because the water depth can be very deceiving.

White, frothing water on the *downstream* side of a boulder indicates a large object, a large drop, or shallow water. Depending on the depth and speed of the water and the size of the object,

these waves are called "drops," "holes," or "keepers." It is good practice to avoid such waves.

Vertical eddies

Obstacles in the current create cavities on their down-stream sides. The laws of nature do not allow a vacuum, so water must move into these voids. To fill the space behind an obstacle, water must flow upstream. Water moving opposite to the main current is called an eddy.

Eddies can be found near shore where a point of land protrudes into the current, on the inside of bends or where water drops over a boulder to fill in a cavity behind it. These last eddies are called vertical eddies or keepers, and can be extremely dangerous because the current is flowing in a circular direction, from the river's surface to its bottom. This current can hold objects underwater for long periods of time. Hence a potentially deadly situation exists in what otherwise may seem to be an innocent looking wave.

Sweepers

Trees fall into rivers and can pose a serious hazard to people working in or around moving water because the current flows through rather than around the branches. A boat may be dragged to the tree, but can't go through it as the water can. If a tree is lying in the river with its roots or base in contact with the shore, it is called a "sweeper." If a boat is forced into a sweeper, the operator must make every effort to keep the boat parallel with the current. If the boat is pushed broadside into a sweeper (or any other object) the occupants must lean into the obstacle and present the **bottom** of their boat to the current. This minimizes the danger of a capsize.

River crossing

Crossing a river *can* be safe and uneventful if done with prepa–ration and care. Look for slow or shallow water. In a slower current, the bottom will be composed of smaller rocks which give better footing. Also note down-stream hazards. When the stream narrows, shortly after a shallows, there is likely to be deeper, faster water. If there is a pool downstream, there is probably a drop-off. These are very abrupt and tend to be unstable. Only when a safe location has been found can a crossing be attempted. Wear proper footgear. If hip or chest waders are worn, ensure that nothing impedes swift removal. People have drowned due to the weight of water in their waders.

Before crossing, study the downstream area and have a contingency plan in case of mishap. Cross individually; watch each person cross until the other shore is reached. A strong staff about five feet long should be selected and used for support. While crossing, face downstream, staff in front, placed firmly on the river bed.

When moving across the current, keep two firm points of contact with the river bottom. If standing still, knees should be slightly bent while leaning a little against the current. This way, one is in a position to sit back in the event of slipping. If footing is lost and one sits back, both feet will be in position to heel into the bottom in an attempt to regain footing or, if carried along, to fend off downstream rocks.

River rescue

The most expedient shore rescue involves the throw-bag.

A throw-bag consists of a length of floating rope stuffed into a brightly coloured nylon bag. One end of the rope is connected to the bag while the other remains free. The rescuer holds the rope's free end while throwing the bag to the victim. This is a very useful rescue tool, but it takes practice. Make sure everyone in the party knows how to use it before starting out.

Before attempting a throw, the rescuer should establish a position on shore that allows ample room to move downstream. Holds the rope's free end in the non-throwing hand. Open the bag and fill it with water to increase its weight so it can be thrown farther. Hold the bag at its opening while maintaining a solid stance. Swing the bag with an underhand motion once or twice and toss to a position beyond, and slightly upstream from, the victim. When the rope can be reached, the victim pulls the bag within reach and takes hold of the grab loop.

The rescuer pulls in any slack rope, then resists the current to "pendulum" the victim to shore with the rope acting as the pendulum arc. Usually, the rescuer will have to move downstream along the shoreline in order to avoid losing the victim, the line, or both, to the current.

As the rescuer slows the victim's downstream progress, the current will push the person toward the shore. This rescue may require the assistance of one or two others if the current is very fast.

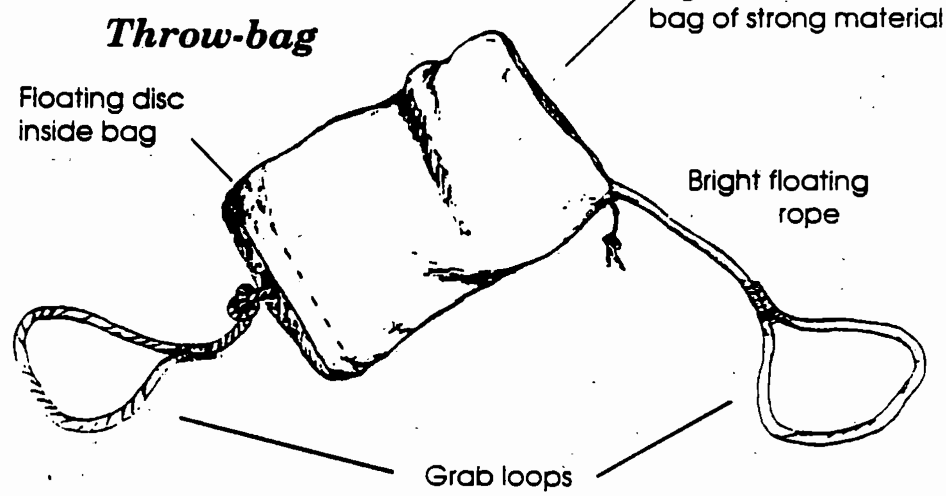
If the rescuer is not able to move along the shore, the retrieved slack rope can be belayed in order to provide a similar effect. In either case, the victim should prepare for the rescue by sitting back and facing downstream. This allows the victim to breath while the water rushes past.

Victims can offer assistance by kicking toward shore. They should watch for rocks or other hazards and push away from them. Only when the victim is fully out of danger or in ankle deep water should the rescue line be released. Immediately upon retrieval, the rope should be stuffed into the throw-bag, starting at the bag end and working toward the free end. Never coil the rope; this method takes too long and the rope is more likely to tangle. Once re-stuffed, the throw-bag is ready for future use.

Although every situation is different, the key point when working around rivers is to think ahead and plan for safety. Those who want more information, or are interested in courses about moving water can contact their local provincial white water association.

— Arne Hetherington,
Kalamalka Jr. Secondary School.

Throw-bag



Research

Counting the returns

Returning adult salmonids are frequently counted to provide essential data on survival rates and to assist fisheries managers in planning future harvest rates. For a small project, the data can be a valuable way to chart a stream's overall productivity, measure the project's success and evaluate and improve rearing and release strategies. On a larger scale, data complied from counts in many streams may provide the first clue to changes in ocean survival rates — a matter of great importance to fisheries managers.

Counting fish is not easy, however, especially in coastal streams made turbid by fall rains. The following advice from the fisheries crew operating a counting fence on Kanaka Creek can help you get the job done right.

Methods

The ideal way to count returns is at a counting fence. It produces the most accurate data, and accuracy is the key. Of course, in high water flows, some fish get over the fence without being counted, but with reasonable water levels it is possible to count each and every fish that passes.

Other methods include:

- **Visual estimates:** walk the creek banks, wear polarized sunglasses to cut surface glare, and make an effort to count all the fish you can. If the water is fairly clear and the bottom is clean gravel, this might give you a reasonably accurate count. When you are dealing with turbid water and a silted bottom, protective colouration works against you and you may only be able to actually count about one third of the fish that are present.
- **Dead pitches:** while this can be tough, cold, smelly work, it does offer a way to get an estimate. Remember, though, that in water with poor visibility you will certainly fail to see many carcasses, so you need expert advice on what conclusions you can draw.
- **Beach seining:** this will capture a fair number of fish in a pool, especially if the bottom is not too uneven. This method can be used in conjunction with Petersen tagging and mark recapture systems.
- **Electroshocking:** this method works well in small creeks, but a fully-trained technician is required for the process.

What information do you need ?

Given a good counting fence and cooperative water levels, it's not hard to get a simple head count. Such information is useful, but there is a great deal more that can be learned. Depending on the location and nature of your project, you may need to answer a number of questions. Your best source of advice on how to set up your adult count and on where and how to carry it out is your community advisor. The CA will know what information is most useful to you, but also what may be valuable to other programs within the department. DFO staff may also be able to help you with specific information on how to go about the count. There are some basics that apply to most spawner counts and this **Tipsheet** will cover the most important of them.

Have the right gear

Whether you plan to count at a fence, walk the stream for a visual assessment, or do a dead pitch, you need the right tools, clothing and equipment.

- **Field book and mechanical HB pencils.** The field book must be waterproof for obvious reasons, and the mechanical pencil solves the problem of how to sharpen a wet pencil with wet hands. A spare solves the problem of how to record data after your pencil vanishes into a deep muddy pool. (Waterproof paper for notebooks can be purchased from survey suppliers and forestry outfitters).
- **Scale books and tweezers.** Scale books can be obtained from DFO; there are two different formats, so be sure to get the right one for the sampling you will be doing.
- **Tape measure.** Get a good, plastic-coated tape (metric) for measuring fish lengths.
- **Knife and machete.** You need the knife to cut open dead fish if you are checking for egg retention. The machete is needed to cut fish you have sampled in half — so local fishery officers can identify your work and you avoid sampling the same carcass twice.
- **Head and body bags.** Heads from fish with missing adipose fins must be cut off and sent in to the Mark Recovery Program so that the coded-wire tag can be recovered. Freezer-quality Ziplock bags or head bags from DFO are the only choices for storing them. Be sure that you have each head clearly labeled so that data from its tag can be matched up with scale sample data.

• **Good rain gear and boots.** These are essential for your own safety and comfort.

• **A vest with many pockets or a small knapsack.** Use this for carrying gear to leave your hands free for climbing, measuring and writing.

• **A first aid kit and air horn.** These are absolutely necessary if you are working in the bush..

Procedures

• **Never try to work alone,** even on a sturdy counting fence. Always work in teams of two or more. Be sure that someone on each crew has CPR and first aid training.

• **Even small creeks can rise quickly** and exert amazing force. Lifelines should be rigged. Life vests may be necessary. A "rescue station" with a thermos of warm soup, dry clothes and a blanket is a must.

• **Plan the day's activities** before you go out to the site. Assign specific duties to each member of the group so that nothing will be missed and nothing duplicated.

• **If you are walking a length of the stream,** as opposed to working at one site, be sure you already have a map showing your stream marked off in clearly identified reaches. Record all data for each reach separately. This is especially important for follow-up work in succeeding years since it will reveal any changing patterns in where the fish spawn.

• **Remember that you are working in public** — the work you are doing may seem routine to you, but the public can find it offensive. Be sensitive to this and keep things as clean and pleasant as possible. Be prepared to answer questions politely and with accuracy.

• **Each crew member should have their own field book.** This provides a backup record if one book gets misplaced or destroyed. It also means that you can compare entries and note any questionable data before it is recorded in the Camp Master Record.

• **Never erase an entry in a field record book.** Such data collection books are admissible as evidence in court — should the need arise — but only if they show no erasures. If an error is made, strike the entry neatly and re-enter the data on another line.

A page in a typical data collection book might look like the illustration.

Your project may also want to collect other data — there is no such thing as too much data, but you have to know why you want it and how you can use it.

Make sense of it

Field data, recorded in field books, is a valuable resource. Like many resources, however, it is bulky and awkward in its raw state. You need to process it to extract what you really want.

A Camp Book or Master Record should be kept and each day's information logged in it.

Keep it accurate

• **One person should make all entries to the Master Record for the day** — changing people can lead to confusion.

• **All secondary records** should be compiled from the original field data — never copy from a copy.

Notebook legend:

Mark

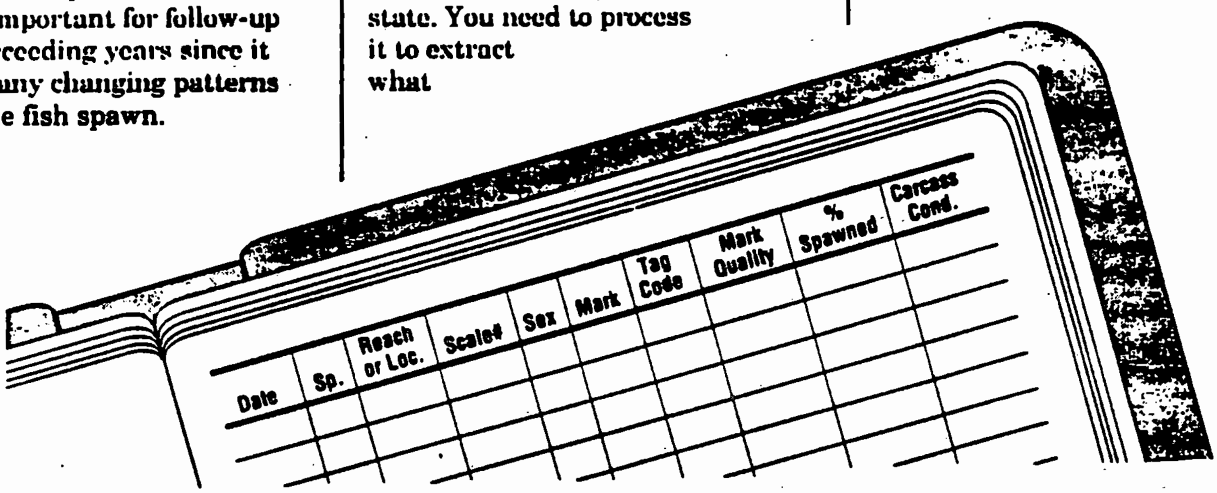
AD — Adipose
LV — Left ventral
RV — Right ventral
Rmax — Right maxillary
Lmax — Left maxillary

Mark Quality

1 — Fine, tight to body
2 — About 1/2 clip
3 — Nick, or maybe natural damage

Carcass Condition

1 — Fresh, gills red
2 — Moderately fresh, gills mottled
3 — Soft, gills white
4 — Extremely decomposed



Sampling of hatchery fry

Periodic fry sampling is an essential aspect of any hatchery rearing program.

This procedure involves the capture of a representative sample of fry from each rearing container to allow weight and/or length measurements to be taken. By periodically sampling your hatchery fry, you can monitor their growth.

There are several good reasons for monitoring growth of hatchery fry.

Feeding rate

As fish grow, their feeding rate changes (see **Tipsheet on** Feeding and Ponding). It is therefore necessary to monitor the growth of hatchery fry in order to update feeding rates.

Food conversion rate

Simply stated, food conversion rate means how many kilograms of food do your fish have to eat to gain one kilogram in body weight.

This is a very important measure of success for your rearing program. The food conversion rate of your fry from one sampling date to the next can be calculated using the following equation:

$$\text{food conversion rate} = \frac{\text{weight gain(kg)}}{\text{food (kg)}}$$

A food conversion rate of 1.0 is the theoretical maximum (1 kg of weight gain for every kg of food). If the food conversion rate is greater than 2.5 the fry are not feeding efficiently, and you should review your rearing procedures with your community advisor.

Condition Coefficient

An important indicator of the health or "condition" of salmonid fry is the ratio of their weight to their length, also called their condition coefficient.

If length measurements are taken when weights are taken, then the condition coefficient can be calculated from the following formula:

$$\text{condition coefficient} = \frac{\text{weight (grams)}}{\text{length (mm)}} \times 10^5$$

Optimum values for condition coefficient are near 1.0. If the condition coefficient of your hatchery fish varies greatly from this you should consult your community advisor.

Inspection

A regular sampling program also provides an opportunity for close inspection of individual fry. This often leads to the early detection and treatment of diseases which can prevent serious outbreaks.

Types of sampling

There are two basic methods for conducting weight sampling. These are bulk weight sampling (sometimes called wet weight) and individual weight sampling.

Bulk weight sampling is used to obtain as estimate of average fry weight. Conducting this on a weekly basis should be adequate for monitoring growth and for updating feeding rates. If a scale accurate to .01 grams is available, you can take individual weight measurements.

Length sampling can be undertaken when doing either bulk weight sampling or individual weight sampling.

In the first case, an average condition coefficient for the entire sample can be calculated, while in the latter case, individual condition coefficients can be calculated. Individual length and/or weight sampling should be conducted monthly.

Equipment

A. Bulk weight sampling

The following equipment is required when conducting bulk weight sampling:

- ✓ balance (accurate to 1 gram)
- ✓ dipnet
- ✓ small plastic basin
- ✓ ladle or fry spoon
- ✓ tally counter
- ✓ thermometer
- ✓ paper towels
- ✓ pencil and paper.

B. Individual sampling

In addition to the above equipment, the following will be required for conducting individual length and/or weight sampling:

✓ balance (accurate to 0.1 grams)

✓ plastic ruler marked in mm increments (gluing an end piece on the ruler to slide the fry up against facilitates measurement)

✓ anesthetic

✓ extra basins for anesthetic and recovery baths

✓ aerators (if available).

Procedures

A. Bulk weight sampling

1. Place a basin of water on the scale, weigh it and note weight.*
2. Remove a dipnet of fry from the container; try to obtain a representative sample or samples.
3. Support the net, and let the water drain for approximately 10 seconds.
4. Gently spill approximately 50 fry from the dipnet into the basin of water (approximately 25 will be sufficient for smolts). Return the surplus to the rearing container.
5. Note the total weight (fry, basin and water).
6. To count the fry, use the fry spoon to return them to the container. Transfer a few at a time, and accurately count them with a tally counter. (You may want to retain them separately for length measurements.) Repeat the procedure as often as necessary to sample a significant percentage (say 6 - 10%) of your fry.
7. Subtract weight of water and basin from the total weight to obtain weight of the fry.
8. Divide the total weight of fry by the number of fry to determine average weight.

B. Individual sampling

1. Set up equipmenth.
2. Draw a dipnet of fry from the rearing container; try to obtain a representative sample.
3. Transfer approximately 50 of the fry to a holding tank or basin. It should be well supplied with dissolved oxygen by aeration or water flow. Return the surplus to the rearing container.
4. Remove fry one at a time by hand. Measure length from tip of nose to the fork of the tail. (This process can be simplified with the Penny Fry Measure, see page14)
5. If a scale accurate to .01 grams is available, weigh the individual fry and note weights.
6. Record all data including deformities and signs of parasites or disease.
7. Monitor temperature of holding tank water and change the water if the temperature changes by 3°C.
8. Work as quickly as possible; try to have three or four people available, each with a specific job; i.e. recording data, measuring fish, transferring fish.
9. Monitor fish closely for signs of stress such as darkened colour, erratic behavior, swimming at surface, and long recovery rate.

* Some scales can be reset to zero with the basin of water in place. In this case you can add the fry and read their weight directly.

Stress

A certain amount of stress is unavoidable during sampling activities, particularly individual sampling. Changes in water temperature, reduction of dissolved oxygen, crowding and handling all cause stress.

It is important to know that the effects of these stressing factors are cumulative. A single stressing agent may not cause harm but, when combined with others, the cumulative effect may cause serious problems, even death.

The stress caused by sampling will be kept to a minimum if the procedures described above are followed carefully. There will be no ill effects on the fry from regular sampling activities which are carried out in this manner.

The knowledge you obtain from regular fry sampling should help you maintain a successful rearing program. This helps to ensure the release of healthy juveniles which will have a better chance of survival.

Scale sample reading

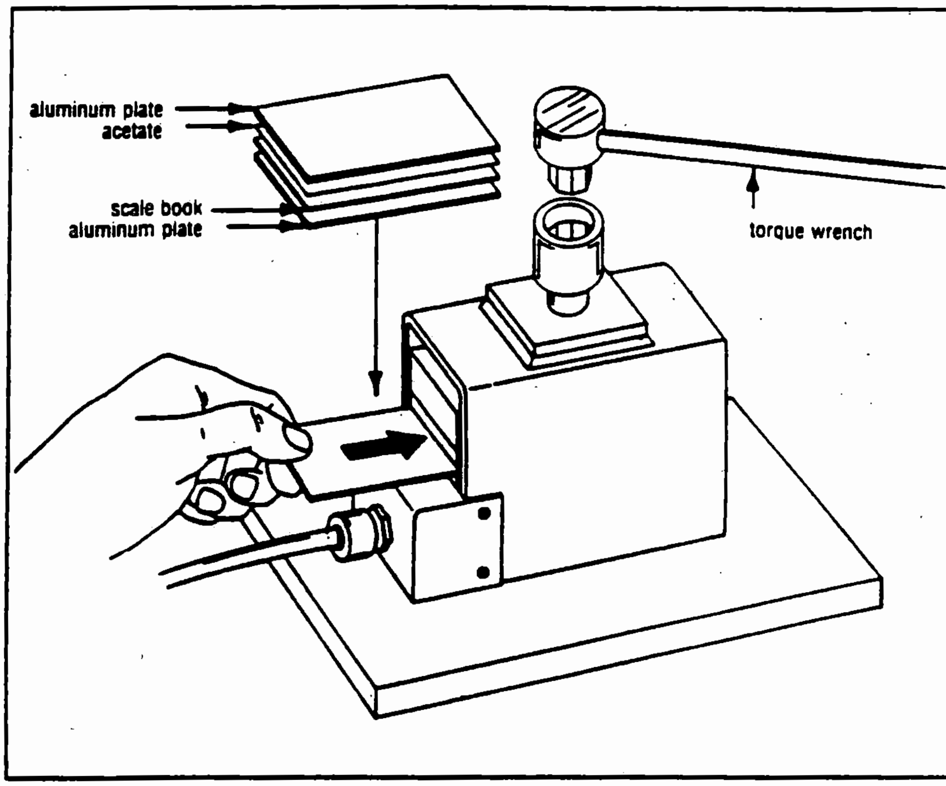
Why read scales?

Reading scales from salmonids can provide a lot of information about their lives. From these readings an experienced person can tell the species, the age of the fish, how fast it has grown and in what stage of its life, how long it has lived in fresh or salt water and, in the case of steelhead or cutthroat trout, if it has spawned before. Such information is valuable for fisheries managers and for your projects.

Scales can be read simply by pulling them from the fish and putting them under a microscope to interpret what you see. There are definite limitations to this simplistic approach, particularly if you have a number of scales to read and have to keep them stored and organized.

It is possible to overcome this by permanently recording scale samples as a plastic impression. After this is done, there is no need to keep the original scales as all the information needed has been impressed into the sheet of plastic.

The scale press shown can be built from readily available parts.



How scales grow

Scales on salmonids don't become more numerous as the fish grow, they get larger. In this process, the fish grows a new, larger scale under the old one, which remains on top. There is a definite ridge left where the old and new scales meet. If you were to slice a scale in half through the center, it would look somewhat like a pile of plates, with the highest point being the tiny first scale of the fry.

Stacked ever larger beneath that are the mid-year and, nearest the fish, the most recent protective scale.

Reading, or more accurately, deciphering this stack of plates involves an accounting of these ridges. A popular misconception is that these rings are like those in a tree — "one ring, one year." Unfortunately, this is not so, in fact several rings may form during one season's growth.

Making good impressions

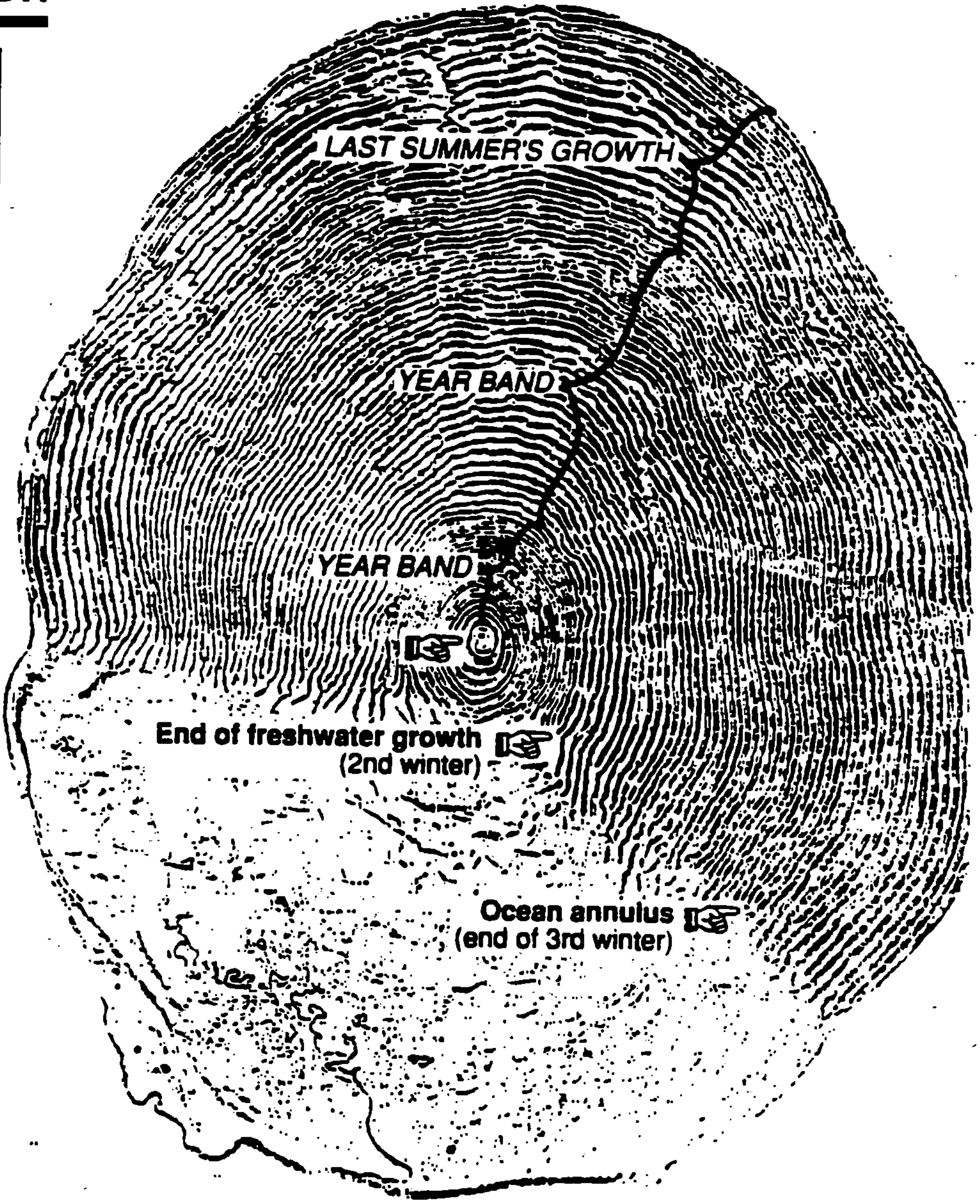
Getting good scale impressions starts by taking care while taking scales from the fish. The scales should be taken from the "preferred" area, which is above the lateral line and between the dorsal and adipose fins.

Pull the scale out cleanly with tweezers, clean it by wiping it between thumb and forefinger (do not let go with the tweezers) and place it on a scale book. A common error is to stick the scale to the book upside down. The ridges are on one side only, the side away from the fish, so put the scale in the book the same way you took it from the fish, with the side that was next to the fish next to the paper. Don't forget to fill in the written information on the scale book. Once you have taken scales from fish it's surprising how they all look the same!

To make an impression with the machine, you sandwich — between two aluminum plates (perhaps the thickness of a dime each) — the scale book with a piece of .020 thick clear acetate 64 mm X 127 mm (2 1/2 X 5 inches) which can be obtained from Layfield Plastics Ltd. in Richmond) on top, facing the scales.

This is then slipped into the heated press and the press is screwed tightly down. Depending on the temperature and pressure, about 3 - 5 minutes should be sufficient time to make the impression. Remove the plates and let them cool to produce a perfect impression of your scales. You may need to experiment a little to find exactly the right time to leave scales in your press. The part of the scale book you wrote your information on is normally attached to the plastic impression with clear cellotape.

If you can't get proper scale books you can make your own by using wide brown gummed butcher's tape (the old-fashioned paper tape that looks like brown paper bag material, gummed on one side). Place the scales on the gummed surface.



How to read scales

Learning to read scales, and tell the species, age and growth rate of the fish they came from, takes years of experience. The visual elements that indicate such things are subtle. But even the novice can learn some interesting facts about fish scales and will be able to find examples of some of them in actual scale impressions under a microscope.

1. The rings are only visible on the portion of the scale that was imbedded in the fish skin. The exposed portion appears virtually clear. This exposed portion is called the posterior — because it is nearer the tail. The imbedded part is called the anterior. The most important part of scales, to a reader, is the posterior-anterior margin, the line where the two sections meet. The rings are often easiest to identify along this line.

2. Salmon begin to form their first scales when they are between 40 and 50 mm long. This first scale, which remains as the center of the scale for the fish's full lifetime, is called the "focus."

3. When a scale sample is taken, the date must be noted. If it is not, the outermost ring (or annulus) has no point of reference for the reader.

4. The number of rings that are created in a given year or season can vary from one fish to another — genetics and food supplies influence this.

5. It is the spacing and thickness of the rings, plus the subtle visual pattern that they form, that reveals seasons and speed of growth.

6. Rings formed in fresh water are usually finer than those formed in salt water.

7. Coarser rings with wide spaces indicate summers — as time of fast growth. The rings formed in the winter are finer and closer together.

8. Each species has its own distinct pattern of rings. As well, the pattern of freshwater rings for different sockeye stocks are distinct. Using this information, the scale lab can help fisheries managers know which stock is being caught in the fishery at any given time.

The scale lab staff check their findings from scale readings against known samples from tagged fish on a regular basis to check their own accuracy.

Scale sampling

In laboratories in Vancouver and Nanaimo, DFO staff examine salmon scales and cross sections of fin rays and otoliths (a small bone found in the salmon's inner ear) to determine the age of individual fish.

All three reveal a series of concentric circles which, when examined by a skilled reader, can tell both the age of the salmon and how many years it has lived in fresh and salt water. It is like counting the annual growth rings on a tree stump, except scales do not form one ring per year.

Why is age important?

Knowledge of the predominate age group found in a particular run of salmon is an important management tool. If we can predict when the offspring of a given year's spawn will be returning, a management strategy can be worked out beforehand.

For example, if historic records show that a stock is comprised of mostly four-year-old fish, we can predict an abundance of salmon (and possibly a commercial opening in some cases) four years after an especially strong escapement. Conversely, we can plan special conservation measures to protect returning spawners four years after a particularly poor escapement. Also, for PIP enhancement projects, it's nice to know when to expect those first returns!

Equipment:

✓ scale books and scale sampling tweezers, available from your community advisor

✓ notebook, to record lengths

How to take scale samples

Scale samples are taken from both sides of each fish; the number of scales required varies by species.

Scales from each side are arranged in individual squares in scale books. (See illustrations of scale book formats.) Always complete sampling one side of the fish before starting the second side.

1. Place the fish on its side
2. Wipe the preferred area (see diagram) clean of water and slime.
3. Remove scale from preferred area by grasping its

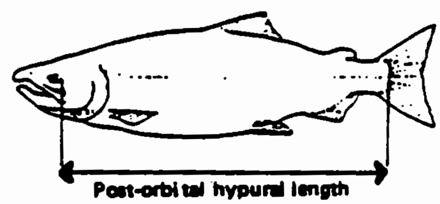
exposed edge with tweezers and pulling.

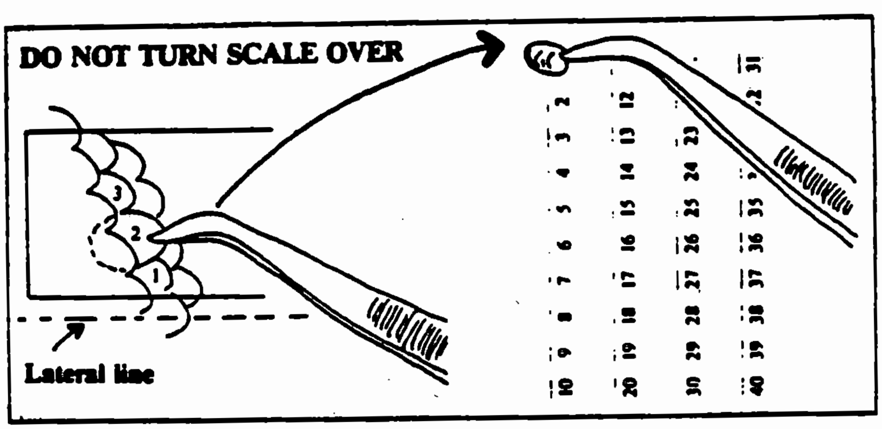
4. Hold the scale up to the light to check for deformation. If it is deformed or abnormal, discard and select another.
5. Center the scale on the numbered square on the scale book so that the side that faced up on the fish remains facing up on the book. To check if the correct side is facing up, scrape the surface of the scale with the tip of the tweezers. It should be rough with ridges.
6. Be sure the scale is sticking firmly to the scale book. Use no additional water to adhere the scale, just the moisture already present.

Turn the fish on its other side and repeat the procedure.

How to report length data

In some instances length data accompanying the scale samples is requested. The most common length measurement used for adult salmonid sampling is the ***post-orbital hypural length***. This is the measurement from the back of the eye socket to the back of the hypural (tail) bone. This measurement can be employed on carcasses whose tail fins and noses are decayed. Fork length (nose to fork of tail) measurement is used in all juvenile sampling. Be sure





Science and Research

all measurements are clearly identified as to which samples they go with. For example:

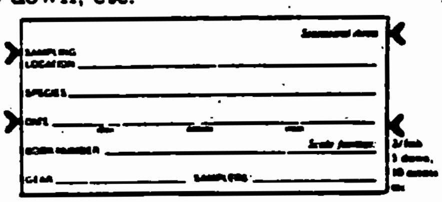
Sample	Length	Book	Scale #
1	96 cm	1	1 to 5
2	103 cm	1	6 to 10

Length measurements should accompany scale samples of chinook (both river-caught and spawners), and all freshwater species.

Scale book care

1. Keep as dry as possible. Moisture from rain, etc., will dissolve the book's adhesive coating and cover the scale, or wash away the adhesive so the scales will not stick to the book. If a book becomes wet, start a new one rather than have the glue spread.

2. Fill in data on inside brown cover of scale book. Do not write lengths or other information on outside covers; these covers are destroyed when the scales are pressed in the lab. Scale format should be specified as to 10 across, 5 down, etc.



3. Record all length data on separate data sheets.

4. Clean scales provide the most meaningful readings.

This fall, why not take samples from the fish you are using for broodstock. Your community advisor can have them analyzed for you at the scale lab in Vancouver. The information obtained will provide you (and DFO management staff) with additional insight with respect to the salmon stock you are working so hard to conserve!

Scale book formats

SIDE 2 SIDE 1

10	9	8	7	6	5	4	3	2	1
20	19	18	17	16	15	14	13	12	11
30	29	28	27	26	25	24	23	22	21
40	39	38	37	36	35	34	33	32	31
50	49	48	47	46	45	44	43	42	41

SCALE FORMAT:

10 across
Use with these species: chinook spawners, coho spawners, steelhead

SIDE 2 SIDE 1

5	5	4	4	3	3	2	2	1	1
10	10	9	9	8	8	7	7	6	6
15	15	14	14	13	13	12	12	11	11
20	20	19	19	18	18	17	17	16	16
25	25	24	24	23	23	22	22	21	21

SCALE FORMAT:

10 down :Use with these species: chinook spawners, coho spawners, steelhead

SIDE 1 and 2

10	9	8	7	6	5	4	3	2	1
20	19	18	17	16	15	14	13	12	11
30	29	28	27	26	25	24	23	22	21
40	39	38	37	36	35	34	33	32	31
50	49	48	47	46	45	44	43	42	41

SCALE FORMAT:

5 down
Take three scales from side 1 and two scales from side 2.
Use with: chinook (ocean-caught), sockeye spawners* and all freshwater species

SIDE 2 SIDE 1

5	5	4	4	3	3	2	2	1	1
10	10	9	9	8	8	7	7	6	6
15	15	14	14	13	13	12	12	11	11
20	20	19	19	18	18	17	17	16	16
25	25	24	24	23	23	22	22	21	21

SCALE FORMAT:

2 across
Use with these species: chum adults, chum spawners

5	5	4	4	3	3	2	2	1	1
10	10	9	9	8	8	7	7	6	6
15	15	14	14	13	13	12	12	11	11
20	20	19	19	18	18	17	17	16	16
25	25	24	24	23	23	22	22	21	21

SCALE FORMAT:

2 across
Use with all species of juveniles. Take a smear or scraping of scales with a scalpel. Slide the scales off the scalpel *the same way up*. Use a probe or point to assist in removing scales to the book.

* Sockeye sampling is more complex, please consult your CA.

Submitting samples for diagnosis

When fish health problems occur and diagnostic assistance is required, it is important to submit a suitable sample and information in order to obtain an accurate diagnosis.

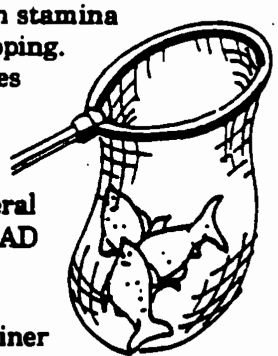
The first and best approach is to arrange for an on-site visit by the diagnostician. However, if this cannot be managed, a sample of moribund or freshly dead fish should be submitted as soon as possible.

First and foremost

Telephone: Call the diagnostician to make arrangements:
1. Before samples are collected
2. Before treatments are started

Have the following information available: loss records, water temperature, fish densities, water quality, etc. Decide on the best transportation to ensure delivery of live fish to the laboratory. Travel schedule information must be provided during the initial contact so that diagnostic personnel are aware of expected arrival time of the sample.

Collect Fish: Choose five to ten MORIBUND (sick) fish that show signs of disease and abnormal behaviour, but which appear to have enough stamina to survive shipping. Check the edges of ponds and outlets for lethargic and sick fish. Several FRESHLY DEAD fish may be submitted in a separate container with appropriate labels if moribund fish are not easily obtainable. Dead fish which are decomposing are NOT ACCEPTABLE samples for diagnostic evaluation. A RANDOM SAMPLE of healthy fish may also be requested.



Common behavioural signs of problems include crowding of fish near water outflows, near aeration devices, and near the water surface; erratic swimming; flashing; lying on the bottom; and lethargic movements.

Arrive alive

Transporting affected fish:

CARE must be taken in preparing the sample for shipment. The choice of container or system of submitting samples will depend on the type of transportation available and the distance from the diagnostic centre. Several suitable options include:

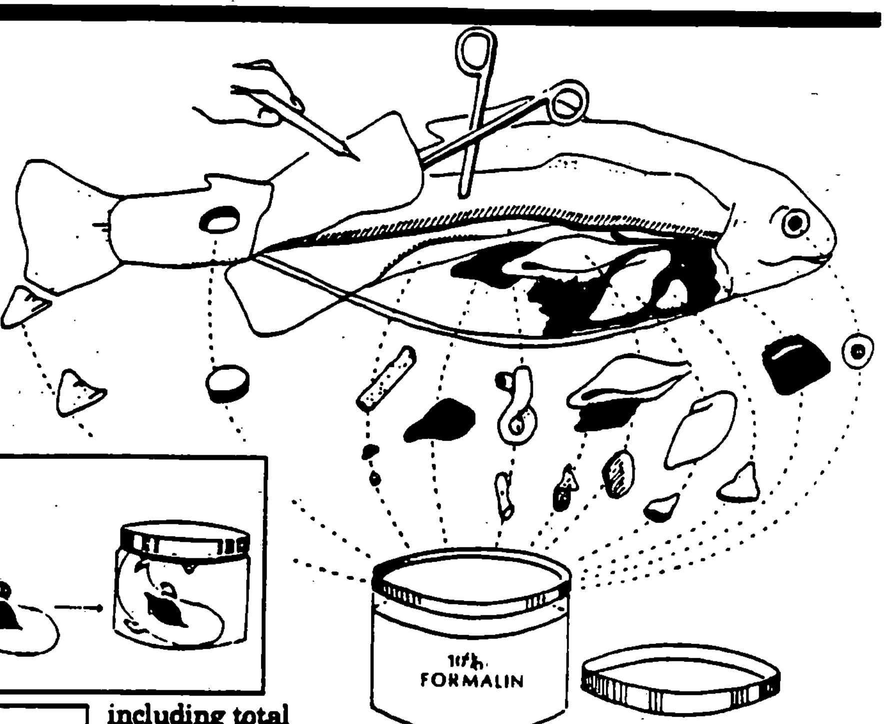
1. OPEN CONTAINERS: provided with an aeration system. This system is suitable when delivering live fish by hand.

2. PLASTIC BAGS: Live fish travel well in adequate water in strong durable plastic bags. Flush water and space above with oxygen or medical air. Seal this bag inside another. Ten smolts or fingerlings will survive in 2.25 litres of water. Load a suitable Styrofoam chest or bucket with bagged ice or ice packs on the bottom and sides. Fish should not be in direct contact with ice as false disease signs can be induced and parasite load reduced. Ship IMMEDIATELY.

3. ICED OR FROZEN: Fish may be submitted in individual bags on ice or frozen if a live sample proves impractical. Remember that ice MELTS; a suitable container for the ice is therefore necessary to prevent leaky packages.

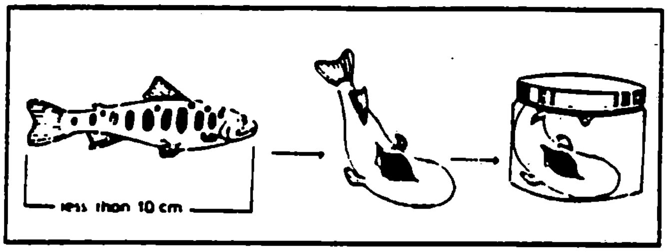
Frozen samples are appropriate if the fish cannot be shipped right away. Add a small amount of water to the bag before freezing. Ship with additional ice in an insulated container.

Preserved samples



Fixed or chemically preserved samples are suitable for histological and parasitological examination. The preferred fixatives are 10% buffered formol saline or Bouin's.

Samples of fry-to-smolt size must be slit open along the ventral surface to allow rapid penetration of the fixative. Major organs and tissues of larger fish are removed, sectioned to one cm thickness and preserved in five to 10 times the volume of fixative. (10% formalin can be made by adding one volume of 37% commercial formaldehyde to nine volumes of water. Fixative is improved if the final solution contains 0.9-1.0% table salt.) A 70% (measured) solution of methyl, ethyl or isopropyl alcohol, or isopropyl alcohol in water can also be used as a fixative in emergencies.



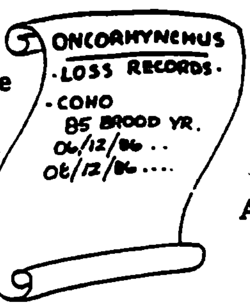
Preserving solutions

10 per cent formalin:	
Formalin	100 mls
Water	900 mls
Bouin's solution:	
Saturated aqueous picric acid	750 mls
Formalin	250 mls
Acetic acid	50 mls

NOTE: As fixative chemicals cannot be shipped by air or post, drain off the excess fluids from the fish sample after a 24-hour fixation period, wrap the sample in fixative-soaked disposable towels and seal in a leak-proof container.

Provide information: each sample submitted must include information concerning the source of the sample:

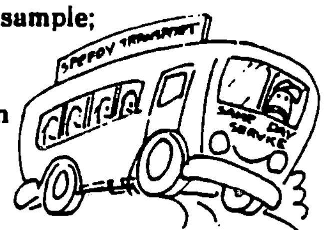
- Project name
- Address, age of fish, source and pond number
- Loss records for the past two weeks, including total number of fish per pond
- Water source and quality, DO_2, pH, temperature, salinity, ammonia



Provide information on:

- COMMON DISEASE SIGNS observed in sick fish, which include redness of external skin areas, abnormal skin colouration, ulcers, bloated abdomens, popeye, eroded fins, scale loss, eroded areas, emaciation, opaque eyes, excess or absence of mucus on skin, gill colour, abnormalities of internal organs.
- RECENT FISH MANAGEMENT activities including grading, subsampling, or other stress-inducing operations.
- UNUSUAL WEATHER CONDITIONS OR ACTIVITIES IN THE AREA. Basically, send as much information as possible.

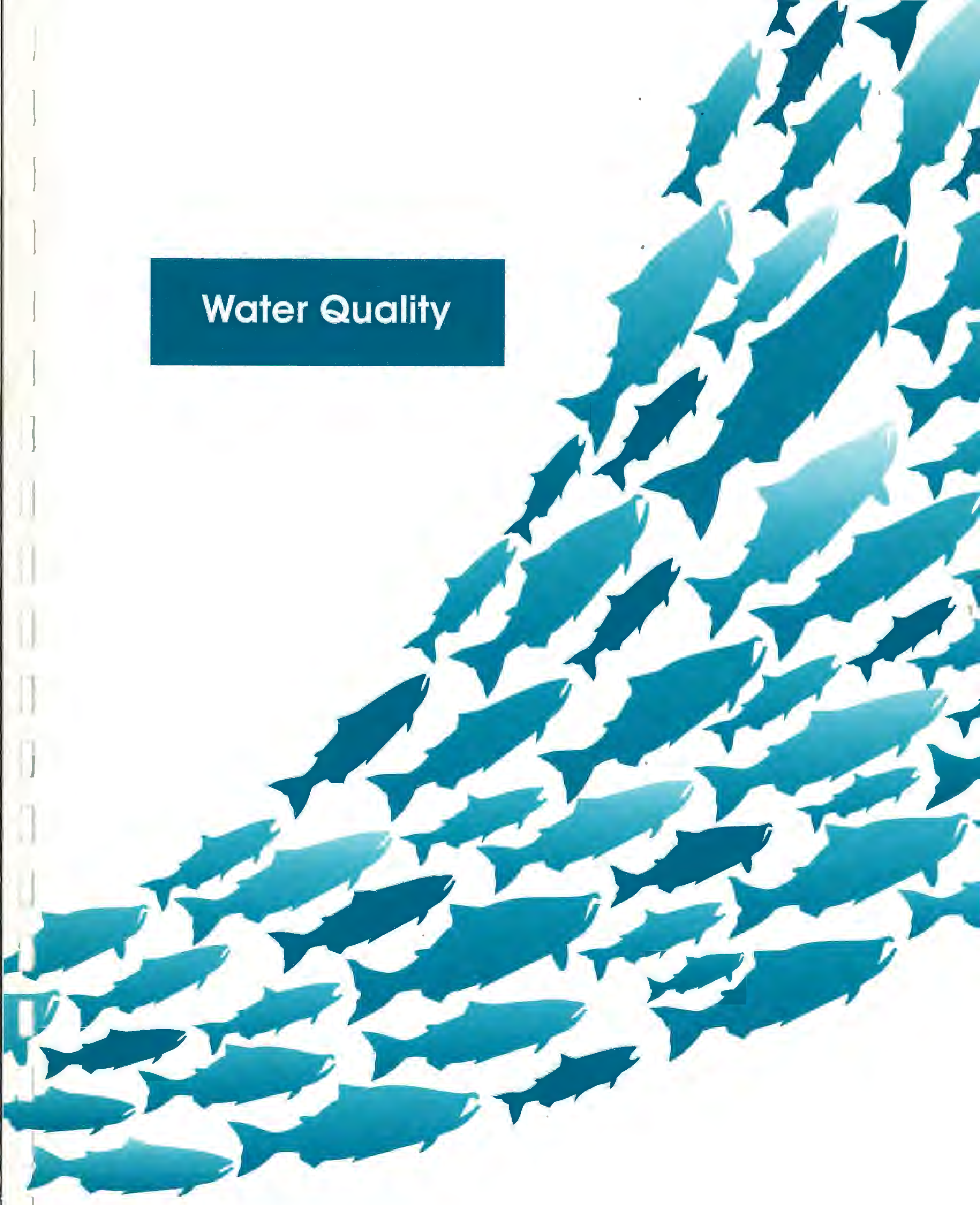
Shipping: Transport by the fastest methods. Samples that arrive early can be examined the same day. Label samples adequately on the outside. Indicate nature of sample; e.g., live fish or frozen fish (perishable). Label package with Laboratory address, telephone number and with instructions "Call upon arrival." Make sure the diagnostic centre knows how and when the fish will arrive.



Results: Call the laboratory for preliminary results within 24 hours. Remember, no news is not necessarily good news as the diagnostic centre may have had problems contacting you.

For further details contact:
Dorothee Keiser, Diagnostic Service, Pacific Biological Station, Nanaimo, B.C. V9R 5K3
Phone: (604)756-7057
Prepared by Joan McKay

Water Quality



Aeration

If water is to be usable in fish culture projects, it must contain the correct amount of oxygen and other dissolved gases. If there is too little, we obviously have problems. Likewise, an excess of dissolved gases can also endanger eggs or fish. This aeration **Tipsheet** will explain the principles of balancing the total gas pressure through aeration.

Total gas pressure

Water contains varying amounts of dissolved gases, dissolved minerals and suspended particulate matter. For fish culturists, the most significant of these components are dissolved gases, particularly oxygen (DO) and nitrogen (DN). Coupled with dissolved argon and carbon dioxide, they are measured to give the Total Gas Pressure (TGP) expressed as a percentage for a water sample. At 100 percent, the total pressure of the dissolved gases present in the water is equal to the pressure of these gases in the surrounding atmosphere.

Frequently, however, the pressures are not equal. Water may contain less than 100 percent of certain gases, or it may be supersaturated — contain more than 100 percent of one or more.

For fish culture, as discussed in the **Tipsheet** titled *Monitoring dissolved oxygen*, it is necessary to have dissolved oxygen levels of 95 to 100 percent. Nitrogen levels should be at about 102 to 104 percent.

Symptoms of gas bubble disease

1. One or both eyes extruded from the socket.
2. Hemorrhaging in the eye area.
3. Bubbles in the fins.
4. Bubbles in the skin tissue.
5. Bubbles in the roof of the mouth — look for atypical feeding.
6. Sounding — fish seek deepest water.
7. Extended abdomen — yolk sac fry may be so filled with gas that they swim belly-up or erratically near the surface.
8. White spots or coagulation of yolk in fry.
9. In less extreme cases there may be poor feeding and/or low growth rates.

Fish culture implications

The major concern about super-saturation from a fish culturist's perspective is its role in causing gas bubble disease. Bubbles form in the blood and tissues of the fish, on the surface of newly-hatched fry, in yolk sacs, or in the mouths of fish.

Gas bubble disease can occur at any stage of the life cycle, but tolerance is lowest at the alevin and fry stages. Since this is also a vital stage in the raising of hatchery or incubation box fry, the disease is of great concern.

Aeration may be necessary when using ground water, but care must be taken to see that aeration methods do not lead to supersaturation.

Suggested reading

"Summary of water quality criteria of salmonid hatcheries," Sigma Environmental Consultants Ltd., Revised Oct. 1983. Report to the Department of Fisheries and Oceans.

Contact your local CA for this and more information.

What factors affect TGP?

The TGP of water is affected by several factors. These include the water source as well as various environmental factors.

● **Water source:** free-running streams are aerated naturally; groundwater, however, often requires treatment

● **Barometric pressure:** the capacity of water to contain dissolved gases decreases as the air pressure decreases.

● **Temperature:** the solubility of a gas decreases as temperature of the water increases. Therefore, water which is already saturated with gases can become supersaturated when the temperature is raised.

● **Injection of air under pressure:** supersaturation can also occur when gases are carried to depth in plunge pools at waterfalls, dam spillways, or by aeration devices. The sucking of air into pipelines or pumps due to small air leaks can also be a cause.

Aeration methods

All aeration methods are based upon speeding up the natural exchange of gases.

Water Quality

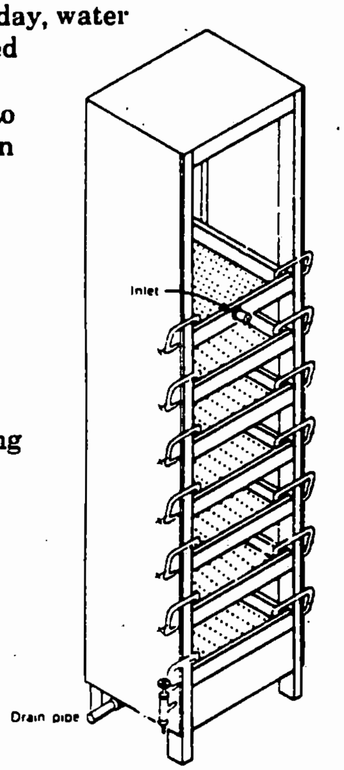
Supersaturated water, held in a glass beaker, will give up excess gases by the formation of small bubbles on the sides of the container, and by direct discharge form the water surface.

Since this dispersal is affected through the exposure of the water surface to the surrounding atmosphere, the various man-made aeration systems have relied upon a combination of tumbling or spraying to speed up this process.

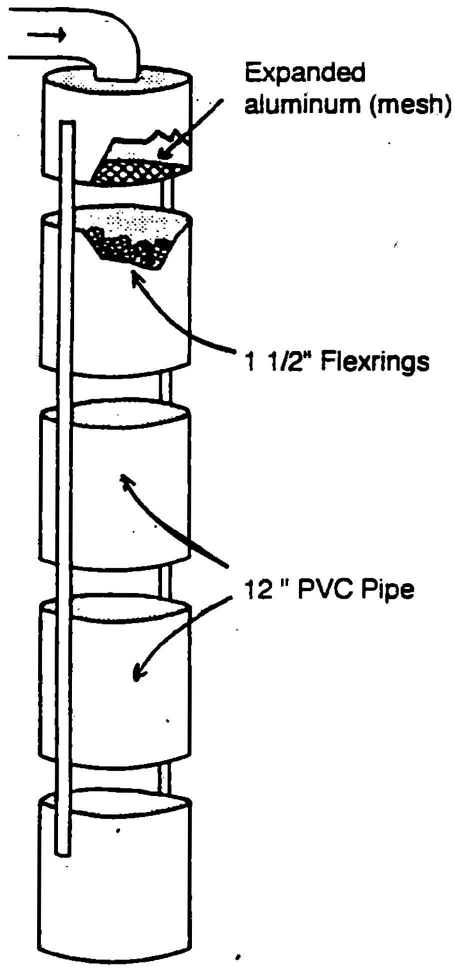
Weirs, equipped with splashboards, paddle wheels or rotating brushes have been used, as have various sloping, corrugated surfaces. Man-made waterfall devices have been used also to speed up oxygen absorption, but these can lead to *excessive* absorption.

One common method involves dropping water through a series of stacked and perforated trays. **(See illustration below.)**

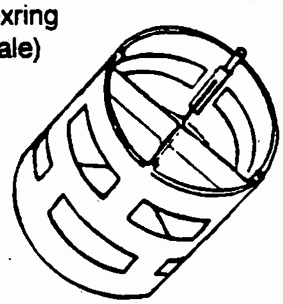
In another common method in use today, water is pumped up and allowed to flow down through tubes packed with plastic rings or through towers containing wooden slats.



Fresh air is introduced through the sides of the device. **(See illustration below.)**



1 1/2" Flexring
(not to scale)



Gases exchanged by aeration

● **Oxygen:** absorbed or dissipated by aeration until a level of 95 to 100 percent saturation (ideal) is achieved.

● **Nitrogen:** present in well water; removed by aeration.

● **Carbon dioxide:** very soluble; common in groundwater; easily dissipated.

● **Methane:** present in all well water; easily removed by aeration.

Factors involving water quality are heavily interdependent. Removal of carbon dioxide, for example, increases the alkalinity. Fluctuation in temperature and barometric pressure are other interdependent factors. Also, fish have a higher tolerance for supersaturation in hard, as opposed to soft, water. The type and amount of aeration needed for a given project will be affected by all of these considerations.

Expert advice

This **Tipsheet** provides only a basic overview of aeration and aeration methods. Each water supply is unique and aeration needs will vary.

It is very important to achieve a **sufficient degree** of aeration when dealing with supplies of groundwater. You must also avoid supersaturation. For proper protection of fish health, it is necessary to achieve levels of 95 to 100 percent oxygen saturation and under 104 percent nitrogen saturation. We recommend that you obtain advice on aeration from your local community advisor.

Bubbles and bubblers

Joe Kambeitz, CA for the southern Fraser drainage in the lower mainland, prepared the following to de-mystify aeration methods.

Everyone who has fish living in some sort of artificial situation has thought, at one time or another, about aeration. Whether the fish are housed in a small aquarium or in huge concrete raceways, one wants to have as much life-supporting oxygen present as possible.

Why add air?

The initial charge of dissolved gases is put into most of our projects by means of aeration towers or stacked screens. Beyond such well-known techniques as flowing water and aeration towers, there are other ways to put oxygen into water and specific times when these may be needed. Such times include when our main water systems fail (horrors!), when we transport fish, when we confine fish in small containers to sort them or to anesthetize them before fin clipping. The method most often employed is bubbling the gas through water.

How does it work?

The same principles that apply in a well-designed aeration tower also apply here.
Where a water surface is in contact with air or oxygen, it absorbs some of the gas. In the aeration tower, water is broken into tiny droplets and dropped through the air. With air injection (bubbling), the opposite happens; the air is broken into fine bubbles and rises through the water. For the gas exchange to be efficient, the gas and water must meet over the greatest possible surface you can provide. The geometric analysis is quite easy. If you were to put a given volume of gas through your water as very large bubbles — let's be ridiculous here — say one cubic foot sized bubbles, or as small, one cubic inch sized bubbles, the smaller bubbles would present **ten times** the surface area to the water. It is this surface area that gives the gas exchange its efficiency.

As in the aeration tower, where we broke water into as tiny droplets as we could, so, in underwater diffusers, we want to break the gas into the smallest bubbles we can.

Obviously, if one cannot always achieve good efficiency with large bubbles, one could always turn up the volume and increase the overall number of bubbles to provide the necessary oxygenation. Of course, this could be the simple choice for better gas transference. However, one then might be concerned about the turbulence caused or perhaps about the cost of compressed oxygen. If so, another approach is worth investigating.

In the years since we discovered that oxygen in water could be replenished by bubbling, a variety of methods have been employed. I would like to examine several of these, mainly perforated and foam hoses, aeration stones and ceramic plates.

The methods

■ The micropore perforated hose

This is commonly a small diameter plastic hose that has been run through a "pinwheel" device which uses needles to punch small holes through one side of the hose. The ends are connected to a gas source (air or oxygen) and bubbles are produced at each hole. The advantages are that it is cheap and that large areas might be serviced in this manner. The disadvantages are that it produces a large bubble (compared to other methods) and that one must provide a framework to hold the tubes down near the bottom or the tube, once filled with gas, floats to the surface where no amount of bubbling will be of any use. The lead lines, metal frames and the inconvenience of netting fish around all that equipment make it a last resort or one that is used very infrequently.

■ The foam hose

This air hose was designed originally as a soaker hose for gardening work. When it is filled with air, its surface releases a wide variety of bubble sizes into the water. This method is far more efficient than the perforated hose. Its larger diameter makes it easier to handle and less apt to tangle around nets. The disadvantage is that, for larger jobs, you may still need a frame to hold it down and in an efficient gridwork.

■ The air stone

The air stone has been with aquariums since time began and I still haven't figured out *why* they are always blue! In any event, they are perhaps more efficient than a foam hose, they will stay on the bottom by themselves and, overall, are a pretty good deal. Their drawbacks are that they are usually small and therefore of value only for very small jobs like fin clipping, display aquariums, etc.

■ Ceramic plate diffusers

These are the state of the art in bubblers. A fairly thin ceramic plate is mounted in a support frame with a free space under the plate. When gas is pressured into this space, the ceramic plate produces bubbles so fine they are hard to see with the naked eye. If you despair over the cost of a tank of oxygen, this is the system for you. In my estimation, a ceramic plate will use six to ten times less gas than micropore tube to do the same job.

The disadvantages are that they are expensive (about $175 each), they break if you freeze them and they should be used with caution. The recommended pressure on the underside of the ceramic plate should never exceed 50 pounds per square inch. If it does, the plate could explode spectacularly from its frame and cause serious injury. I recommend that these only be used with pressurized gas from an air or oxygen cylinder fitted with a preset regulator, set for 50 psi, that **cannot** be adjusted. A flow meter can be installed beyond the regulator to adjust pressure downward if it is needed.

If you use a ceramic plate diffuser in conjunction with a compressor, the same pressures apply. You should also know that the underside of the ceramic plate can become fouled and inoperative if it gets contaminated with oil, etc. The pressure will just force the material into the plate and plug it. You should use an air filter, similar to the ones used to clean air between the compressor and a scuba tank that is being filled, to prevent this.

Some final thoughts on bubbles — whether you decide you need to diffuse pure oxygen or whether you will settle for the 20 percent that is in the air — the configuration of your diffusers will make a difference. Placing one bubble producer below another ruins the efficiency of each. Bubbles produced in the lower unit float upward and bump into and join onto those from the upper unit, producing larger, but fewer, bubbles and lowering the surface ratio. Putting ceramic plates in a slanted or vertical position has the same effect and you're just wasting gas. Always lay plates in a horizontal position.

Transport considerations

It is a good practice to condition your transport tank water **before** you put fish into it. If you intend to load a tank to near capacity, turn up your air injectors to produce a slight oxygen super saturation (13 - 17 ppm). The fish will be excited when you load them due to the moving and crowding. They can easily use up much of the dissolved oxygen in a short time and, if you did not super saturate, the aeration system may not be able to replenish it quickly enough to save them. As well, you should wait 15 to 20 minutes before driving away. This lets the fish settle down and you can stabilize the oxygen level. Too little gas is obviously harmful; so is too much. The gas will start to come out of the water like the bubbles in soda pop. If fish live in this type of water for extended periods, they develop gas bubbles in their bloodstream. This condition is life threatening. What you want to achieve with bubbling is a situation where you replenish the oxygen into the water at a level that is in balance with atmospheric pressure. Your fish will be happy and your project will run with confidence.

(For more details of transporting fish, see **Tipsheet** on "Transport and release of hatchery juveniles," page 43)

You can get more information about foam tubing and ceramic plate diffusers from Point Four Systems on Clarke Street in Port Moody, B.C.

Monitoring dissolved oxygen

Factors that affect DO levels

Water source: if the hatchery water supply is a natural stream, then there are probably suitable levels of DO. Groundwater is usually low in DO and may need to be artificially aerated.

Barometric pressure: the amount of DO that water can hold decreases as air pressure lowers. (Air pressure decreases with poor weather or with an increase in elevation.) Even minor changes in DO concentrations can, at certain times, mean the difference between good survival and heavy loss of incubating eggs.

Water temperature: as water warms, it cannot hold as much DO. For any particular temperature there is a maximum amount of DO that water can hold. This upper limit of DO is called the saturation level. Oxygen in water does not usually reach 100 percent saturation, but a minimum level of 95 percent should be maintained.

Figure 1 shows just how important temperature is in affecting DO concentration. The time at which the most oxygen is needed is just before the eggs hatch. The solid line shows the critical oxygen level for developing chinook eggs just prior to hatch. An oxygen level below the line will probably mean considerable loss of eggs.

The broken line shows the maximum amount of oxygen that water can hold at different temperatures (100 percent saturation). The two lines cross at just over 10°C and just over 11 milligrams per litre (parts per million). This means that above 10°C, it is almost impossible for water to hold enough oxygen to sustain the eggs.

The critical oxygen level is a little different for each species, but 10°C should be the **maximum** water temperature at which to incubate eggs near to hatch.

Fish themselves: the more fish that are put into a space, the more oxygen they will use. Therefore, it is important to restrict the number of fish in any given area so there is more oxygen available for each fish.

Oxygen needs

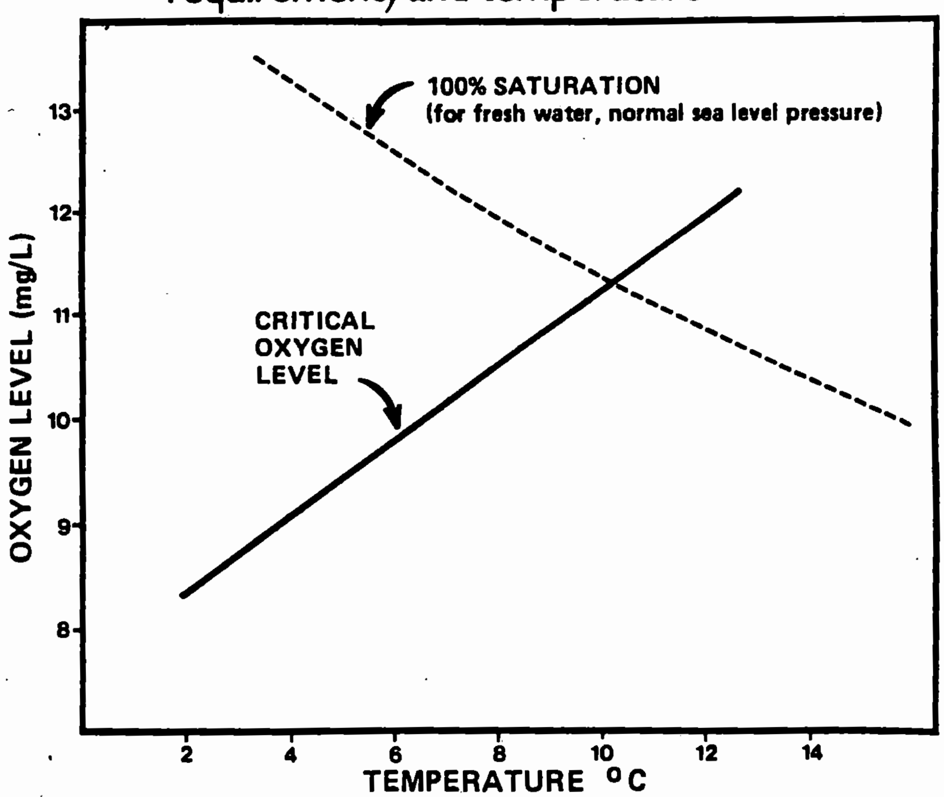
Fish have different oxygen needs at different stages in their life cycle. Figure 2 shows both the critical and safe (recommended) oxygen levels as a fish goes through its life cycle.

The recommended levels of oxygen during fish development are:

- **fertilization to eyed stage:** 6.0mg/L (6 parts per million, or 6ppm)
- **eyed egg to hatch stage:** the recommended level is set differently according to the water temperature, but it is important to remember that above 10°C it may be impossible for the water to hold enough oxygen for eggs as they near hatch (see Table 1, next page).
- **post hatch** to alevin, to fry stage: 7.8 mg/L.

It should be noted that just because there is enough oxygen in

Figure I. Relationship between critical oxygen level requirement) and temperature



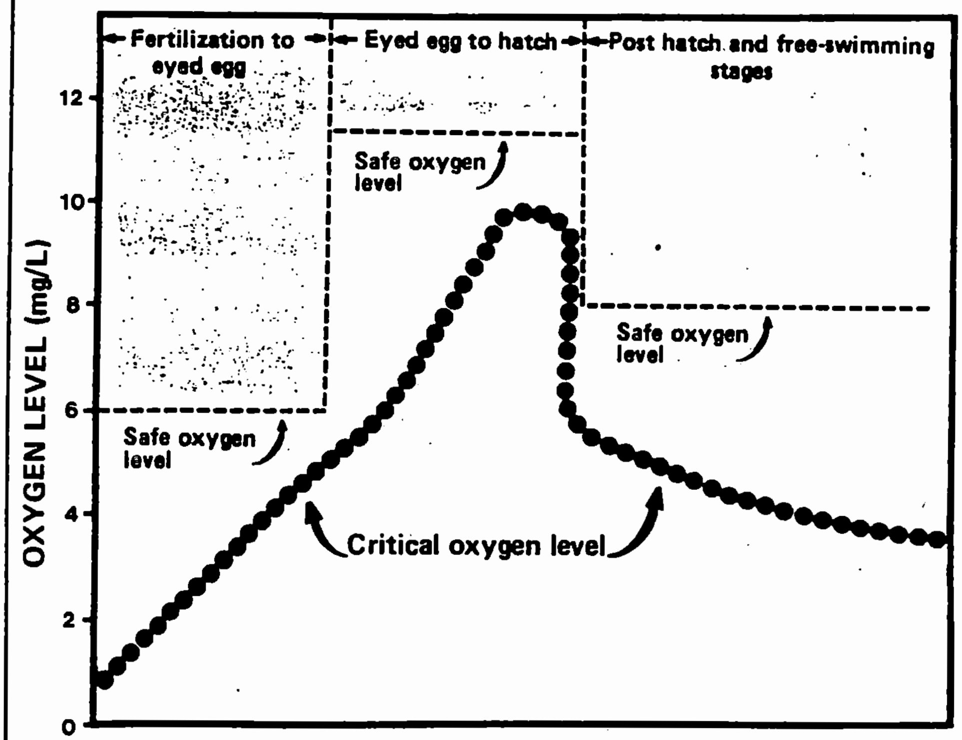
the outflow does not ensure that the levels are being met inside the container. Check to be sure the water is going through all the eggs or fish. Also watch how the fish behave. Any changes in behaviour could be a signal of problems. There is no substitute for watching your fish.

Table 1

Minimum acceptable DO concentration for eyed egg stage to hatch

Temperature (°C)	Oxygen concentration (mg/L)
2.5	8.5
5.0	9.5
7.5	10.3
10.0	11.2

Figure 2. Safe oxygen levels during fish development



How do I measure DO?

Winkler method: probably the most accurate, but most small hatcheries do not need this degree of accuracy; requires a lab set up with specialized glassware; involves titration, mixing chemicals, and calculations.

DO meters: very accurate; cost between $700 — $1,000; useful when many readings have to be taken; some calculations required.

Hach chemical kits: cost up to $500; work on same principles as Winkler, but chemicals come in pre-measured plastic pouches; multi-purpose kits available; with care, can get within 0.2 mg/L accuracy.

What precautions can I take?

1. **Always** have a backup water supply that can be utilized **in minutes** if the regular supply is disrupted.

2. Watch for behaviour changes in your fish. **Never** assume they will be okay simply because there is a lot of water in the container.

3. **Never** overload eggs or fish in a container.

4. Have a small aerator in hand if you have to transport your fish.

5. Be prepared to release all of your fish if necessary.

How can I tell if DO is low?

1. Have equipment to measure it.

2. Fry may become very excitable, darken in colour, or come to the surface gulping for air.

3. In cases of bad oxygen starvation, fish die with their backs sharply arched and mouths open wide.

References

Suggested reading:

"Summary of water quality criteria for salmonid hatcheries." Sigma Environmental Consultant Ltd. Revised Oct. 1983. Report to the Department of Fisheries and Oceans.

Contact your local community advisor for this and more information.

Oxygen systems for hatcheries

Sufficient oxygen is essential for survival of all fish. Some emergency situations make adding oxygen to hatchery water supplies essential. It is important to remember that oxygenation is never a substitute for proper loading rates.

Oxygenation systems are used for a variety of reasons. At the Necoslie hatchery in Fort St. James, oxygen is used during the last three weeks of rearing to increase growth rates. Some hatcheries use oxygen during low flow periods of the year just to get them through to release time. Others, such as Sechelt, Mossom, and Sliammon hatcheries, have oxygenation systems which act as back-up systems in case of water supply failure. In the aquaculture industry, constant side stream oxygen promotes growth. At the Sechelt hatchery, as vaccinated fish are transferred to a Capilano trough, oxygen is added to ensure good recovery.

Oxygen systems also come in handy when static bath treatments are necessary for treatment of disease. Many of these static treatments involve leaving the water to the pond or tank turned off for about one hour. With an oxygen system in place, turning off flows for treatments is not a concern.

Injecting oxygen into the water helps keep oxygen levels up when sorting large numbers of adults in a holding container. It is not uncommon for oxygen demand to become very high during sorting because the adults are usually crowded for handling and they are being stressed.

Adding oxygen does not mean that flow load rates can be increased. Oxygen will not remove ammonia and by-products from the water; only appropriate flow regimes will accomplish this.

Oxygen as a back-up is time-limited in that, eventually, ammonia build-up will occur. However, for the short term, i.e. eight to 10 hours, oxygenation systems offer excellent emergency back-up.

Equipment

A manual oxygen back-up system is easy to install and is affordable. At the Sechelt hatchery, the oxygenation system consists of :

✓ a six-valve brass manifold for the six Capilano troughs,

✓ a three-valve brass manifold for the circular tubs,

✓ 11 lengths of PVC hose,

✓ two oxygen regulators preset to 50 PSI,

✓ two flow meters,

✓ 18 metres (60 feet) of black micropore tubing (1/4 inch) to make six airstones, each 3.5 metres (10 feet) long for the Capilano troughs,

✓ three 61 cm (24 inch) long diffuser tiles for the tubs,

✓ all appropriate fittings and clamps,

✓ two pigtails, and

✓ three oxygen cylinders.

Method

The six-valve manifold attaches to one of the oxygen regulator/flow meter combinations. From each of the valves, attach a length of the PVC hose that is long enough to reach from the valve manifold to the rearing container.

Make each 3.5 metre (10 foot) airstone by sealing one end of the piece of micropore. This can be done by heating the end of the tubing with a propane torch and gently folding the end closed. These micropore airstones have to be weighted down. One method is to insert a piece of stainless steel rod into the micropore tubing. Another is simply to attach old gillnet leadline to the outside of the tubing to add weight.

The open end of the micropore tubing is then fitted with a brass fitting that will fit into the 1/4 inch diameter PVC tubing.

The pigtails mentioned in the equipment list allow three oxygen cylinders to be run at once. This means the fish culturist doesn't have to worry about running out of oxygen quickly; by connecting three large oxygen cylinders, you could run the oxygen at two to four litres per minute for about three days.

This system is completely manual.

Automated systems

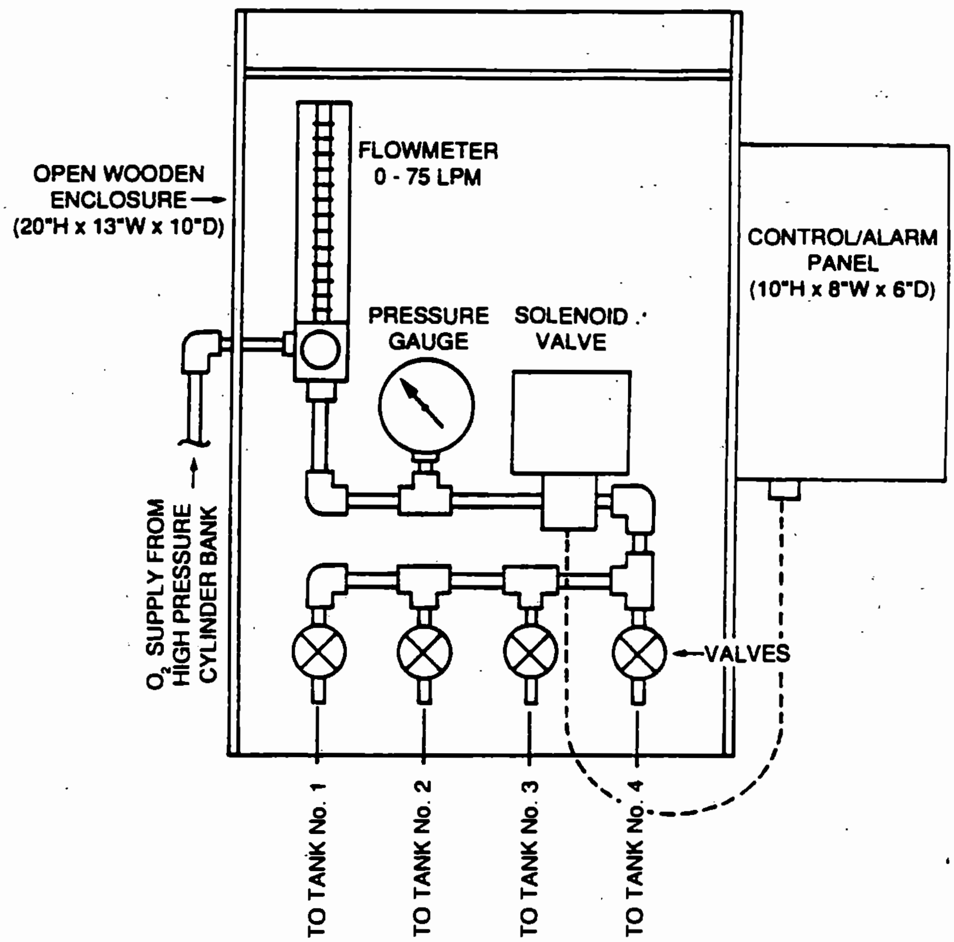
An emergency oxygenation system can be made totally automated, as is the case at Mossom hatchery. The automated system is much the same as the manual system described above, with the addition of a control box which contains a solenoid plus relays and is connected to a float switch alarm located in the main header tank.

Water Quality

The Mossom system has the added benefit of providing a back-up flow of oxygenated water to the incubation containers. To facilitate this, the six Heath tray stacks drain into a central sump area. A small pump is set up to draw water from the sump area and deliver it to the main header. In the main header sits a 61 cm (24 inch) ceramic airstone which is supplied with oxygen from the same delivery and supply system as the rearing containers

Essentially, a recirculating closed water supply system has been created, complete with oxygenation. The airstones remain in the rearing containers and main head tank at all times. All oxygen flow levels have been pre-set.

When flow to the main head tank is interrupted, the low level alarm activates the emergency system. At the control box, solenoids and relays open the valves, delivering oxygen to all the rearing containers as well as to the main header tank. Also, the pump in the incubation room automatically starts, recirculating the oxygenated water from the sump to the main head tank and through the Heath trays. This system should provide enough time for the problem to be corrected. However, if possible, it would be prudent to have the low level alarm connected to a dialer unit to alert an emergency response team.



Prince George Fry Distribution Site:
Back-up Oxygenation System

Distribution Manifold & Control/Alarm Panel
Illustration adapted from R. Barratt, Point Four Systems Inc.

Source

All of the equipment can be purchased at Point Four Systems Inc. Rob Barrett at Point Four has had extensive experience in putting these systems together and is very helpful.

Extra equipment needed for an automated systems is:

✓ control box,
✓ solenoid,
✓ relays,
✓ float switch alarm.

For the incubation set-up, additional equipment is:

✓ water pump,
✓ appropriate length of 1 1/2 inch PVC pipe,
✓ one 61 cm (24 inch) ceramic micropore bubble diffuser, and
✓ all appropriate fittings, clamps and hoses.

Above: the pump draws water from a sump and delivers it to the main header. This provides a back-up supply of oxygenated water to the incubators.

Re-use, recycle and recirculate

Most hatcheries operate on a "single-pass" or "open" system, especially in British Columbia where water is usually abundant and gravity feed from the source is practical. There are, however, times and places where it may be desirable (or even necessary) to operate on a recirculating system.

This **Tipsheet** looks at some of the technical requirements of recirculating systems and illustrates with the set-up of one such system operating in B.C. — at the Steveston Secondary School in Richmond.

Greg Bonnell, biologist with SEP's Resource Restoration Unit, says that recirculating systems begin to make economic sense in situations where you have to pump your water supply anyway. He warns, however, that everything that adds to the complexity of a system also increases the number of things that can go wrong.

NOTE: Even in "single-pass" systems, if you have rearing troughs set up "in-line" so that water passes through one before entering the next, what you really have is a recirculating system. Pay close attention to loading densities and oxygen levels in this situation.

Why do we recondition water?

If you are going to recirculate the water in your system, you have to recondition it. That means removing what you don't want (suspended solids, carbon dioxide and ammonia) and adding what you do want (oxygen). You will, in all probability, have to adjust the temperature as well.

Some water quality factors

Ammonia — must be removed from recirculating systems. Ammonia, at given levels, is toxic and damages gill, kidney and liver tissue.

Suspended solids — from fish feces and uneaten food — should be kept to a minimum in any fish culture operation. They cause gill damage.

Carbon dioxide — is produced in the respiration process and must not be allowed to build to excessive levels.

Oxygen — must be present in adequate amounts. Oxygen requirements vary by life-cycle stage and with water temperature.

Bacteria — if water is recirculated, disease-producing organisms must be removed.

Temperature — affects the rate of egg development, fish growth and metabolism rates. Water that is too cold slows growth. Water that is too warm can be low in oxygen and may foster the growth and spread of disease bacteria.

All these factors, along with pH levels, are interrelated. All recirculating systems add some percentage of make-up water to that which they recycle, causing these factors to fluctuate.

How do we recondition water?

All the elements mentioned above must be dealt with if water is to be recirculated.

Ammonia — biofilters change ammonia to harmless nitrate ions. The bacteria that make the conversion grow on any coarse medium. Gravel filters, suspended above the bottom of the tank so water can move right through the gravel, are commonly used. A note of caution: the biofilter must be operating properly or nitrites can be released into the water. These are toxic to fish. Ammonia can also be removed by ion exchange — passing the water through a column of zeolite (a silicate material). The zeolite holds, but does not alter, the ammonia. Accumulations of ammonia must be periodically removed by washing the column with a sodium solution (or sea water).

Suspended solids — start with some prevention — avoid over-feeding your fish. That will eliminate the problem of excess food in the tanks or ponds. There will still be fish feces. They cannot be prevented, they must be removed. This can be done by mechanical filtration (sand or diatomaceous earth filters like those used for swimming pools) or, if space is available, by using settling basins. In either case, periodic cleaning and waste disposal will be required.

Carbon dioxide and oxygen — to remove CO_2 and add oxygen, the water must be aerated. This can be done by running the water through the air (in an aeration column, for example) or by running air through the water (bubblers and diffusers). You want to keep total gas pressure at 100 percent, but under 102 percent.

Water Quality

Bacteria — if you are going to recirculate water, you must disinfect it to guard against the spread of disease. In most cases, this is done by ultraviolet irradiation or ozonation. To be effective, either must be properly operated — **expert help is a must.** In cases where you know you have a serious disease problem (BKD, for example), do not attempt to recirculate the water.

Temperature — all the processes involved in fish culture are affected by water temperature. Eggs develop faster and fish grow more quickly in warmer water. Unfortunately, warmer water also promotes growth in disease organisms, lowers dissolved oxygen levels and alters the various chemical balances so essential for fish health. Heating or cooling the water may be required even in single-pass systems, especially during incubation.

Water quality is the key

Water quality is always a vital factor in fish culture success. As the percentage of recirculated water in use rises, the importance of watching your water quality increases.

"You really have to stay on top of all the chemistry," says Bonnell, "If you don't have a way to do that, recirculating is not going to work."

Steveston Secondary makes it work

One place that does handle all the necessary chemical monitoring is Steveston Secondary School in Richmond. Although Steveston is home to a large part of the Fraser River fishing fleet, it totally lacks a creek or stream that could be used as a water source for incubation and rearing. A recirculating system was the answer devised by teacher Barry Barnes and Community Advisor Joe Kambeitz.

Now the school's hatchery provides a unique educational experience for student volunteers — hands-on lessons in biology and chemistry (as well as basic housekeeping).

Steveston has a large cistern, installed as the low point in the system. Refrigeration coils within the cistern can be used for cooling the water. From the cistern, water is pumped through an ultra violet filter to purify it, then piped out of the hatchery building to an enclosed tower. Within the tower, insulated to keep the water cool during fall and spring days, is a bio-filter where ammonia is converted to harmless nitrates. As it moves through the bio-filter, the water is aerated, too.

After filtration, the water returns to the hatchery building and enters the header trough for distribution to heath trays or, once fry are free-swimming, Capilano troughs.

As it leaves the Capilano troughs, the water passes through a filter box, equipped with several layers of a sponge-type filter that removes suspended solids. (The eggs in heath trays produce no suspended solids, so during incubation water goes straight back to the cistern.)

The only real problem teacher Barry Barnes has found with the system is that, by the time it has been piped outdoors and through the bio-filter, the water can warm up a degree or two. This could be solved by putting the refrigeration coils in the header trough so that temperature could be adjusted just before the water is distributed.

Steveston taps unusual sources

With no creeks nearby, obtaining clean, disease-free water to fill the system each year might present a problem. The closed system has a capacity of 13,638 litres — collecting that much rainwater takes a long time, even on the wet west coast. The unusual need has prompted unusual donations: water for Steveston has been donated by two Greater Vancouver bottled water companies — these fish go first-class all the way!

Students take charge

All aspects of operating the hatchery are taken on by student volunteers. They make a commitment to the routine that keeps this unique hatchery operating. Sediment filters must be changed and cleaned daily — it may be a housekeeping chore, but it is essential. Water chemistry is checked daily, too, with students monitoring pH, hardness, nitrites and nitrates as well as temperature. Ammonia is checked daily during the hatch period, then three times a week until release.

Proof is in the fry

Steveston's system works. The project, which took its first eggs in the fall of 1987, can incubate and rear up to 25,000 chinook each year. Chinook were chosen because the eggs can be obtained from Chilliwack hatchery's late summer run in the fall and the fry are just ready for release in May. That leaves the school with time to drain and clean the system before summer break.

Directory

The material in this booklet is extensive, but not exhaustive. For further information, you may contact the sources below.

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