The Volunteer Egg

Take

(A Beginners Guide)

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1. Introduction

The taking of eggs, combining them with sperm and putting them into some flowing water should be a simple process. However, like all things, there is mystery and technique involved. The following guidelines tries to break down what happens in a salmon egg take and give the reader small topics that are greatly expanded to allow some understanding of what is happening and why. This is not intended to describe in working detail the scientific processes and formulas, there are other volumes that do that. This takes you in chronological order through the steps and tries to fill in gaps that you may not be aware of.

Questions on the delicate process involving formulas that apply chemicals in these processes are best answered by your Salmonid Enhancement Community Advisor or a competent fish culturist.

2. Selecting Your Brood Fish

Whatever species you are working, with your paramount goal in selecting your brood stock is that the result, that is, the enhanced fish you create, maintain the fitness and characteristics of the native stock. Very often an innocent bias in this selection can set your project on an unintended course that has negative genetic consequences.

In normal circumstances brood is selected throughout the run to mimic the natural run of the year. A percentage of Jacks should also be used similar to the percent of the run they represent. There is a tendency on all projects to select large fish or fish that may have a lot of eggs for brood. This can be a mistake as they truly are not representative of the overall population. This is an easy topic to discuss, particularly if you have an abundance of fish to sort through. If you don't, and struggle to capture enough brood each year in a small system, and all you can really hope for is the return of some of your efforts, this is for you.

There will be a peak of migration into your stream each year. One cannot count on those few that show up early or those that show up late as good quality for your brood. Any number of things can go wrong with a salmon to make his timing go off and arrive early or be late. If you are pressed to capture enough brood to produce a return of fish, concentrate on the peak of migration.

Nature's way of telling you which fish are best suited genetically, physically, and for that particular environment is to produce abundance at that particular time and place. You should take this as your sign. If you have lots of incubation and rearing capacity and you would like to profile the entire run it's ok; if you want lots of fish go for the peak. For those of you that would like to explore working with early or late timed fish I should note that without years of research we cannot identify either of these groups as 'pioneers' (the front edge of a new population), or "survivors" (the trailing edge of an old population) or which may be which. However, selecting fish from across the run with a bias toward the peak is the preferred option. If getting enough fish is the problem, focus on the peak rather than chasing the few early and late fish, as they will take care of themselves.

3. Holding Your Brood

It is a very rare project where we can capture brood fish and take the eggs immediately. For the rest of us this means holding the brood until the eggs and sperm "ripen", or become free in the belly cavity. This can take from several days to sometimes a month.

All Pacific Salmon stop eating when they enter their natal streams (certainly not eating enough to offset their energy output), and therefore are physically deteriorating and using up their stored fats and energy. In this condition they are very susceptible to diseases and parasites. It is in your interest to sort and hold these fish as gently as possible. Fish that are taken really green unripe and held for an extended period do not produce eggs or sperm that will be 100% viable; 80% may be all one might expect after holding Coho for several weeks. Also, if you have an egg target, hold 50% more brood to meet that target, especially if you have limited incubation. This is because the first egg take may use only one third to half of your holding fish that are ripe. The next egg take is smaller and so on until the remaining twenty percent may die or never get ripe and you will be short of your egg target numbers. My advice is to hold more brood, take your target number in one or two takes, then release the remaining brood. You'll have better

fertilization, simpler incubation batches and fewer problems with different things of swim up and feed program in the spring.

There are a wide variety of ways of holding your brood until ripe and each method has its own advocates. There are a few simple guidelines that seem to be useful across all of these methods.

Bulk holding in a large container or pond is good until it comes time for the first egg take. This necessitates catching and handling all the fish to check them for ripeness. The first fish you catch and handle aren't nearly as affected as the last, because chasing the fish in confined quarters stresses the brood and will promote a loss of overall quality of the fish you hold. This scenario it quite often results in higher brood stock mortalities and lower fertile production of eggs and sperm. The turmoil and battering that a fish receives during this checking process will rupture blood vessels, scrape off protective slime and increase the occurrence of water hardened eggs because of the intrusion of water into the egg cavity.

The solution is to use divided holding in smaller containers. The simplest improvement is to separate males from females. At the very least, 100% of the stock does not have to be stressed to work with only a part of it. The next might be to evaluate each fish and select a grade arbitrarily assigned to it; very green, green, almost ripe, and ripe are good categories. Sort and hold these

separately from each other and in this way they will ripen in a progression that you can count on and you will muster your egg take teams accordingly.

Light plays an important part in the ripening process. Salmon that are kept in total darkness don't do nearly as well as those fish that can sense night from day, but bright sunshine is also stressful. Keep your fish in shaded containers. Of course water flow is also essential in holding brood. If you hold brood in containers that have their natal stream water flowing through them you can count on having trouble when there is a change in that water quality. If things stay constant the fish will generally be fine, however, if there is rainfall that changes the incoming water this may trigger the brood to move further upstream in order to spawn, and result in any of your brood beating themselves to death trying to get out if it's confined quarters. Mixed water, well water or reused hatchery water helps to "blind" the brood to what's happening in the nearby stream.

To check your female fish for ripeness grasp the tail and suspend the fish head down for a few seconds. Check to see if the ovipositor is distended (this is a soft, pink extension out of the anus area.) There should be slack creases on each side of the ovipositor extending down towards the head. The final check is to elevate the head to above horizontal, lowering the tail and apply gentle pressure under the belly to the area below the dorsal fin. If the

female is ready to spawn you should be able to express a few eggs from the ovipositor.

To check male salmon the fish is grasped by the tail and held belly down flat to your stomach with head higher than the tail. Stroke your hand with gentle pressure from between the pectoral fins down towards the anus. If the male is ripe it will express a stream of sperm from the anal area.

Weird things that are done here: If you are holding a valuable brood for a long period of time and many may die before they become ripe, you can protect these fish and the eggs they carry by giving them shots of antibiotics to keep them healthy. (You will need to get a prescription form a veterinarian for this).

Another weird thing: If you are holding a brood that will slowly ripen over a long period, thereby extending the egg take, incubation, ponding and rearing process over an unacceptable time frame, there are shots of hormones you can give the fish so they will all drop their eggs in a couple of days. On the upside, you get all the eggs at once and it makes the hatchery run smoothly. On the downside, the hormones loosen eggs that are not ripe yet and these will not fertilize. Even though you have your eggs all at once there is a cost to be paid by the overabundance of dead eggs to be picked.

4. Killing the Fish

Before taking a club to the fish there are a few things we want to be certain of:

- Is the fish you are holding the right species? This may be laughably obvious to many; however, I attended a stream side collection for chum eggs where ¾ of the 40 fish killed for it were sockeye. If you aren't certain what species it is, ask for help.
- Is it the right sex? Again, I've been involved with an egg take where 90% of the fish killed turned out to be males. Not a good start for an incubation program!
- Is the fish the right ripeness? Be sure that it has been properly checked and that the sperm or eggs are easily expressed.

To kill the fish as quickly as possible is the most humane method. This is not a job for the faint of heart because a large sized fish requires a good, very hard crack with a heavy club. Hold the fish by the tail with a gloved hand and strike it hard on top of the head above the eyes. Ideally you want to kill the fish with one stroke. The fish should stiffen, shudder somewhat and expire. It should not thrash around causing you to lose your grip, drop to the

floor, and need to be chased down. If any of this occurs you need to pay attention and practice in order to make the next one better, or give it over to someone else who is stronger. Spectators watching this process will immediately make up their mind whether to join your group or not; don't make it a brutal business.

A variation is to have one person hold while another swings the club. Beware! The head of the fish always seems to hang down to about the holder's groin area. If the fish twists or flips itself when the swing is initiated and you miss, the follow through may deprive us of the next generation of little volunteers. Ouch!

In this vein, everybody loves to see the volunteers work with large fish. There are usually lots of cameras present. Beware of looky-loos. They will creep up behind you and carefully focus on the held fish and bang! You knock them a good one with your back swing.

You should also take into account that you are working in cold water with slippery fish and wet gloves; the club will fly out of your hands when you miss a fish. Always, Always, Always, have rope on your club that loops over your wrist, so that when it does slip it won't fly across somebody's knee caps.

Things to remember… Water gently supports a fish that's swimming in it. When you catch several in a net they thrash about and generally start a process of beating themselves up. This will

rupture eggs and blood vessels, causing foreign fluids to get in the eggs and this will definitely make them not fertilizable.

Dropping them on the ground will do the same thing. Do not, under any circumstances, have any part of the fish touching anything when you club it. For instance, if you hold the tail and rest the head along the floor and strike it with the club, it will kill the fish quickly, however, the shock that is transmitted through the body of the fish will rupture eggs, blood vessels and organs and you will not have a successful egg take.

Lastly, appoint someone as official counter, someone with a big voice to keep a running tally of fish being killed. Try to match males with females; you don't want to kill all your ripe females only to find that there are no ripe males. You also don't want one side to outnumber the other by three to one. It will not make for good genetics. Shout out these numbers for all to hear.

After the fish is killed, the males should be laid out on a flat, clean surface. They will have to be taken up and handled to remove the sperm later. This will require them to be cleaned so don't make work for yourself by laying them in the dirt. The females are hung up by the tail or put onto a surface that slopes them head down and a gill raker is cut to allow them to bleed out thoroughly. This takes the pressure out of the blood system so that when the incision is made to remove the eggs there isn't enough blood left to drip into the eggs. Wash the blood away gently but do not spray a

high pressure water hose over the area of the anal ovipositor as this could force water into the gut cavity and activate your eggs.

5. Taking the Eggs

This is where the eggs are separated from the carcass. This is a place to be discriminating, practice avoidance and be aware of small details. The fish will be held head up and sliced open and all the eggs should drop freely into a container.

Be prepared and be organized. Any mistakes here can't be hidden… you will always end up dealing with them later.

Have your egg take area organized away from splashing water and distractions. Ideally, have your egg take person sitting down and everything they need within easy reach. These items would include an egg take knife (this is generally a small plastic special purpose tool called a Zak knife), paper towels, egg container, paper towels, ziplock bags, paper towels, cooler, paper towels, etc…

Have your personnel organized. There should be a boss, ideally it's the person who's slicing the fish. It's their responsibility to do the final inspection of the fish before slicing. They will tell you when you're not holding it correctly or dripping. They inspect every container to see if it's clean and dry before putting eggs in it, and they do the visual exam of the eggs to see if they are acceptable. They are the boss. Understand this and listen to them.

Egg takers are set up like a production line with fish holders, fish wipers, the slicer, baggers, container wipers, etc…

Okay, here we go… The dead, well bled, well washed and wiped dry fish is picked up, ideally with dry, bare hands and held head down until the final approach to the slicer. It is given a final wipe down, presented, (head upward now) as the slicer instructs, the egg take knife is inserted into the fishes vent and pulled upward in one smooth stroke above the gill area. This cut does not go between the pelvic fins as though you were cleaning the fish for the table, it goes around the high side of the fins and then carries on upward. The eggs should immediately fall out of the fish into the container with a fair amount of fluid.

Things that go wrong… The presenter is wearing a wet glove on the hand holding the fishes head and as you pull the egg take knife upward they tighten their grip, squeezing water out of the glove into the eggs. Water will activate the eggs in seconds (and you will get no little fish from these eggs.)

The egg catch container is wet and not clean. (You'll get no little fish.)

There is slime dripped in the eggs, or there is blood in the eggs. You slice into the eggs and release the yolk… (there'll be no little fish).

If all the eggs do not readily drop out, have your presenter stay while you take your clean, dry hand (remember the paper towels) and reach up into the sliced cavity in the area of the heart and "tickle" your way down once to remove the eggs. Do not grab

at things hanging in there and pull them. If the egg skin is attached at the top and you pull it free you'll surely break eggs. If you feel lucky and want to take the chance then you can reach up as far as you can and gently pull the egg skin free.

Do not squeeze and massage the eggs free of the sac and put them into the same basin as the rest of the eggs. Instead put them into a separate, clean container. Later, after all free flowing and "tickled" eggs are taken care of, then deal with the eggs caught in the skin by gently turning them inside out and gently shaking them to remove the eggs. These eggs should be incubated separately, but if space is an issue and they can't be separate make a note of where you put them…Just in case there is a problem and have to be thrown out later.

The eggs that flow freely out of the fish should be soft to the touch. If they feel hard like frozen peas and bounce when you drop one on a flat surface then the eggs are water hardened and again, no fishies. It's up to the slicer to check this before he passes the eggs on.

Watch for unexpected appearance of the eggs and fluid. This is your opportunity to reject eggs that may not fertilize or may generally cause you trouble down the line. Avoid eggs with blood in them, and beware of eggs in milky or discoloured fluid as these are sometimes sick or diseased fish. Avoid dry eggs that have no fluid with them.

A word about the fluid that comes out with the eggs and why it doesn't activate the eggs: This fluid does not fill the body cavity by coming in through the anal opening. It is a product of the developing eggs and chemically is it very much like blood without the red colouring. The eggs will not react to it, however if water enters the ovipositor accidentally, or the fish is collected while it is half spawned and only partially full, some water may enter at this time and it's wise to check "half empties" carefully for water hardening.

This is your best chance at "avoidance." Keeping everything clean and organized, and inspecting each and every fish and their eggs will pay off later. We know what we are trying to avoid relative to incubating… we want 100% success, but how do we avoid disease in our stock? Firstly, understand that "disease" comes in many forms. These can be divided into two basic types; Vertically Transmitted and Horizontally Transmitted diseases.

Very basically, vertical disease is what you have gotten from your parents and what you might likely pass on to your children and in turn to their children. It passes down vertically through the generations. Horizontal disease is what you got when someone sneezed on you at a baseball game, you brought home and gave to your children and spouse, and that they then introduced to the community at a PTA meeting… it travels out horizontally.

If we now look at the entire subject of diseases we can roughly break them down to parasites, bacteria and viruses. When working with eggs and sperm, the only thing that is small enough to get into the sperm or the egg is a virus so basically that is what we are trying to avoid: the vertical transmission of viral infection and obvious genetic disorders. Milky and odd coloured ovarian fluid and sperm should be noted. Physical signs of disease or distress in brood should be avoided. Beyond this disease detection requires diagnostics that are so prolonged or so expensive that they cannot be considered for a small project.

Lastly, eggs will be okay for several days if kept in their ovarian (isotonic) fluid and held in cool temperatures. It's best to keep egg from individual fish separate for this short term storage.

Weird things to do: if you should cut, break or damage eggs during your egg take the contents of the egg will mix with the intact eggs and the ovarian fluid and you will not have good fertilization. Studies have shown that in a normal female there is about 30 cubic centimeters (ml) of ovarian fluid and <u>if you break only 6 or 7 eggs this will contaminate the ovarian fluid and you can expect to have around 40% fertilization.</u> This condition is done not by physically blocking the micropore on the egg, but by paralyzing the sperm with an imbalance of potassium and magnesium that is in the egg fluid. There are three things that can be done to help the situation. First remove the sharp point on the Zak (Wyoming Marisource) knife that

you use to strip the female. Take a file and round the point off so it will not pierce the eggs it touches. By pulling outward slightly when the incision is made on the fish you will keep this point sliding along the inner belly wall rather than trapping eggs in between the point and the sharp edge. Second is make a visual test for contaminated ovarian fluid. Take an eyedropper with a little of the fluid in it. Hold a clean glass of water up to eye level and look closely at it, and put one drop of the ovarian fluid into the water. The fluid should mix invisibly into the water; contaminated fluid will be milky. These eggs should be suspect and discarded, or treated if they are valuable and there are no replacements. Lastly, there is a cure for this that involves very careful washing of the eggs in a bicarbonate of soda (baking soda) solution before they are fertilized. The technique is delicate but it can be done… talk to your advisor or get a paper on the technique (before you start taking eggs, preferably.)

6. Fecundity (Your egg take numbers)

Small projects seem to like the comfort of knowing that they have 219,646 eggs in their incubators. Believe me, an egg take is not the place to count them. At an egg take we want to estimate how many eggs we are dealing with. We do this by keeping and looking at past records, not by counting on the spot. The number of eggs in each female of any species and stock usually follows an average over the years. In specific cases the fecundity can be estimated records of past egg takes. Go with these figures, roughly add 10 – 15% over in case of error and get them into an incubator. The time to get exact numbers is at the eyed stage, so you can have an accurate count to allow you to plan for enough water, rearing space and food arranged. There's enough to do at an egg take without counting the very last egg. So know your fish broad and approximately how many eggs they carry. Figure out how many fish you need to meet your quota and get on with it.

7. Taking the Sperm

Now that the eggs are taken it is time to deal with taking the sperm from the male fish. The fish should already have been tested before they were killed. Wipe the fish down in order to minimize slime or water from dripping into the sperm.

Milt (sperm) is collected by seizing the fish by the tail and cradling it up under your other arm in the same way you would play a guitar. It helps if one leg is supported on a ten litre bucket that's upside down, the belly of the fish is resting on your raised thigh, and the tail is held downward (30˚). With the hand that should be plucking the strings on this guitar/fish, you will apply gentle pressure on either side of the fish in the area of the gonads (about 1/3 down from the head), and will gently massage downward several times to free the sperm to flow downward through the spawn ducts. Now bend the spine of the fish upward (the way your spine would bend if looking at a star directly overhead.) Gently start a single, slow, massaging pass from the area of the pectoral fins down to the anal area. When the sperm starts to squirt out do not speed up or increase your hand pressure, just move along enough to keep the sperm shooting clear of the body. You can shoot the sperm directly on the eggs, however, if the fish sperm turns out watery or bloody you may wish you hadn't. It's much better to use a

small dry, clean bowl or cup for this. The bowl can be quickly inserted into a good stream of sperm or equally pulled away if blood or feces appear.

While squeezing the sides of the fish you are also forcing whatever is in its digestive tract out also. There tends to be hardly anything in there, however if you squeeze too hard or down too far you will definitely express it. Discard any sperm with blood, slime, water or gut contents mixed with it. Sperm can be collected in plastic bags or film canisters and stored at a cool, even temperature for no more than four hours. There is an oxygen requirement for sperm, so blow a breath into the bag before you seal it so that there is air trapped inside. Don't fill any canister more than 1/3 so that there is air trapped inside it to keep the sperm alive.

Weird things to do: If you will notice, almost every ripe spawning male salmon has a small white tip on the end of its anal fin. Also note that it is very difficult to start or finish the stream of sperm on any male fish without dribbling it along this fin on its white patch. This white patch is fungus. Migrating upstream has worn this fin and the fungus is starting to attack. Many groups believe that avoiding sperm that has flowed over this patch will help avoid starting a fungus outbreak in their incubator, so the solution they employ is to hold the fin back while expressing sperm. Other groups prefer to cut the fin off completely.

Weird thing number two: Some groups will check the motility of the sperm on each fish. Looking for motility means to check if the sperm can swim and therefore are alive. When sperm are activated (mixed with water) you should see furious activity for about fifteen seconds. To see this, a clean eyedropper puts a drop of sperm onto a microscope slide and a drop of water is added. The general pass rate should be to see them swim for at least ten seconds. The viewing power should be at least 100X power on the microscope. This procedure sounds excessive but there are times when some projects one out of three or four. If complete fertilization is critical or you have had problems in the past then this might be an option. The reaction of the sperm in water is so quick that many people have a hard time focusing the microscope in time. If you use ovarian fluid (that surrounds the eggs) you can slow this sperm swim to last for over 100 seconds and it will help you see which males to use.

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8. Carcass Disposal

In almost all cases the best disposal of the salmon carcass after you have taken what you need, is to return them to the creek where they came from. Their bodies will decompose and become nutrients to the stream that will feed future generations of the salmonids. There are three points that should be discussed before this happens. First, dumping slit open salmon carcasses into a stream will invite attention from the public and eventually enforcement personnel. A cruiser with its red lights flashing will arrive, at the best scenario, the worst will be, the enforcement will set up a long term surveillance of the stream to try to catch the culprits that are “belly robbing” (poaching or catching fish and cutting them open and only taking the eggs for bait). When the truth of the matter is known it will be embarrassing and a lot of valuable enforcement time will have been squandered.

In every instance when carcasses are disposed of they should be cut in half before returning them to the creek. This is the universal sign that these fish have been used in a hatchery system or been handled, sampled or enumerated in a recognized fisheries project. Secondly the abundance of these returns should not be so that it overwhelms the stream in localized areas. It is fairly easy to estimate how many spawners there are per kilometer, return your fish the same way. If you should capture your brood in one place,

like a fence, it would not be wise just to dump all the bodies below the fence. These fish were destined to migrate, spawn and die throughout your watershed. Therefore you should disperse their carcasses to continue on this natural process. Don't go crazy with this! Several wheelbarrows of caresses dumped into the winter flow will disperse pretty quickly. However an over abundance of carcasses stinking up the back yards of your downstream neighbors' may invite unwarranted criticizing.

For a more thorough understanding and guidelines of projects that involve staking bundles of used carcasses to provide nutrients' in where it's needed in upstream areas consult with your community advisor.

Lastly a little on the cutting-in –half of these fish. It is a lonely occupation, and should remain so, because it involves swinging around of a very sharp machete at a very uncooperative fish. The safest method is to have a round of wood about 12 inches in diameter in some secluded spot. (A chopping block if you will.) Lay the fish across the block and chop it in half with a hatchet, clever or a machete. Be wearing a full set of wet weather gear if you decide to do this. The salmon carcass will protest this treatment by squirting out of every orifice and cavity unidentifiable juices and slime. This soaks the surrounding area well enough to stink to high heaven when the weather gets warmer. The "classic" way to cut the carcass in half uses two very specialized tools. The first being a

peough (prounched phew!) This is a long shovel handle attached to a 6inch long curved spike (in line with the handle) and a razor sharp machete, I said it was unusual because you don't often find a deadly sharp machete this side of the Amazon jungle. Our garden varieties have been chopped into rocks etc so often it's hard to discern front edge from back. Take time with an ax file to put an edge on your tool, use-it, then hide it because if you leave it around somebody else will be doing rock quarrying with it before you ever use it again.

So, for right handers! Have the peough in your left hand, stab the carcass in the head, with the top end of the handle under your armpit, and swing the carcass so the back is on the right side. Now with your right hand swing the machete hard at a 45 degree angle downward hitting the fish just above the dorsal fin. There should be a satisfying ping! And the job will be done. (Please don't try this with the machete hitting the belly first. This can be as bad as the chopping block idea). This is the karate of the egg take and is no place for spectators, dogs, kids or other thing that the swinging machete can hit. That is why I said it is a solitary pursuit. Lastly under no circumstance have one person hold up the fish while another swings at it with a machete. It boggles the mind just to think of the scar….if you survived.

9. Fertilization or Activation

This is simply putting sperm with eggs and gently mixing them and then adding incubation water, not chlorinated tap water. The fertilization of the eggs will be over in ten to fifteen seconds, but leave them in the water for at least one minute and then wash them clean unchlorinated hatchery water.

Which eggs go with which sperm? A word about matrix spawning; If we have a perfect egg take and a perfect sperm take and combine them these two fish should produce around 3000 offspring. Know this! Under the most ideal conditions that exist in a wild system this represents ten times the natural survival. This theoretically means that ten times more brothers and sisters are going to return to your stream to breed in the next cycle and this could have some genetic implications. Most of the fish will come from a few families; there will be less genetic diversity. To solve this we can do matrix spawning, which means that we will split the eggs and sperm into smaller groups and cross breed with other males and females to produce new and unique offspring.

The simplest way I can explain this is: if you are doing an egg take that involves ten males and ten females then take ten clean buckets and put them in a row. When the eggs are stripped from the first female divide them equally between the ten buckets and carry on until all the eggs are taken. Now each bucket has 1/10

of each female in it and ten of them mean that this should be the same as one wild fish except that it really represents a bit of all ten. Next, add the sperm of only one male in each bucket. This one male has now successfully bred with ten females at once and will have 300 offspring each from ten different females. It's simple and takes no more time at all. If you would like to protect the unique genetic characteristics in your stream then this may be the way.

When you fertilize an egg you set in motion a process that is starting to produce an alevin, and some parts of it are extremely sensitive.

The salmon egg is made like a volleyball. It has a tough outer cover and a thin inner lining that holds the air. The way the air gets through the outer covering into the balls interior is through a small hole which seals up. The egg is the same idea; there is a micropore through the outer and inner shells. When water is put on the eggs a small bit enters through this hole and instantly the outer, more durable shell separates from the inner one and then it revolves around so the holes don't line up anymore. If a sperm gets in with this water then the egg is fertile. If water enters with no sperm you can forget about repainting the incubation room or buying cigars… no fishies. This whole process takes only seconds but the process is continuous and can't be stopped or disturbed or the eggs will die.

10. Washing the Eggs

The eggs are now activated with water but they are very dirty. Everything that's in the container but isn't an egg should be removed by washing. There will be blood clots, eggs shells, strings of slime, fecal matter, and of course, lots of dead sperm. All this must be washed or this load of dead material will surely attract fungus that will then attack your incubating eggs. Careful washing is very good for avoiding this situation.

Put the eggs from several fish into a ten litre pail (white preferably.) Fill half full of hatchery water, swirl around gently, let sit for a few seconds to settle the eggs to the bottom, then as quick as you dare, pour the water off, taking along with it the clots, eggs shells, sperm, etc…, whatever remains suspended in the water. If done properly you will see the eggs start to approach the lip of the bucket and you will be able to stop before you spill any. A basin does not work well. The rounded bottom will not catch and hold the eggs until most of the water and garbage are poured off, so this washing cannot be done effectively.

For those of you out there that think you have this activity mastered with the use of a colander or sieve, think again. The screen and holes stop the eggs, letting the water out, but all the garbage you are trying to wash out stays piled amongst the eggs. Do not use a colander, screen or sieve. They don't work well.

At the time of washing, the sperm is already in the egg and sensitive processes have already begun. You have a very short time to accomplish the washing after the eggs have been activated. Research has shown that you have only about five minutes before the egg sensitivity starts to rise. Have your team prepared for this and once the eggs are activated and left to sit still for about a minute, wash the junk out and try not to disturb them, them move on to surface disinfection.

11. Sampling

12. Surface Disinfection

If you look at a well washed fertilized egg under a microscope you will be astonished to see that it is not clean, but has lots of things clinging to its surface; it resembles one of those round Christmas cookies that are covered in shredded coconut (Snowballs). There are also things that are not readily apparent. Along with the clinging sperm there will be fungus, bacteria and viruses. Surface disinfection is a delicate balancing act of soaking the fertilized eggs in Iodine solution. (OVADINE, BETABIDN, ARGENTINE etc). This will kill the things that are clinging to the egg, but will not kill the egg itself. There are two recognized ways to do this; Both involve soaking the eggs for ten minutes in an active iodine solution of 1000 parts per million.

The first method, if you are using Heath trays, is to fill the pulled out tray with the iodine solution. When your eggs are washed they are then put in the waiting tray. This is left pulled out for ten minutes, and is then pushed in so that the incubator water will flow through it and wash away the iodine solution.

This is the most gentle of the two processes. However, iodine in small quantities is deadly to free swimming fish. If your incubator water is reused by flowing into rearing ponds, brood holding containers or flows undiluted into a nearby stream you will want to avoid this method. You could find a way to divert your

incubation iodine water into a field or pond. The iodine is a very active compound and will neutralize quite quickly when it comes in contact with organic matter. The pond, or field, will not be a long lasting chemical dump site that will come back to haunt you.

The second is to have a tank that is full of the iodine solution. The clean eggs are placed in containers that are immersed in the solution for ten minutes. They are then removed and put into the incubator. Don't wash them, just drain and put in the incubator. The small amount of iodine remaining in the eggs will do no harm. Some projects have a special, shallow, wide container that will accommodate several Heath Tray screens. The washed eggs are distributed on the trays, then immersed for ten minutes, carefully lifted and drained, and put in the stack of other trays.

A word of caution: have someone standing over this process with a watch. This is a delicate process and you don't want to forget a container in the iodine bath, as you'll get no fish. Also understand that you are using the same solution over and over. It is an active compound and will lose it's potency after a few uses. After two or three stacks of trays change the solution (do not just top it up.) Lastly, the iodine solution is on the acidic side so it should be buffered with baking soda to bring it close to pH 7.0. Most of the iodine solutions come pre-buffered, so check this out as it is safer to have an error of too much buffering rather than dip eggs into an acidic solution.

13. Incubation

The eggs have now been cleaned and surface disinfected so it's time to put them in the incubator. There are a wide variety of incubation systems from mist and immersion systems where the eggs are soaked for only a short time each day (to the eyed stage only), to substrate incubation where the eggs are layered with gravel or other medium to help take them all the way to the hatching process. Most incubators are the type where you have constant access to the eggs and good control over cleaning and water flow. This would mean that the eggs sit on some form of perforated material and a measured flow of water flows upward through the eggs. The eggs are left like this until the eyed stage.

When the egg is first fertilized it is like one big, single cell. Over time, this will cleave into two, then four, then eight, sixteen, and so on. At the start of the process, for example at four cells, imagine that some environmental insult kills one of these cells. That is one cell out of four, or 25% of the developing fish that is now dead, resulting in no fish. After a length of time, for example when 64 million cells are splitting to make 128 million there might not be the same danger to losing a cell or two.

What I'm saying is that the development processes in the eggs are sensitive and that sensitivity is very heavily front end loaded. The incubation period is roughly divided in halves. The

sensitive first half is “pre-eyed”, and the less sensitive second half is all that comes after the eyed stage.

So what exactly is this eyed stage? Simply, it’s when you can look at a developing egg closely and see the eyes of the alevin looking back out at you. We calculate this time. If you open up the incubator every few days to check to see if you can see eyes you’ll surely kill the majority of them. To calculate when the eyed stage will occur we use a total of Accumulated Thermal Units (ATU). A thermal unit is one degree Celsius for one day. So if your water is ten degrees Celsius then each day you collect ten ATU’s. If you are incubating Coho for example, by looking at an ATU chart you will see that Coho eggs will reach the eyed stage at approximately 225 ATU. If your water temperature is constant 10˚C you will reach it in 22.5 days. If the temperature is 5˚C you will reach “eyed” in 45 days.

Pay Attention! The whole ATU process is approximate. Obviously you can’t use water that’s so warm that the egg can’t develop that quickly and likewise you can’t use water this is so cold that it would bring the egg developmentally to a stop. In both cases the egg dies, so if you look at the ATU process you have to understand that there are “boundaries” to the process. I say that these are 5˚ to 12˚C. The most accurate projection will be made around the middle 8-9˚C and start picking up real error beyond 5 and 12˚C. Even though some eggs can incubate beyond these

limits, you had better develop your own ATU chart to predict eyeing and hatching accumulations. If you have constant water temperature there shouldn't be a problem. If you are using surface water that fluctuates with the weather, you must take the water temperature daily to come up with the accumulation of your thermal units. So now that you can predict the eyed stage, you'll also be able to predict the hatch and swim up phase (when the alevins should be transferred to a free swimming tub.)

When the eggs are incubating they love a stable environment; almost anything will cause mortality of some of these eggs. Vibration or movement of any kind (up to the eyed egg stage) is a killer. If you hit the incubator, pull open the trays, or turn the water on too heavily it will cause the eggs to tumble and cause some mortality. Sudden changes in water, temperature, or water chemistry will all cause mortality. Exposure to ultra violet light (sunlight or fluorescent light) will cause some deaths, so don't play around with the eggs… let your uncle from Saskatchewan imagine what a tray full of eggs looks like rather than pulling out a tray of pre-eyed eggs to look at.

The eggs should not be disturbed before the mid-point of incubation. At the eyed staged to about mid-way to the ends. (The ¾ mark), the eggs can be handled, moved, picked, etc… During the last quarter of incubation one should be very careful with any activity. You can induce a "premature birth", if I can use that term.

The disturbance that would kill the egg when it is pre-eyed will now cause an early hatch and this must be avoided. Be careful during the last quarter because early hatchers don't develop into fry easily, they often develop into pinheads and generally should be avoided if possible.

The uptake of life support from the flow of water around the eggs is not the same from beginning to end. Pre-eyed eggs require 5/8 of nothing at this stage. However, eggs that are hatching should have at least ten parts per million of oxygen in their water. A good rule of thumb is to have one litre per minute of water flow per thousand eggs through any kind of incubator and this should see you through to swim up and ponding.

Weird things that are done here: Scientists have made some unusual discoveries about developing eggs. At this stage they can add a chemical to the incubation water that will turn all the eggs into females or all into males. (I'm sure they have their reasons.)

14. Exorcising your Cranky Incubation Stack

A stack of heath trays has a life of its own. What follows is a result of 25 years of weeping and tears to come up with solutions to these mysterious problems.

The most mysterious of mortalities that occur in an incubator stack are caused by air. The air that's entrained in the water, bubbles that move with the flow and the drop of the water from tray to tray will cause problems. This air will collect under the screens that support the eggs and when a sufficient critical mass is reached it will burp through the screen and cause eggs to tumble about and die. As well, while this bubble slowly forms no water will flow through the bubble, the screen or the eggs. Aha! This explains those irregular dead zones you've noticed every year in your incubator. What is the solution? When installing new tray stacks they should be tilted off being vertical by 3 - 5˚ so they can lean forward. When the bubbles form under the tight screen, they will tend to roll up and out from under the screen support. If you have old trays with slack bottom screens that will rise and cup over the bubble and capture it, I tell you to use a stone, or if you want to go high tech, use a stainless steel nut. Before you load the tray with eggs put the stone (walnut sized) in the centre of the tray. This

stretches the screen down into a point, it's uphill everywhere on the bottom and the forming bubbles roll up and out harmlessly.

There's a stripe of dead eggs down the centre of a few trays every year! The deadly Skunk Stripe. A big mystery? Not really. It's caused by someone, (none of you, of course) pulling the tray above it out before the eggs were eyed. What happens is that the full tray you pull out spills water out of the overflows (which should drop into the back of the tray below) and now it drops directly onto the eggs in the basket tray below. This then disturbs the eggs and kills some. The solution of course is to not pull the trays out before the eyed stage, however if this cannot be accomplished then use a shield. This is a thin piece of material, usually aluminum, that is slipped in place to cover the tray below the one you're pulling out. The overflow water runs harmlessly over the edge of the stack and no harm is done to the eggs.

Two last things have to do with the cleaning wire and its plug. If you have to pull the plug and drain water out then drag the cleaning wire along the bottom of the tray, not up under the egg support screen. In pre-eyed eggs this jostling while scrubbing the underside of the support screen will surely do damage to the eggs. Now that you've cleaned the bottom of the tray, replace the wire and plug in the hole and make sure it's pushed into place. It may stay there, but that tray will now fill with water and that slight pressure may pop the plug out. You'll return the next day to find all

the water flowing out the popped plug, no flow in anything below the popped plug and all those eggs that are in that tray, and all the trays below, are dead. Many projects put a wire, a turn toggle or a strap to hold the plug in to ensure that this doesn't happen.

Lastly, design your system well – adjust the water and remove the valve handles so they can't be fiddled with. Keep accurate records of ATU's, egg picks, of incidents, unusual weather, temperature changes, etc… If eggs die there is a way to find out when and these can be traced back through your records to find out what happened.

15. Water Quality

The water quality you use on your incubating eggs is important. One might sum up the basics of what's important in one word, and that is "stable." The quality should not jump around; temperature, chemistry, pH, oxygen, etc… should all be stable. The conditions can change but it's best if the change is slow. Quick movement in any of the life support conditions can be harmful to the eggs. It's well worthwhile to consider this when choosing your incubation water. This quality criteria for Salmon culture is summed up on page 26 of the third edition of Habitat and Enhancement Facts and Figures. This is a one page condensation of a 162 page version called Summary of Water Quality Criteria for Salmon Hatcheries (a SIGMA publication 1983.) Between these two sources you will become a water quality expert. You should analyze and understand the basics of your water before you build a hatchery around it.

16. Prophylactic Treatments

There are a number of chemicals we can add to the flow of water that supports the eggs. As I have said in the chapter on Surface Disinfection, this is always a dicey business. The reason we would add these chemicals is to suppress (not kill) the growth and development of organisms that might attack the eggs. If a chemical is strong enough to kill things it would most certainly kill the eggs at the wrong concentration.

First and foremost among the "things" we are trying to suppress is fungus. We've tried our best to eliminate it in our egg takes, we've tried to wipe it out with the surface disinfection, but it still persists. It may remain or a new batch has come in with the water. In any event, we want to suppress its growth and development. There are a wide variety of chemicals that would do this for us. Since the egg is the very beginning of the life cycle of a fish it is felt that what we administer to the egg will eventually be part of a fish we may eat. We are therefore held back from using most chemicals. We use only those few that are "approved" by government agencies as being food safe for human consumption.

Heavy salt solutions used to be the flavour of the month, but the incredible amount of salt needed (and disposed of) made it fall from favour after a few years. The most recently used treatment is with a chemical called "PARASITE S." This is an brand name for

formaldehyde. After the eggs begin incubating it is administered every third day as a solution added slowly into each stack of eggs, and presto – no more, or very little, fungus on your eggs. Be warned! This is a dangerous chemical;

- Your incubation area or room should be adequately ventilated.
- You'll need gloves, apron, organic breathing filters and full face mask or goggles to handle "PARASITE S."
- You'll need a safe place to store this chemical that corresponds to the Material Safety Data Sheet (MSDS) requirements
- Completely understand the characteristics of this chemical and the first aid needed for any accidents

But… it does miracles. If you are plagued by fungus maybe it's worth the effort.

17. Shocking the Eggs

At about the midway point in the incubation process we come to the “eyed” stage. The timing is different for each species so pay attention to your ATU’s and a chart of developmental stages for each species. When you have reached the eyed stage (where visible dark eyes are looking out of the egg at you) the eggs can be disturbed and handled without too much danger.

There are a number of eggs in the incubator that will be dead. You can recognize these because they have turned white or opaque. There are also many eggs in the incubators that are not viable but show no signs. You will want to give all the eggs in your incubator an environmental shock that will reveal these dead eggs so they can be picked. If you don’t and only carefully pick the visibly dead ones… well, in a day or two you’ll be picking again, and a few days after that you’ll do it all over again. Shocking the eggs does this all at once. You shock, the next day you pick, and if you’re lucky that’s all you have to do until they hatch. The classic shock is to pour the eggs from 16 inches in height into a bucket that has two inches of water in it. While this is being done the incubators are cleaned. Eggs will be counted, and redistribution can occur to even out the eggs mass in your overall incubation in order to prepare for the hatch.

18. Picking the Eggs

A day after the egg shocking, pick all the dead eggs from the incubator and set them aside tray by tray, separately, from each other batch of eggs for counting. This is the time to carefully pick all dead or suspect eggs out of your incubator. If done correctly, this will be the only time you should pick. When there are a lot of eggs to pick this can be a mind numbing exercise, particularly if it is to be an upper tray or the lowest near a wet floor. Normally eggs are incubated in the dark so lighting is also an issue. The tray can be removed from the incubator and placed on a convenient surface (no fluorescent lights or direct sunlight) to pick easily. Remember that these eggs are alive and need oxygen so the tray should not be removed from the water flow for more than 15 minutes at a time. In the case of just pulling the tray out (which stops the flow) it should be pushed back in for 5 minutes every 10 minutes before it is pulled out again to resume picking.

If the tray is removed for picking a simple solution is to build a shallow box at a convenient, well lit spot. Provide a flow of incubation water from a small hose that is placed in the back of the tray to maintain the incubation water, and then you can take your time.

Fungus is a problem. It starts growing on the dead stuff but quite often spreads out like a filamentous net to surround live eggs.

When you pick up one of these clumps a very gentle shake will remove any eggs trapped. Anything other than this is a waste of time. Fungus that has attached itself to a live egg will do so with such tenacity that when you pull the fungus and the live egg apart the fungus net will pull a very small piece of the egg case with it. Over the next several days the liquid surrounding the alevin wall will ooze out this hole and solidify and give the strange impersonation of small white worms. The egg is doomed and you will waste a lot of time "saving" eggs. My advice is to not even shake the clumps, just throw the whole thing out.

The actual repetitive picking up of the dead eggs can be a problem. The egg is delicate and easily squeezed. This egg picking is generally done in the dead of winter in an unheated incubation room, so manual dexterity can be a problem. A solution that is used by many to change this delicate maneuver into an easily done repetitive motion is to put a stopper in between your tweezers. Tape in a small block of wood on one leg of the tweezers about an inch above where you will grab the egg. Size it so the tweezers will just grab an egg, but can't close any further to squash the egg. Now you can snap the tweezers down on the egg as hard as you wish and still do no more than pick it up. The problem is the delicate control needed to gently close the tweezers on the egg. This stopper removes that necessity and will allow you to pick at 2 or 3 times your former speed.

There are other ways to pick dead eggs using siphons or turkey basters, but I've yet to see one that will beat out a bent piece of steel lumber strap with two paper clips and a stopper taped to it. Another consideration when you have lots of eggs is an automatic egg picker. This device uses rotating perforated plates that pick up the eggs. Light is shone through them, and the device rejects those eggs that light does not shine through. It sounds simple, but it's not. There are electric eyes, motors, little pumps and sensors galore to adjust. Most will sort over 200,000 eggs an hour and they take at least an hour to adjust and calibrate to work 90% pick. This means you should still pick the 10% it has let through. Oh yes, a cheap one is over $6000 and they will not work on eggs with fungus clumps.

A novel way of separating dead eggs from live ones is to float the dead ones off. The live egg is ever so slightly heavier than a dead one. A salt bath is made up using an extraordinary amount of salt (as I recall it's about 8 - 10 lbs dissolved in 5 gallons of water.) Test and retest and you will come to a solution where the dead eggs will just float to the surface to be skimmed off. This is a delicate balance; just a little too much salt and they will all float, too little and they all sink. Test the solution before each batch is separated. The preceding batch has diluted the solution and it needs constant adjusting, but it works if you've got a lot of dead

eggs to separate. Oh yes, the dip time in the brine is less than a minute and the eggs should be rinsed immediately.

Lastly, I have a use for the eggs you've taken from your incubator. First count them, match this figure against the number that survived this far and you have valuable data to record in your log books to compare with past or future egg takes. If you are interested, you can clarify the opaque egg, look into the interior of the egg, and tell exactly when it died. Matching a good ATU record with this, you can bring the death timing estimation down to a single day in the past. This makes for some interesting forensic detective work. Simply pop the dead eggs into Stockards Solution or vinegar. Wait a day or so and presto, it looks like a live egg again. I like to look at it under a dissection microscope, a good trick is to take a black piece of paper, punch a hole through it with a paper punch and rest the egg in that. All the light shines up through the egg, giving you a good view of just what's inside. There are lots of slide packages around that show the developmental progression day by day, and cell by cell, that you can compare to. Now you can answer the questions: Was this egg ever alive? When did it die? And hopefully, why did it die?

19. Counting the Eggs

The best time to count your eggs is at the eyed stage. There are a number of reasons for this. First, it's going to be in the middle of winter and you won't have anything else to do. Secondly, you won't be in a rush, like at an egg take, so you can take your time and be accurate. Thirdly, in the middle of the incubation period the eggs will be expanded to their full diameter and therefore more accurately volume measured. Lastly, counting your eggs at the eyed stage allows redistribution in the incubator trays that will make it easier to calculate hatch flows and any overcrowding problems.

We want to have an accurate egg count somewhere in the process. This will provide us with the data to figure out water flows in the incubator and in the tanks and troughs after they hatch. Not only does the living space have to be figured out in advance but food orders, food sizes and storage also have to be calculated.

There are a number of tried and tested methods to quickly calculate your egg numbers. Page 19 of the Facts and Figures booklet outlines several that use weight, volume and displacement. The method I prefer is the Modified Von Bayer method. In this you use a ruler, line up 30.5 centimeters of eggs (in the groove of the ruler), make them all touch one another, count how many eggs there are in the line and use the chart and Presto! You have how many eggs per litre (dry) you have. Now it's easy to accurately

redistribute the eggs back into the incubator. I tested this system out, purposely using three females (9000 eggs) of dissimilar size, did the Von Bayer method and then had an independent actual count of every egg… the two figures were 3 eggs apart.

20. Hatching the Eggs

This is a predictable process if you are closely monitoring the ATU's. The eggs will hatch earlier during in the last quarter of their incubation if you give them some sort of insult. I mean by this that you can change the temperature, the chemistry of the water (this could mean chemical flushes), or there is a sharp mechanical shock. It's like a premature birth… and you will have all the same problems too! Be careful of the last few weeks of incubation.

Nearing the hatch time there is a strong rise in oxygen use by the eggs and this is the time when the water should be turned up to provide a litre of water per thousand eggs of flow. This may be excessive for some species but it is a good rule of thumb to remember. Water on its own is of little use unless it's carrying the required oxygen. Another good rule is to have at least 10 parts per million saturated of dissolved oxygen in the incubation water. You may notice alevins with their head cracked through the egg shell… but they are dead. Some of this is caused by thousands of fish hatching at once, using too much oxygen and some die in the struggle to free themselves of the egg. A strange thing occurs when the eggs hatch. The splitting open of the eggs releases the liquid contents that surround the alevin into the incubation water. This dissolved organic fluid separates with the air that's entrained into the water that tumbles from one tray to the next and foam is

created. In a large facility many is the person on the morning shift that opens the incubator room door to wade through knee deep, thick foam. It's normal… wash it down the drain and know that your eggs have hatched.

21. Supporting the Alevin

The hatch is complete, you've opened the trays briefly to remove the egg shell accumulation and now it's time to provide support for the alevin. In natural conditions the alevin has an instinct to wiggle downward in the direction of upwelling water. They will find a little nook, wedge themselves in it, let out a sigh, rest, and consume that lunch bag they brought with them that you and I call a yolk sac. They like to be upright and still. If they are kept from doing this they will constantly struggle… this uses energy in that sac for the struggle energy that should be used for body size. In nature this support is provided by the gravel. To provide support in a stack of heath trays the simple way is to insert at least 3 layers of Vexar plastic screen into each tray. I cut them the exact size of the tray and gently nestle them among the alevins. Close the lid and that's it. It seems too simple but it's effective.

I did a two year experiment in a small facility where we put support medium in every other tray in a stack of heath trays. The supported alevins were ponded 1/3 heavier than the unsupported ones. This means they are more robust, pond easier, have fewer pinheads and are overall off to a better start. The Vexar (trade name) mesh I use is that orange 1"-1.5" mesh heavy plastic fencing. It comes in four foot rolls and is commonly used around construction sites to stop people from tumbling into an excavation.

You may want to cut a strip as wide as the tray and three times longer. By folding it twice it's a nice, neat package to go into the incubator. You can never really fold and crease this fencing and the package springs up and bulges in the middle, not providing support. It workss better to cut three individual screens, it works better.

The alevin is a wriggly little guy who points his way down to the water source. If you have a bulk incubator and try to support a massive amount of alevins use a tight medium that's not too open. Otherwise all the alevins will migrate down through the open medium and form a suffocating layer on the bottom. An open medium (like biorings) can give you this result if you're not careful about density.

22. Buttoning Up

Buttoning up is simply what happens to the alevin when it has used up all the food that is in its yolk sac. The sac shrinks and becomes a mere orange split along the fish's belly. It resembles a shirt with four buttons undone, then three, then two, then all the buttons are done up and you cannot see any orange line. After this line has disappeared there is still approximately one to two weeks of nutrition for the alevin enclosed in the belly wall. Pond your fish when 90% of all those in the incubator show no sign of any yolk.

If you pond too early they are not ready to be fully free swimming and you'll force the use of the internal yolk. The fry are also not ready to take nutrition in by mouth and this may result in small bits of the yolk coagulating, causing a blockage in the intestines and you will then have a fry that will starve to death by being a pinhead.

23. Ponding

Finally we're at the last chapter. If you've done everything half right you should have lots of fish to pond. There seems to be as many gentle ways to introduce your fry into the open waters of their rearing tank as there are projects and they all seem to work. There are the straight out dumpers that plunge them straight in, to those that remove the lids of the heath tray screens and place the whole thing into the bottom of a rearing trough. These people like to do this in the late afternoon and let the fry slowly evacuate their trays in the dark. I kind of like that.

There are two lessons about ponding. The first is that after the fish are put into the trough they should be crowded together. This crowding should put them into about 25% of their normal rearing area. The fish are now going to learn to feed, and they seem to teach one another. When the food enters the trough it doesn't just drop into the fish's mouth, the fish has to be motivated to grab it. A few of the fry will be naturals, and they will teach the rest quickly if they are crowded together for about five days.

The second, and very important, fact about newly ponded fry is that they should be fed every 15 minutes for the entire day (not dark.) This reinforces the feeding pattern and sets a healthy start for your fish. This may sound excessive, but it's not. In a trough of

50,000 Coho fry the entire amount of food for an 8 hour day may be 3 tablespoons total. Keep this feeding pattern up after they are released (after 5 days) into the whole rearing pond. After you move on out of the starter food sizes you can increase the time between feedings. Most groups don't feed every 15 minutes, but develop or buy feeders that grind it out slowly to continuously drop feed in the pond. Beware of this! If the feeder does not drop sufficient food for everybody to get a bite at once, the slow trickle of food will only feed the pigs that hang out under the slowly trickling feeder. This will surely set you up for having a great diversity of sizes later on.

Lastly, as you're ponding your precious fish you are going to notice two headed ones or ones with one head and two bodies or perhaps ones that I affectionately call Cheerios, permanently bent in a circle (Lordosis, Scholiosis). You may even see albino ones. Firstly, it means that you are doing something right. These fish are a testament to the gentleness of your incubation system. In nature, where 3000 eggs become 300 free swimming fry, these fish would not have survived. The fish you see are a product of generational genetic disorders or flukes of the fertilization and development process. They will ultimately die, either within the hatchery or when released into the wild, but at least you know your incubation system and techniques were safe and effective.

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