THE WHITLOCK VIBERT BOX HANDBOOK

BY DAVE WHITLOCK
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BRIEF HISTORY OF THE VIBERT BOX

The background story of the Vibert Box system has three major phases: the research, development and use in Europe, its application in the United States, and the research and development of the Whitlock Vibert Box.

PHASE I

Dr. Richard C. E. Vibert of France developed the original Vibert Box design and patented it in about 1950. Dr Vibert, who was then employed by the French Ministry of Fisheries, had considerable opportunity to experiment and apply various hatchery and stocking procedures with trout and salmon.

There were many problems connected with trout hatcheries in those days. The survival rate of the hatchery trout in wild nonvirgin waters was very low. First, the trout were overfed with a high percentage of fats and carbohydrates in their diets; very little natural food was available. They did not get the exercise they required. Hatchery domestication had greatly handicapped the fish in dealing with natural enemies. It was very difficult to stabilize the water temperature. Dr. Vibert, along with others, felt there must be a better means of hatching the ova. There were some portable devices constructed such as the Harrison Box, a large, flat, zinc box that had perforated sides. The eggs were placed in a thin layer on the bottom of the box to prevent the spreading of various diseases. The box was then sunk to the bottom of the rivers. When the fry absorbed their sacs, they got out by themselves through the perforated sides. But the Harrison Box was very bulky and heavy; and, for its size, could hold only a comparatively small amount of eggs. The main disadvantages of the box were the labor of charging the container with box gravel and ova and, of course, its manipulation. Four men were required to carry it.

Around 1950 Dr. Vibert, bearing in mind the principles of the "Harrison System" devised an improved method of restocking by incubating eyed ova in small, specially shaped, plastic boxes, slotted for the escape of alevin. Experiments were carried out in the research center, as well as by planting boxes in many rivers of France. Some 5,000 boxes were planted in France alone. Other experiments were carried out in Switzerland and in England, and by angling clubs in various other countries.

From the beginning of the development of this box, Dr. Vibert wanted to produce more trout and salmon fry and fingerlings for restocking, and to have these fish of such good quality that they could survive in the wild. For this purpose, he took eggs from wild trout he caught in France during spawning time. He hatched these eggs in Vibert Boxes and the fingerlings were released in the same place from which he had taken the eggs. After much study he concluded that the fingerlings hatched under the gravel were better developed, more deeply pigmented, and on the average 15% heavier than those hatched in hatchery troughs. In the Southwest part of France the researchers tried for many years to plant hatchery-reared brown trout fry. Those fry did not survive; but, with the Vibert Box, brown trout were introduced with great success.

The Vibert Box came close to copying Mother Nature, and in 1950 he described this procedure in full detail. In 1954 Vibert came to Biarritz where he set up an Inland Fisheries Research Station; in 1964, for better efficiency in the research area, this station was moved from the Administration of Water and Forestry to the National Institute of Agronomical Research, a bureau which then had twenty research departments. About 1,300 scientists and 6,000 support personnel were involved. Dr. Vibert became Director of the Hydro-biology Research Department.

Dr. Vibert proved that trout and salmon fry hatched under gravel were heartier than those reared in hatcheries. Through many experiments and observations he found conclusively that the fry hatched under gravel were better developed, that mortality was less, and that they were less vulnerable to predators than the fry from the hatchery trough. Best of all, it was found that the hatch was more than 80% higher in the Vibert Box, while mortality in the hatching trough was very high.

Dr. Vibert is now retired from the Institute with full honors. However, he is still interested in his salmon and Vibert Box experiment. In fact, he has worked with me on the new Whitlock Vibert Box, which still employs the original Vibert Box.
principles but involves a nursery for the young fry until the egg sac is totally absorbed. Dr. Vibert completely approves this new version.

PHASE II

The second phase began when the original Vibert Boxes produced by Pezon & Michel of France were distributed and sold throughout Europe and eventually introduced, in about 1967, in the United States. In Europe the boxes were usually sold precharged with 500 to 1,000 trout or salmon eyed eggs per box, ready for immediate placement into incubating areas of the various streams and rivers by water authorities. The economy-minded Europeans were fast to embrace this new, simple, and reasonable method of quality fish production. The charged boxes were used by small private hatcheries as well as by private and governmental streamstocking management.

In the late 1960's, several eastern Trout Unlimited groups in the United States began to use the Vibert Box for restocking brown trout in a few streams. For the most part, they were considered successful on the basis of hatched-egg percentages, and enthusiasm was quite high among these chapters of Trout Unlimited. About that time, Green Country Flyfishers of northeastern Oklahoma was being organized. Two of their main goals were to join the Federation of Fly Fishers and to establish a wild brown-trout fishery in Oklahoma or in neighboring northwestern Arkansas. A search and study for suitable streams was successful in Oklahoma’s Mayes County. Approval for stocking from the State of Oklahoma and obtaining trout were the first two obstacles GCF had to clear. Stocking adult fish was the first choice, but they had very limited funds and the only brown trout stocks available were nearly 1,000 miles away. The club was also informed by several coldwater fishery biologists that their best chances to establish trout in a “virgin” water, especially if it might be marginal habitat, would be with eggs, fry, and/or fingerlings in that order of preference. We were faced with trucking fingerlings from Pennsylvania or Colorado or flying the fry in. Before we contacted or committed for either, Milton Blaustein, a Green Country Flyfisher member, called my attention to a short note in Trout magazine about a Vibert Box trout egg stocking system that the Catskill Mountain Chapter of Trout Unlimited had used with great success. I immediately wrote to Don Warren, author of the article and chairman of that Vibert Box project. Don encouraged us to try the box and sent information on how to purchase and use this box. Green Country Flyfishers decided to try this French egg incubation system.

Eventually we obtained permission from the Oklahoma Wildlife Conservation Department to plant brown trout eggs in a ten-mile stretch of Spring Creek near Locust Grove, Oklahoma, provided the eggs were free of disease. We initially ordered 50,000 brown trout eyed eggs from George Stack’s Paradise Brook Trout Company in Cresco, Pennsylvania, and purchased 100 Vibert Boxes from France. Despite our inexperience and meager planting information, the planting went very well and we had a hatch of approximately 90% of the 50,000 eggs.

Due to our deep concern for this project on a virgin stream we went to great lengths to record all our experiences, methods, and results so that we could add to and improve upon the rather limited information that was available in print. This project became the initial phase of Vibert Box research and development program that the Federation of Fly Fishers now sponsors. During the next few years our use, experience and study of the Vibert Box systems at Spring Creek, my research laboratory, and plantings elsewhere in the United States gave us considerable data and understanding about the nature of trout and salmon reproduction, stocking, survival, or failure.

Green Country Flyfisher’s wild trout Spring Creek project was a significant success in establishing a wild spawning population of both brown and rainbow trout. These fish, hatched from
eggs, successfully adapted and established themselves as annual residents, proving their ability to cope with the extreme and unique environmental and seasonal circumstances there.

The Federation of Fly Fishers adopted a national Vibert Box program after the second year of GCF's use and research with Vibert Boxes. Information was written on the system, audio-visual slide shows were produced, grants for research and development were made, and member clubs, TU Chapters and other interested and qualified groups were encouraged to start Vibert Box stocking projects in specific waters throughout this and other countries.

PHASE III

The third phase began after the original Vibert Box had been thoroughly tested and enough data reported to evaluate its performance and effects in a number of waters. It was discovered that under ideal circumstances (high quality, silt-free gravel, excellent water percolation flows through incubating areas, and low populations of in-gravel predators), hatching of fungus-free eggs and production of egg sac to swimup fry was high. On the other hand, in many streams and lakes that have low or nonexistent natural spawn populations of salmonoids the box was inefficient.

A new design seemed in order to further cope with the environmental problems characteristic of so many waters, as well as those external problems of obtaining boxes from overseas. Their cost and shipping charges had risen sharply and the shipments were not always on time.

Here, in my opinion, were the needed improvements:

1. A more efficient incubator in less-than-ideal waters.
2. Discouragement of siltation collection in the box.
3. More resistance to fungus attack design.
4. A nursery system to catch and retain hatching egg sac fry from natural stream or lake-bed hazards and predators.
5. A slow, deliberate and efficient nursery discharge of swimup fry.
6. A domestic manufacturer to control production and delivery costs.

After 3 years of research and development, laboratory and field testing on several prototypes, one design met all criteria for improvement. We called it the Whitlock Vibert Box, dubbed "WVB". Though my name, as research designer, was added, the Whitlock Vibert Box is not just a product of two fishery researchers but was developed with the input of many Vibert Box users, machinists, draftsmen, engineers, and fishery biologists, plus a lot of data researched by individuals.

THE VIBERT BOX

Dr. Vibert's original design, patented and manufactured by Pezon & Michel, is basically an instream incubator for salmonoid eyed eggs. The box, made of clear plastic, has a self-locking lid, measures 70 x 63 x 46nm. Its rectangular shaped compartment will hold up to 1,000 trout eggs and about half as many of the larger salmon eggs. All four sides, top and bottom, have rows of slots that measure 3 x 11mm. The size and shape of these slots retain the eggs, restrict most predation, and allows water to pass through the incubator to oxygenate the eggs. The eggs hatch and the jelly-like egg sac fry pass out through the slots in the box within a few hours to about a day.

The Vibert Box is buried and anchored just beneath the streambed's surface so that it is retained in the course, porous water-percolated gravels. The box is buried at a depth that allows it to be shielded from the direct sunlight and hidden from sight; there should be little likelihood that drifting stream objects will come in contact with it. Actually, it is placed most ideally where salmonoids normally dig and build their redds for natural spawning.
After the eggs hatch, the egg sac fry normally distribute themselves throughout the redds area around and below the box until they absorb most or all of their egg sacs. Then they work their way up through the channels in the coarse gravels to the top of the stream bed. These "swimup" fry dart immediately to the water’s surface to gulp air to inflate their swim bladders. When this is accomplished the fry are free, efficient swimmers and begin to feed, thus completing the first process of their life cycle.

After swimup, it is a common practice to recover the Vibert boxes and evaluate the box’s hatching performance by counting those dead eggs remaining in the box. Boxes are also reusable after cleaning and sterilizing. Except for taking, fertilizing, and the initial incubation of eggs until they are embryos durable enough for placement in the Vibert Boxes, the fish are exposed completely to all the natural elements of wild reproduction and natural stream life. Other than any genetic alteration or domestication in hatchery brood stocks, the stream-hatched Vibert Box products are not tampered with or tamed by man. No evidence can be seen to differentiate fish produced by the Vibert Box from those of the same genetic background deposited by natural spawning.

Dr. Vibert and I have both witnessed somewhat larger and heavier average swimup fry from gravel- planted Vibert Boxes than the hatchery trough fry and or natural deposited egg fry. On the basis of certain experiments of mine, I now believe that this is due to the "womb" effect. To explain this further, eyed eggs were agitated with movement and light density over the final two weeks of incubation. These newly hatched egg sac fry were 25 to 30% smaller by body weight than those from eggs retained in an undisturbed 500-egg charged Vibert Box. Further agitation of egg sac fry of both types showed reductions up to 15% of body weight over those allowed to remain solitary in the gravels during sac absorptions. Further, these smaller swimup fry did not compete or grow to equal sizes of those unmolested swimup fry over an eight week period of feeding in the captivity of a common aquarium. The exposed eggs embryos are irritated or stimulated more and in responding use up stored yolk nutrients. Vibert Box eggs are somewhat more shielded from external stimuli and they develop more tissue with less wasted energy.

Vibert Box Slot Function - Retains Egg and Releases Sac Fry

THE WHITLOCK VIBERT BOX

The WVB is a trout, salmon, and char egg stocking device that works on the same principle as the original Vibert Box but with a number of modifications; changes in size, materials, and design drastically improve its function. The WVB is made of polypropylene and is molded flat; it folds into shape for economical molding and easy shipping, assembly, cleaning, and reuse. It measures assembled, 145 x 90 x 60mm. All sides, top and bottom have various sized and shaped rectangular slots as required for water circulation, desiltation, egg and fry retention and emission, and predator-entry restriction.
The WVB has two major compartments, one to serve as an efficient incubator for up to 500 trout eggs and the other a nursery area for a similar number of egg sac fry. It has been designed so as to function with all trout, salmon, and char eggs in any water that will support those same species in their mature state. Such areas are spring creeks, streams, rivers, sloughs, ponds and lakes, provided, of course, that in each case the box is specifically planted to meet certain standard like-support qualifications existing in that particular water.

This means that the WVBs are first charged with eyed eggs and placed in the incubating areas either below the stream bed in coarse gravels or above the lake’s bottom in a mound of rocks or special cages. The boxes must be shielded from sunlight and direct agitation or movement while remaining in a level upright position. Eggs hatch and egg sac fry pass immediately down through the incubator floor slots to the nursery below. Here the fry remain for some major portion of egg sac absorption without danger of excessive siltation, predation or entrapment. Eventually as each normal fry develops its swimup instincts, it escapes the nursery from upper sides or top for its journey into the free water. It then surfaces to inflate its air swim bladder as described in the Vibert Box sequence.

Phase One: Incubator protects and hatches the eggs which are trapped through floor into nursery.

Phase Two: Sac fry remain in nursery protected from natural predators or entrapment. Fry eventually absorb yolk and pass through escape slots as swimup fry.
The WVB incubator, using only one to two layers of eggs, allows for greater opportunity for all eggs to receive plenty of water circulation. Since there are practically no egg suffocation deaths, fungus is not greatly encouraged to infect the incubator. The eggs in the Vibert Box incubator, often much more crowded, are more prone to suffocation and fungus infection. Crowded eggs allow fungus growing on dead eggs to encircle and kill healthy eggs. The WVB's incubator is a great deterrent to the “one rotten apple in the barrel” effect.

Naturally the WVB retains the egg sac fry somewhat longer, but the same recovery time is to be observed with both boxes since swimup fry in both cases remain in the area.

Those fry refusing to escape the nursery area have been shown to be physically or mentally inferior to those freeing themselves, so no concern should be taken when these slowpokes are found upon recovery of the boxes. They can be dumped out into the water at recovery for a second chance to survive.

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**Data Average on a Statistical 100 Trout Eggs on Three Major Instream Incubation Systems**

The three major instream incubation systems are hatches from: Natural Reproduction, Vibert Box and Whitlock Vibert Box.

Test egg quality were, physically and mental: 30% abnormal, 30% normal, and 40% superior.

1. **Natural Reproduction** of 100 eggs (including loss to natural mortalities):
   40% survived, hatched and produced 24 swimup fry
   Breakdown statistics on fry production based on 40% survivors hatched and 24 swimup fry:
   - 0 abnormal survival
   - 7.2 normal survival
   - 9.6 superior survival

2. **Vibert Box** production of 100 eggs (including loss to natural mortalities):
   90% survived, hatched and produced 50 swimup fry
   Breakdown statistics on fry production based on 90% survivors hatched and 50 swimup fry:
   - 0 abnormal survival
   - 15 normal survival
   - 20 superior survival

3. **Whitlock Vibert Box** production of 100 eggs (including loss to natural mortalities):
   95% survived, hatched and produced 85 swimup fry
   Breakdown statistics on fry production based on 90% survivors hatched and 50 swimup fry:
   - 0 abnormal survival
   - 25.5 normal survival
   - 34 superior survival

Note that under ideal natural stream conditions WVB produces a significantly larger number of average and superior fry. WVG virtually eliminated indiscriminate mortality until fry are mature enough to cope with streambed and water hazards.

Data above based on literature studies and experiments using test aquariums and natural stream test sites. Precise percentages will vary a little as to parental quality of eggs and water stocked.
The WVB produces more superior fry per quantity of egg deposit than the Vibert Box in a given area and substantially more than natural spawning. Those eggs deposited by spawning fish are often randomly eaten or destroyed by environmental pitfalls or extremes. These extremes might be siltation, entrapment, drought or flood. Hatching fry of natural spawn or VB are subjected to further indiscriminate mortality before superior fry can develop their survival skills. This adds up to a total reduction of surviving superior fry even before the laws of nature can take effect. The WVB nursery allows all hatched eggs to develop advanced egg sac or swimup fry before any natural losses take place.

THE WHITLOCK VIBERT BOX
Its Parts and Functions
A. Top: Top of lid to incubator section. Has 60 3.5 x 13mm slots for water circulation and swimup fry escape passage. This also functions to restrict predators and serves as a desilting mechanism.

B. Incubator Lid Flap: For opening the incubator. Has 69 2 x 2mm vents for circulation, egg retention, predator restriction, and silt restriction.

C. Incubator: Holds incubating eggs in one or two layers - approximately 250 salmon to 500 trout eggs.

a. Sides of Incubator - restricts eggs and provides circulation.

b. Incubator Floor - has 63 3.5 x 13mm slots for circulation, egg retention, and desilting. Also provides additional passage for swimup fry. Floor slots permit egg sac fry to droop down into nursery.

D. Nursery: Catches and retains egg sac fry and allows swimup fry to escape.

E. Tabs: These are for locking the sections into place.
a. Sides of Nursery - upper three rows of slots are for swimup fry escape, water circulation, silt and predator restriction. Lower three rows of slots are for egg sac fry retention, circulation, and desilta-

tion.

b. Bottom of Nursery - holds resting egg sac fry; 8 rows of 2 x 2mm holes for desilta-
tion, circulation, and predator restriction. This also allows anchor attachment.

NO-NURSERY WHITLOCK VIBERT BOX
USE

Should there be circumstances where the Vibert Box system is desired, the Whitlock Vibert Box can be easily converted into just a large incubator holding any number of eggs up to 2,500. Simply fill the nursery section with eggs and lock up the empty incubator lid flap. Turn the WVB upside down so that the incubator section is on the bottom. Place anchor in redd area or hatchery raceway. This practice is not recommended unless there is an extremely good flow of silt-free,
oxygen-saturated water and a rather low predator or entrapment problem.

![No-Nursery WVB Plant Diagram]

THE WHITLOCK VIBERT BOX - THEORY AND APPLICATION

The Whitlock Vibert Box is not a replacement for natural reproduction. It is a simple management tool that provides efficient stocking of trout, steelhead, salmon, and char in the first method yet devised that is most like natural reproduction. WVB implanting of green or eyed eggs as described in preceding chapters will produce these fry in most waters where mature fish can normally survive well.

Using the WVB, however, is not a simple random operation of getting any fertilized eggs, going to any water, and planting them by any persons in any lake and stream bottom. The WVB's most extreme opponents protest hard and loud that it is a method that encourages unauthorized and wasteful introduction of these fish. They also say it is a poor replacement for natural spawning and is neither economical nor effective. Almost without exception these people HAVE NEVER used the WVB nor do they have all the facts.

These are the facts about the Whitlock Vibert Box System:

WHERE TO USE THE WHITLOCK VIBERT BOX:

1. In virgin waters, with appropriate trout, salmon, or char.

2. In streams or lakes in which the natural fish population carrying-capacity has not been reached.

3. In streams or lakes where only part of the water is being used only by larger stocked fish.

4. In "put, grow, and take" fisheries.

5. In streams or tributaries, to establish or reestablish natural spawning runs.

6. In waters not ideal for natural reproduction such as tailwaters, sloughs, silty streams, or lakes.

7. In marginal environmental areas for the establishment of resident populations.

8. In those areas where private or public stocking projects have very limited funds or budgets, but where volunteer manpower is available.

9. In streams or lakes, for introduction of new species or better strains.

10. In areas where excess eggs are available, but neither suitable natural spawning areas nor hatcheries exist, such as runs up short rivers which are blocked by dams or waterfalls.

11. In cases where we wish to insure against natural catastrophic losses of one or more younger generations of fish.
12. For economical management of streams or lakes where hatcheries are not available and/or water sources or funds are not annually reliable.

13. In streams and small lakes where the lowest profile of introduction is desired so as to not draw attention of larger predator fish or disorient or displace the critical territorial system of resident fish.

**WHY USE THE WHITLOCK VIBERT BOX?**

1. It is the most effective and economical method to stock any practical number of salmonoid eggs in a desired area.

2. WVB produces more swimup fry per egg quantity than any other means, including natural reproduction in a wild environment.

3. WVB fry are more hearty and adaptable than the same eggs incubated entirely in a hatchery.

4. Usually, no more than a few days are needed for annual stocking by WVB users.

5. The method allows for immediate stocking an extremely easy, uncomplicated, portable means for the transportation of eggs to any place around the world, from foot to jet transportation.

6. It is the best method, other than natural reproduction, to produce wild, high quality trout - thus it can be an important supplement to natural reproduction, or can develop natural reproduction!

7. Its use can help to develop an attitude or understanding among the public that depends upon a fishery water for sport, water supply or food. They will realize how unique a treasure the fish that reside there truly are.

8. It is a method of stocking that can establish excellent relationships between state authorities and the angler; the state might provide eggs and authorization for application, and the anglers provide planting labor and equipment.

9. In all areas where WVBs and VBs have been used, there is now far greater understanding of, and respect for all management and natural problems of maintenance of fisheries on the part of anglers that were involved in its application.

**WHO CAN USE THE WHITLOCK VIBERT BOXES?**

1. Small organized groups of anglers or rod and gun clubs.

2. Flyfishing clubs.

3. State or Federal fishery management agencies.

4. Private clubs or landowners.

5. Conservation organization, Boy Scouts, FFF groups, and the like.

6. Indian tribes for their land waters.

7. TU, FFF, the Izaak Walton League, CAL Trout, Atlantic Salmon Association, and other national organizations, clubs and chapters.

8. Private fish hatcheries.

**WHEN TO USE THE WHITLOCK VIBERT BOX:**

1. When careful study of water indicates fertilized eggs are the most desirable and practical method of stocking.

2. When a particular stock of fertilized eggs is less than 24 hours into incubation or after they have “eyed” out - usually 3 or 4 weeks into incubation.

3. When the waters to be stocked are in their “normal-ideal” condition, and this condition coincides with the availability of eggs desired. Usually mid spring, late spring, or fall to early winter are the best times.

4. When there are excess of hatchery or wild egg stocks available for waters that are not at full, natural carrying capacity.

5. During periods that do not interfere with other uses of the waters to be implanted, i.e., natural spawning times, or times of heavy use by fishermen, hunters, landowners, and special activities.

**GUIDELINES FOR SELECTING WVB WATERS**

The WVB has been designed and tested successfully for use in all fresh waters that normally have the necessary qualities to support the particular free swimming salmonoids that would be considered for stocking with the WVB. This means that it can,
when selectively implanted, incubated and produce swimup fry in both still and flowing waters.

WVBs have been used to produce swimup fry from eggs in the following particular waters:

FLOWING WATERS:
1. Over spring mouths
2. Spring creeks
3. Runoff tributaries
4. Small and large freestone rivers
5. Small and large rivers
6. Irrigation canals and ditches
7. Tailwaters below hydropower dams
8. Hatchery raceways
9. Aquariums

STILL WATERS:
1. Springfed ponds
2. Natural lakes and ponds
3. Reservoirs
4. Beaver ponds
5. Sloughs
6. Aquariums

It must be understood that the use of the WVB is much simpler and usually more successful in most flowing water systems than standing water systems. Test data indicates standing water efficiency is approximately 10 to 25% less than that of flowing waters. However, my tests and other inputs from users show a direct relationship of successful ratios. These are usually proportionate to the degree of understanding and experience in each case. All waters are unique, and our ability to recognize or identify the problems, limitations, and qualities of each, coupled with careful common sense will greatly enhance each effort's success. This cannot be stressed too much. Do not leave the thinking to this handbook! Use it to guide you - and use your own personal judgement to cope with unique problems in each water.

If the same trout, salmon, or char already reside or migrate into the water you are considering for stocking, a great deal of the water's environmental character and potential is obvious. If, for instance, you wish to introduce brook trout into brown trout water, then further investigation is needed, since each fish has a slightly different range of tolerances. You may find one is far better suited than another, and thus be able to avoid an expensive failure, or, on the other hand, you may vastly upgrade the population by
introducing a more suitable resident. By all means, consult either biological data or a fishery biologist if you are not familiar with these specific species requirements.

Here is a good general outline of criteria for suitable freshwater habitat for most salmonoids.

- Normal temperature range extremes 38°F to 80°F. Ideal average 50°F to 60°F
  Excess of 70°F to 80°F for a few hours to several days depending again on water components mentioned herein. Lakes should be free from winterkill/freezeups.
- Streams should have little or no anchor ice freezeup.
- Most trout may endure from days to months in temperatures in excess of 75°F if the water is naturally pure, well oxygenated, and free of excess CO₂ and N₂ gases.
- Oxygen 4 ppm or below critical - 5 ppm or over is acceptable.
- Oxygen saturation level - ppm per temperature:
  32°F - 14.62 ppm  59°F - 10.115 ppm
  41°F - 12.80 ppm  68°F - 9.17 ppm
  50°F - 11.33 ppm  77°F - 8.38 ppm
  85°F - 7.63 ppm
- pH factor range 6.8 to 8.6 - 7 is neutral, less than that is acid, and greater than that is alkaline (basic). The more alkaline, the greater potential for good health and rapid growth. 7.0 to 8.0 is considered ideal.

Good habitat natural indicators:

1. Abundant aquatic plants
2. Very clear water to slightly natural chalky
3. Aquatic insects in order of highest demand for ideal water conditions:
   a. stonefly
   b. mayfly
   c. caddis fly
   d. midges, damsels and dragonflies

4. a. Crustacea - shrimp, sowbugs, scud, crayfish
   b. Aquatic snails
5. Sculpin, catter minnows, and stone catfish (these are the canaries of the fresh water fish world)
6. Hog suckers, horny-head sucker and whitefish
7. Smallmouth, rock bass and chub
8. Streambed of aggregate - sand, stones, large rocks, and bed rocks
9. Limestone rock present
10. Variety of streamside and in stream cover such as: boulders, moss beds, logs, roots, undercut banks, color to deep water, willows, alders, watercress, and lilies
11. 30% or more overhead cover (shade), terrestrial or aquatic

It is appropriate here to again state that each water is unique, and the WVB system gives stocked fish their greatest opportunity to adapt to a new environment even if it might not be considered ideally suited for habitation.

To this point, motivation for a Whitlock VIBER Box program has been covered, so what are the next steps to be taken? If the reader is not a representative of a governmental fishery management agency, there are certain steps FFF feels should be taken to qualify for WVB usage, regardless of what waters you wish to stock. We recommend a three part WVB program.

Part I. Recognize, choose and study a water that would benefit from the program. Select species to stock.

Picking a suitable water is an extremely important decision for many reasons. Such a water should be in need of help or improvement of fish population but not beyond help.

Seek advice from fishery personnel, collect biological data and all the information you can gather. Also be practical; pick a water as close to your base as possible and small enough in area to be manageable with your manpower, funds, and finances. With experience and success you can gradually expand. Initially, it is extremely important that success or failure be obvious, otherwise your efforts will be
questioned and contested by opposing interests, yourselves, and supporters.

Picking the water also requires choosing the right fish for residence. The wrong fish will surely result in compounded problems and failures. The right fish will often adapt to great environmental extremes or minor WVB mistakes. A stream, for instance, might only be suitable for egg plants in the spring, because it might freeze over so early each fall that it would be impossible to work.

It is also extremely important to evaluate what access, control, restrictions, or management policies are possible before investing in a WVB program in a particular water. If such things are out of balance or wrong, this may well be a chronic problem rendering the water deficient. If such a situation cannot be altered, a WVB program might only be little more than a way to spend your money and energy.

Part II. Contact the authorities in charge of the water you have chosen - local, state, or federal government, or private ownership. Sell them on your WVB plan, and obtain the needed permission or authority to use the WVB.

Ask for a meeting with these authorities, and submit your plan. Show them as much WVB information as possible. Have copies of this handbook to leave with them. If possible, have an experienced WVB person present to answer questions. Be prepared to demonstrate the WVB, or present one of the audiovisual shows to them. Have ready as much data and information as possible to identify, name, locate and characterize the water. Be able to back your statements with facts about what you believe is needed for this water and why.

When making a presentation to officials of a governmental agency, be sure to inform and invite representatives of the technical management of the fishery, such as the head biologist. These people are the key to acceptance in many instances, since they will be asked officially for their opinions on WVB, and will probably be most directly involved in overseeing the project.

Do not merely request that they do a WVB program, but insist it be a private or co-op program. Fishery departments are besieged with many requests for state stocking or habitat improvements. Self-help programs greatly impress most management agencies.

This is one very good reason why WVB can work so well. It is a program the users of the water can be directly involved with.

Have some sort of long range WVB management program worked out - say, over a three-year period. Include in your presentation as much backing by fishery biologists, the public, legal counsel, and your own organization as possible. Remember, particularly, the burden of justification, responsibility, and proof is on you at this point. Do not accept an initial skeptical or negative attitude as final. They might well be testing your enthusiasm and dedication. In any case, have answers ready for the arguments which may be voiced against WVB.

In many cases, state fishery departments are willing to go along with such WVB programs if you allow them to oversee the project, supply some technical assistance, and control the source of eggs or provide them to you. All these are reasonable controls and helpful aspects of developing a working relationship. I would still advise you to have your own qualified or knowledgeable fishery biologist. His personal attention will be extremely helpful.

Part III. WVB planting and program study on particular project water. Timing is often important, so two or more of these phases might be accomplished at the same time by a WVB program group, particularly Parts I and II.

With the completion of Parts I and II, you will be ready to obtain, charge, and plant the WVB boxes. The water should be mapped out for planting, boxes charged, and teams supplied with materials and instructed in their use.

Plantings always go much smoother and are more successful if time has been taken to make a practice run on all parts of the charging and planting techniques. Have an experienced WVB user or qualified fishery biologist with you if possible. No handbook or imagination can foresee those combinations of common and unique problems each group area and water will have.

Above all, set your plans so you can plant and continue to maintain observation for all stages and development of stocked fish. Record and photograph every phase possible. I cannot begin to express the importance and value that this will be to you and the FFF in the future.
NATURAL REPRODUCTION OF SALMON, TROUT, AND CHAR

Trout Spawning Scene

In order to understand and utilize the WVB system fully, the more knowledge and understanding one has of natural reproduction the better. The Whitlock Vibert Box is the closest thing to natural reproduction, and it works on exactly the same principle in the same areas that wild fish use to deposit, protect, and incubate their eggs to produce fry. The egg’s fertilization, deposition, embryonic development, hatching, egg sac fry and swimup fry periods are each critical links in the chain to produce free swimming fish that feed, grow, mature, and reproduce to complete the life cycle. As in any complex animal’s development, the formation of the embryo by parents and eventual birth are the most critical facts of the life cycle.

ADULT FISH

Salmonoids generally mature sexually in from 3 to 5 years. The males, who accomplish this in 2 to 3 years, are often termed “jacks.” Individual species, environmental conditions, seasons, and similar factors also have a direct influence on these residents. Trout and char generally spawn annually after they mature. Some, in colder waters or larger bodies of water like the Great Lakes or Pacific Ocean, will not enter the stream to spawn every year; an example would be the rainbow trout strain known as steelhead. Larger and older trout often stagger their spawning years.

Pacific salmon spawn only one time in their life cycle and die shortly after. The Atlantic salmon does not follow this one-time cycle, and if not caught, but allowed to recover and return to the ocean, it will make one or two more runs, usually staggering them one or two years apart.

Salmon transplanted in landlocked freshwater systems still display these same ancestral traits. Uniquely, all three salmonoids - salmon, trout and char - are capable of adapting their system to live in either fresh or salt water, but all must spawn only in freshwater.

SEASON TO SPAWN

Each individual species of salmon, trout and char have a particular season to spawn. Rainbows, cutthroats, golden trout, and steelhead are generally spring spawners. They will deposit their eggs as soon as the brood streams reach ideal temperature as they warm from winter’s cold. Salmon, both Pacific and Atlantic varieties, generally enter their home streams
**The Natural Nest Areas That Most Spawning Salmonoids Use (Stream cross-section diagram)**

a. Water in riffle too swift and turbulent for safe egg deposit and is exhausting for adult fish to build nest and hold in.

b. Water in run is usually too deep and contains many other fish and predators for nesting.

c. Water in pool is too slow, silty, and deep for nest building and incubation of eggs. Usually infested with vegetation, decaying organic matter, fungus, and predators.

d. Waters at tail area have even and ample flow. Gravels are silt-free and percolating with spring seepage flows from b and c areas. Most stable area for holding and incubating natural deposited or WVB eggs.

from early summer to fall, spawning soon after they find the right conditions and their place of birth. Brown trout, brook trout (char), Arctic char, and Dolly Varden are fall spawners. They generally wait for the cooling of summer water to reach ideal temperatures before they deposit their eggs.

Fishery biologists have discovered ways to “trick” salmonoids into spawning at selected times by alternating light, temperature, and diet. This would be like creating faster or false seasons. This is now routinely done in many large hatchery programs so that the culturists may have more ideal times to produce fish to best accommodate stocking program demands and/or fresh food market needs. Certain genetic work has also been done to produce strains of fish that spawn at a time drastically different from that in which the species normally would.

**THE SPAWNING RUN**

The pattern of the brown trout is typical of natural trout reproduction. With only a few exceptions all other trout, salmon, and char follow the same pattern.

Browns are fall spawners. As autumn comes to a particular area, summer water temperatures begin to drop, days grow shorter, and there is less direct sunlight. Cold fronts bring chilly air, cold rain or snow showers, and frost becomes apparent in the coloring of the meadow grasses and leaves on the hillsides. The browns become restless and soon move from their summer territorial homes, grouping first in small 3 to 6 fish pods in the runs below the riffles or in deep ledge holes. Within a week or so, a school of concentrated adult browns has formed, usually holding in a deep run in certain pools. The fish begin to take on more distinct shades of colors, their flanks changing from a silvery primrose to rich cadmium yellows and rusty golds, especially the cockfish (male). Males also develop a much more pronounced head and hooked jaw; they seem more restless and aggressive. At times, especially during twilight hours, the cockfish leap and tail walk the surface over the holding school of browns. They snap and strike smaller intruding fish but do not appear to feed much at this time.
which salmonoids spawn will usually reveal these exact physical characteristics - if the fish has a choice.

Shortly before or immediately after the henfish moves into the spawning area and selects the site of her nest, she will choose a cockfish. Sometimes two or more cocks will fight each other for her favor, and usually the largest and strongest fish will dominate and remain with her. Once the pair stakes out the nest area, all other fish are driven away and/or discouraged from coming close to their site. Usually one or two other cocks will remain just outside the territorial circle, especially the very small "jack" males.

NEST CONSTRUCTION

The henfish turns partly on her side and with fast, strong, strokes of her tail begins to disrupt the streambed's contents of sand, gravel, stones, and silt. This is the first stage of nest building for the "redd" or depression in which she lays the eggs. The current flow, usually fairly brisk, pushes the disturbed parts downstream. The smaller particles such as silt, sand, dead or live vegetation, and aquatic insects are washed away with the current. The gravels are sorted and drifted according to their size into a clean coarse mound a distance directly below (behind) the depression made by her tail sweeps. Usually this depression will be just large enough to cradle her and the cockfish.

The cockfish seems to take little or no part or interest in this nest building action other than staying just outside the henfish's flanks. On occasion he moves in to brush her side or charge other trout or minnows gathering in the area.

EGG LAYING AND FERTILIZATION

When the henfish is ready to begin laying her eggs, she signals the cock with a tight circle over the nest, and he moves quickly to press near her side. They settle in their redd side by side and open their jaws as if loudly yawning. She begins to expel the bright reddish orange eggs into the depression. Her arched back and fluttering fins signal him to begin venting a white liquid sperm directly on the groups of free eggs. The eggs, 25 to 50, sink slowly to the bottom as the sperm eddies around them, fertilizing each one.

As the eggs reach the bottom, the current and finwash of the pair gently rolls them into the openings created by the clean, coarse, gravel mound. Most of the
Eggs are exposed only seconds to open sunlight. Other fish, such as chubs and small trout, seeing or smelling fresh eggs, will dart in and gobble up some before the male can break his mating trance and chase them away.

In a series of sequences the tenchfish moves a few inches upstream after each egg deposit and repeats the digging, egg laying process until she has deposited all her eggs. This often takes more than a day, due to the tussle and work of digging and egg laying. Occasionally the pair are disturbed, and the spawning may cease for a few hours or even a day or so. A large amount of spawning is done in the twilight hours or at night. This systematic process evenly plants the fertilized eggs in a nest of clean, coarse, gravel that will hold, protect, and incubate the eggs and egg sac fry.

Most trout and salmon lay from 1,500 to 4,000 eggs per female. Larger fish sometimes lay more and/larger eggs than smaller fish of the same species. The eggs hatch at a rate influenced by water temperature - usually between 30 to 60 days. An additional egg sac fry period less than incubation is common. From egg laying, most trout and salmon fry require several months to become free-swimming, stream-feeding residents.

INCUBATION

The incubation process begins as soon as eggs have been deposited and fertilized. As they each settle in a redd niche and are covered with additional gravel, they lay in the semi-darkness and almost double in diameter as the water is absorbed, and then a tough skin-like shell forms. There is a slight, early tendency for each egg to stick or adhere to the individual rocks in the redd mound. I suspect this is a device to keep the eggs from being too free during the first critical hours of incubation. This "green" egg period, when the embryo is first establishing itself in the placenta sac, lasts about 10 days, and the egg is extremely delicate and sensitive to disruption at this time.

With each day of incubation, the eggs grow darker as the tiny body parts form and develop. When the period is halfway to hatching, it is quite easy to see the head, large eyes, and thin "C" shaped body of the fry. The yellowish red yolk and blood system still gives the egg an orange-like cast under the slightly milky colored shell. Occasional movement of the embryo is quite common.

Since most of the eggs are only semi-concealed in the coarse gravel, and water constantly flows over them, they are at the mercy of the environment. The current brings them oxygen, but it also can deposit choking silt, especially if the eggs are in lower depressions of the redd. Silt also carries fungus spores. The odors of the eggs are carried on the current paths and bring many hungry miners of the gravel in search of a tasty meal. Sculpin, suckers, crayfish, predacious insects, leeches, and many other gravel miners take, indiscriminately, as many of these eggs as they can find — but losses vary in each area.

HATCHING

In about 30 to 60 days the eggs begin to hatch. Through a weak or rotten part of the shell membrane the little egg sac fry pokes his head or tail out. The shell then splits, and the newly born fry escapes its confines. These are called egg sac fry or sac fry because they are amazingly incomplete little fish. They have a large yellow yolk sac twice their size and almost no fins or characteristic body coloration visible to the naked eye. Under magnification you can easily see the heart and circulating system working.

These sac fry are fairly uncoordinated and usually remain trapped in the niches that held their egg shell. Movement is apparent, and some fry, with
uncoordinated reflexes, do move a few inches in unpredictable directions. If the redd is sitting-in or too deep, the sac fry will entrap themselves and die. Predators continue to enjoy themselves also. Nearly 60% of a hatch was eaten or killed in my large aquarium redd by just one small crayfish over a ten day period. Entrapment often takes 10 to 20% of the sac fry.

A sac fry develops quickly unless the water is very cold (below 38°F). It absorbs the egg sac to accomplish growth and structure. It cannot eat at this time - only breathe water directly through its mouth opening and gills. By the time the egg sac is just a tiny bump on the stomach, the fry has physically undergone drastic changes. It is much larger, has distinctive parr coloration, its fins and tail are large and functional, and it is quite alert and physical. Now the fry is ready to leave the subsurface gravels.

From egg laying through the complete development cycle of these eggs, a great natural attrition takes place. Only a few of the most intelligent, strong, and healthy fish survive. In many waters it takes from 3,000 to 10,000 eggs to produce one fully matured rearing fish. It should not be such a surprise, then, why your stream has such poor fishing for large adult fish or has low natural reproduction, especially if you and a lot of other fishermen are killing as many legal size to trophy fish as you can catch!

Man represents the most serious threat to the fish’s life cycle, since he stands with one foot at the top and one foot at the bottom of it all. As an unnatural predator he seeks to kill the largest, strongest adult fish first, and as many as he can. The other foot stands as a threat to pollute, silt, alter, or reduce natural volumes and to introduce objectionable fish to the waters. So both ends of the life cycle are in jeopardy. This double jeopardy and the natural predation losses add up to more than most streams can manage. Nature was simply not programmed to cope with the impact of large invasions of civilized people.

The law of survival of the fittest is a cruel, unmornental and impersonal judgment for these fish. Yet without this law the species would, generation by generation, become less capable, as weaker fish interbreed. Eventually the species would die or be killed off for lack of capability to cope with dangers, diseases, and hazards. The natural reproduction cycle of salmonoids is especially geared to give up large normal losses. If we understand this scheme and then apply the WVB system, we can trick nature a little to gain some on the abnormal losses while still using the wild steam as an incubator, nursery, and residence for these fish.

EGGS FOR THE WHITLOCK VIBERT BOX

Trout, salmon, or char eggs are rather large and durable compared to many other fresh water spawning fish. They vary in size according to the species and size of the adult fish. Salmon eggs are generally the largest, with steelhead, rainbow, Arctic char, browns, cutthroat, and brook following in that size order.

Green eggs can, if carefully handled, be safely moved from about 24 to 48 hours after fertilization. Green eggs are not generally recommended for WVB planting as there is no way of sorting out dead or blank (unfertilized) eggs at this early stage. Only if a hatchery incubation system is not available, do we advise the use of green eggs for WVB charging.

The embryos become too delicate to handle or move until about 3 or 4 weeks later, when they are well-eyed. Usually the eggs for stocking or hatchery use are held in trays or cylinders with water circulating over them through this period.

When you decide what fish eggs you wish to use as stocks, look for these things if there is a choice:

1. Obtain fish eggs from residents of the water or watershed you are stocking, or from a similar system.

2. Try to get the wildest stocks available. Avoid many-generation hatchery fish as this domestication is not ideal for creating a wild fish stock or natural wild reproduction.

3. Egg stocks must be certified disease free!

4. If shipping is necessary, use the closest ideal source and ship air freight.

5. If the stocking area is ideal, order the youngest possible eyed eggs. If the area is of poor quality use the most advanced eyed eggs.
King Salmon and Brook Trout Eggs Show Size Range of 3 to 7.5 mm of Most Salmonoid Eggs

6. If you have a choice, request largest size eggs per specie.

7. Reserve eggs as far ahead of time as possible.

8. Work with egg source for setting up the most ideal time for planting conditions and shipping.

Try to have the eggs shipped or delivered in the least time possible. Avoid, if possible, overland or air shipments that coincide with holiday rush shipments. If water conditions or other problems prevent immediate planting, be prepared to store the eggs in well-ventilated, moist containers that you can refrigerate or ice to maintain a temperature of 36 to 38°F. Melting ice held above and dripping over eggs wrapped in a heavy, clean, gauze cloth, such as a baby diaper, suspended on a tray made of hardware cloth will keep them for as long as two weeks in a regular sportsman's ice box, or home refrigerator.

HANDLING AND SORTING EGGS FOR WYD CHARGING

First and foremost, remember that these eggs contain delicate live embryos; they can easily be deformed or killed by mishandling. They are sensitive to exactly the same life support requirements as the mature fish.

1. Keep eggs within a temperature range of 36° to 55°F, and never change their temperature faster than one degree per 5 minutes.

2. Keep eggs moist or wet with pure, untreated water from a well, spring, rainwater, clean lake or stream that is exposed to air or well aerated by circulation or a bubbler. This keeps ample oxygen available to diffuse through the shell membrane. Never use tap or snow water!

3. Live, healthy eggs will be uniformly shaped and brightly colored. Remove any eggs that look opaque, clear, bloody, or broken. If yolk fragments from broken eggs stick to other eggs, remove these also; rotting yolk particles attract fungus.

4. Do not drop or mash eggs or attempt to move or count them with hard abrasive utensils. This is certain to bruise or rupture the egg shell embryo body or egg sac. If you suspect harm to any eggs, separate or discard them; otherwise, dying eggs will spoil healthy ones.
5. When handling or transporting eggs, be gentle; water is the most reliable shock-absorbing medium.

6. Do not expose the eggs to bright light, especially direct sun rays or those high in ultraviolet rays. Store eggs in very indirect light or total darkness before, during and after handling. Extreme cold or warmth or fast changes in temperature will shock and kill the embryos.

Healthy Eyed Brown Trout Eggs Ready for WVB Charging

CHARGING THE WHITLOCK VIBERT BOX

Though there must be any number of suitable ways to put the counted eggs into WVB, the method described below is, to me, the most practical and workable. Varying conditions, circumstances, and personnel will call for altering procedures to best accommodate the efficiency of loading the WVBs. The procedure described below is most efficient if a team of three or four people is used, each doing one or more specific steps.

WHITLOCK VIBERT BOX ASSEMBLY

1. Wash each unfolded WVB in warm water and mild detergent with a soft brush. Rinse thoroughly with clean, warm, natural water if available.

2. With the beveled side out, fold each hinged area 180 degrees while still warm, then allow hinge to relax.

3. The two small side flaps are the box ends. The section between is the bottom. With beveled sides down, fold box ends up 90 degrees, then fold up both sides, snapping the locking tabs on the ends into corresponding slots in the sides.

4. If nursery is to be used as incubator (described on Page 8 “NO-NURSERY WHITLOCK VIBERT BOX USE”) attach the locator anchor line as described in step 7 below, and charge with eggs before the next step.
5. Fold in shortest side extension to form incubator floor and snap tabs on the ends into corresponding slots in the back side. This closes the nursery section completely.

6. Fold top side down to top of box, closing the 2 snap tabs on each end. Leave incubator flap open.

7. Attach a three-foot length of locator anchor line to the middle of the back side of each WVB (front is the side on which incubator lid flap is located). Do not attach anchor to line at this time. The WVB is ready to be charged with eggs.

WHITLOCK VIBERT BOX LOADING

1. Prepare a cold, natural-water bath, an inch or so deeper than the height of the WVB, in a sink or large tub with temperature somewhere around 48° to 55°F. Use ice to cool pure natural water. Do not use distilled or city tap water!

2. Immerse a dozen or more WVBs in a cold-water bath, and allow time for them to cool down to bath temperature. A few pieces of ice will keep the bath temperature constant.

3. Have eyed eggs at the same temperature as the water bath. If they are colder, gradually pour small amounts of bath water over them so that the temperature change-rate averages one degree per 5 minutes.

4. Cull the bad eggs just before or while you are counting them to place in WVB incubators. Use a pair of tweezers, forceps, spoon, or feather to remove the bad ones. Be ruthless in culling; any bad eggs may cause dozens of others to die during WVB incubation.

5. Suspend eggs in water bath and transfer a small lot into a plastic margarine bowl - about 1/3 bowl full and water. Water is the best shock absorber and transfer mechanism you can use.

6. Now carefully pour eggs and water into a WVB incubator section being held just under the water and upside down. Lid flap and incubator chamber in this position accepts the eggs without spills. Adjust the count of eggs so that no more than two layer levels of eggs cover the floor of the incubator if the eggs are to be planted in flowing water. One layer is better if eggs are to be planted in standing water.

7. Carefully pour eggs from the incubator back into the empty plastic bowl. Note the level of eggs in the bowl, and then count eggs to nearest ten or so. Record count number for data information.

8. a. Fill the plastic bowl with eggs to original count level. Proceed to fill each WVB incubator with this count. Each box will contain approximately the same simple eye measurement - saving a great deal of time and individual egg handling.

b. Incubator double layer count will run about 200 for king salmon, 275 to 300 for steelhead, 450 to 500 for rainbow and brown, and 450 to 550 for brook trout.

9. When each incubator is filled carefully, snap the lid locked, keeping the box at the same angle under water until locking.

a. If boxes are to be planted within a short time, settle the eggs by slowly leveling and shaking the WVB under water. Settle them evenly on the floor of the floor of the incubator. Drain water out, holding box level. Stack and store in ice box of same temperature.

b. If some time or distance is to be covered before planting, settle the eggs on the inside top of the WVB incubator.
incubator. Keep the box upside down and place it on a flat, porous surface such as screen wire or ice box bottom. This keeps eggs from being squeezed by weight and vibration into and through the incubator escape slots - where they will be damaged or killed.

10. After all boxes are charged, cover stacks with wet cloth (gauze diaper) or wet moss and suspend ice over them. Temperature will gradually become colder. Drain off excess water as ice melts. Open lid every few hours to ensure circulation of fresh air or add pure oxygen.

11. A good, sturdy ice box with hinged lid, drain, and two handles (such as Igloo or Coleman) makes an ideal storage and transport box. Outside temperatures and light do not come in contact with the eggs.

12. Do not allow boxes to move freely inside the ice box! Fill empty spaces with additional gauze, moss, or ice. (Caution: Do not attempt to charge WVB on stream or lake side locations unless there are absolutely no indoor facilities available)

EQUIPMENT LIST FOR CHARGING WVB
1. A clean well-lighted work area equipped with table or cabinet-top, drain, and sink. Home, motel kitchens, or fish hatcheries are usually ideal.

2. Ice boxes are needed for temperature and light control, plus storage and transformation of eggs.

3. Have plenty of crushed ice available.

4. An accurate easy-to-read durable thermometer is a must, 0° to 100°F range.

5. Have fresh water supply - preferably refrigerated. Remember: No tap water or snow water!

6. A sink or tubs are necessary for cold water bath egg-loading.

7. Have available several large, clean towels.

8. Use eight ounce plastic margarine or butter container bowls or insulated foam cups (8 to 12 ounces) for charging; avoid using breakable bowls or cups.

9. Have available a number of smooth-edge, large, plastic spoons or a large feather wing quill to pick up good eggs.

10. Tweezers or forceps will be needed to separate bad eggs.

11. Several clean pieces of heavy gauze, such as toweling or diapers, for covering stacked and loaded WVBs.

12. Cleaned and assembled WVBs with incubator lids open.

13. Twenty pound test lead-core trolling line for locator anchors, three feet for each box. Heavy nylon or dacron fishing line can be substituted, 15 to 20 pound test.

PLANTING THE WVB IN FLOWING WATER

Placing the WVBs, charged with live eggs, below the bottom surface of flowing waters requires specific knowledge and techniques for the highest potential success. Each water is different, yet common similarities must exist if the WVB is to function.

WHERE TO START

Make a survey of the water and become familiar with its length, character, and physical properties. If natural spawning does or has occurred, note carefully the areas chosen by the wild fish. Most likely they will also be ideal for WVB implants. However, never plant WVBs directly in or over natural redd sites - such practice is destructive and self-defeating.

Look for areas having a good steady flow of water, but not erosively swift. It should have a stable depth of 6 to 12 inches over the bottom. The bottom should contain a high percentage of gravels (small stones) from 1/2 to 2 inches in diameter. It should be relatively free of silt, mud, and sand particles as well as live or dead vegetation. Such areas are usually located just below the pool area where it narrows to form a "tail" or shallows, and surface flow quickens from the narrowing and shallowing of the water. It usually extends to the rough-surfaced, fastest flowing water area we term as the riffle. (See diagram). All free, natural-course flowing waters form these physical properties. They become easy to recognize once you are aware of them.

The physical structure of a streambed - be it brook, spring creek, small or large river - shaped uniquely by the combination of gravity-flowing water against the various ground angle planes, solid and loose materials. Water flows over the streambed, but since the bed is not solid, it also flows through and under the bed. The tails of pools are most often quite clean, porous, stable areas that water flows over,
through, and beneath. This combination is what incubates deposited eggs best. If these areas in your
waters are too deep or fluctuate too much, look for
closer cutoffs, tributaries, or feeder brooks: that's
what natural spawners do.

DRY RUN TESTING

If there is time, WVB sites should be selected
before the WVB planting day begins. Site selection and
dry-planting runs with empty WVB are extra
precautionary measures. In this way, you can
enhance your chances for excellent program results.

Plant a few boxes and observe and record what
seemed right and wrong with your method and the
advice derived from this handbook. Also observe the
WVB blank plants over a series of intervals. Do the
boxes hold well, silt, washout, or become lost? You
can develop some critical method and performance
data even before you begin using the eggs.

It is also good to erect a simple screen device to
collect bottom moving materials. You will be amazed
at how much sand, silt, plant particles, and the like are
carry down any stream in just one hour. Dry-run tests
will also show the best sources of extra redds.

You might need to truck in a supply rather than gather
it along or in the stream. This site selection and dry-run
testing also points out accessibility problems that
might otherwise be unforeseen on WVB day.

I know all this sounds complicated to the
uninitiated, but it really is not. You will gain
knowledge and respect for your water and fish that you
never dreamed existed - that is for sure! That alone is
tenfold payment for any work, time, or money you put
in.

STEPS FOR PLANTING THE WHITLOCK
VIBERT BOXES IN FLOWING WATER

Step 1. Assemble WVB planting personnel
equipment, and charged WVB at a convenient place on
waterside. Teams of three or four people work most
efficiently for planting each box. If possible, each team
should have a WVB experienced user included. Each
team should be individually equipped for planting
WVBs with all the items in “Equipment Needs for
Planting”. If dry runs have not been made, take time to
demonstrate to the group the planting procedure agreed
upon.

Step 2. Designate areas for teams to cover, and
give each team an appropriate number of WVBs to
plant. WVBs can usually be planted by four people
(one team) in 15 to 20 minutes per box.

Step 3. Run over check list for each team’s
equipment.

Step 4. Adjust WVBs in ice boxes at streamside
to stream temperature by removing ice and pouring
small amounts of stream water over boxes. Adjust
temperature one degree each five minutes. Keep the ice
box drain open so excess water does not accumulate
in the box. Keep the box lid closed except to pour water
over the boxes. This egg tempering usually takes 30
minutes or less. Through the planting periods, continue
to keep WVB eggs in the ice box at the same
temperature as the stream water. A good system is to
pour stream water over the boxes every time you
remove one for planting.

Step 5. Advance teams to WVB planting sites.
Each area should have one or more boxes planted in it
according to how many and how large these areas are.
Cross Section of Typical Aggregate Bottom in Tail of Pool Before Redd is Dug

Redd Hole Made in Aggregate Bottom

Proper Position of WVB in Gravel Lined Redd

Final WVB Position and Gravel Set
WVB Planting Facilities: ice box, notebook, pens, WVB stream tags, thermometer, locator anchor, and WVB anchor.

Wide distribution is far better than close grouping in most areas. Occasionally, some waters have just a few suitable sites; then grouping is better.

Step 6. Each team member does one or more specific jobs in unison.

a. Locate the site of WVB redd.

Project Team Checking Stream Temperature

b. Dig a redd area approximately 3' x 3' by dislodging gravels and pulling them up and to either side. Form a redd depression approximately 6 to 10 inches deep. Work up its bottom area to dislodge small particles and create a bed of clean, porous stones.

c. During redd digging, another member of the team prepares the WVB by attaching the anchor on the bottom and the locator anchor to the locator anchor line.

d. One or two team members must collect one or two buckets (about five gallons) of sized gravels (1/2" to 2") for the redd from the streamside, streambed, or from a hauled in source.

e. The WVB is attached to the WVB placement tool and is lowered level into the redd floor. There it is held in place as level as possible, broadside to current flow. Incubator section is always on top. (Note: It is absolutely necessary for the WVB to be placed level on the redd bottom. If not, the box incubator and nursery will not function with best efficiency. Make every effort to place them solidly level).

WVB Placement Holder in Position for Planting Box

f. While the box is held steady, another team member carefully pours sized gravel over and around the box, continuing until the box is almost completely covered.

g. Carefully extend the locator and anchor directly downstream and rake stream gravels over it, burying the anchor and line several inches beneath the gravel.

h. A team member should now kneel or bend down and look through the glass bottom bucket releveling the WVB by sight; then he should cover over the redd area with gravels moved by redd digging. Carefully tap and smooth these down so they do not make a large hump in the stream bed. Humps would tend to erode or attract and capture silt. Glass bottom buckets and long sleeved rubber gloves are most important in the final positioning and conditioning of the WVB plant.

i. Place three large rocks on the bottom at the sides and below redd area. These should be two to three feet away from the redd’s edge.

j. On a stake, limb, root, or other convenient object in sight of and in line with the WVB plant, place a numbered tag. Record the tag number and data in your notebook - this will serve to locate and identify the WVB just planted for later recovery and date
WVB being held and placed underwater in Redd Area

The locator anchor line is tied to the front side of the WVB before assembly

The correct level position of WVB is absolutely necessary to insure correct function of WVB systems

Tabulation. If both banks are stable, stakes may be placed on opposite banks, aligned with the redd site, the distance from one stake to the redd site being measured and recorded on the stakes.

The record in your notebook, the tab at streamside, and the triangulation of three large rocks and the locator anchor set up a fairly reliable WVB recovery after swimup.

At this point you should realize that when we dig into a stream’s bottom, we are breaking the skin of the streambed. Water quickly erodes it if it is left weakened or exposed, thus jeopardizing the WVB plant by exposing it to light or molestation; or it might even be washed away. Before you dig a redd, make sure the area is not already eroding. If the bottom is lighter colored than the average color of bottom elsewhere, this indicates gravel movements. Avoid this area since the WVB may be washed out. At all cost of effort, the WVB must be planted level and shielded from sunlight and water erosion!

Slower flows require that the WVB be planted shallower in the streambed; faster flows require that it be platted deeper. Closer observation, common sense, and experience will help you to plant WVBs in the most advantageous way.

For future reference, note the amount and types of gravel compositions, predators, flows, and all other factors that will affect hatching - or perhaps indicate why a planting has failed or succeeded.

AN ALTERNATIVE WVB PLANTING METHOD

A new WVB placement method has been tested and seems to solve most of the WVB placement problems we normally encounter. Where stream turbulence, depth, bottom instability, level placement and anchoring is difficult this new method eliminates almost all problems. It does however incorporate an additional item, a small wire cradle or gabion-like basket, which slightly increases the cost and labor to make them. The additional trouble may be greatly compensated for in easier, more perfect, fast and efficient WVB placement.
**A WVB Locator System**

This new method also almost totally insures inst WVB loss, misplacement, uncovering and extation by predators. It assures perfect gravel size ding around the box for best circulation, and during uration nursery and swimup fry escape! The only hor needed is the one for the locator line.

**W TO PLANT WITH THE CRADLE**

1. Remove a WVB from ice chest and place it the center of the basket, resting bottom of the ersory on the bottom of the basket.

2. Pass WVB locator line through side of sket and attach locator anchor.

3. Set basket and WVB in shallow water to ect eggs from rapid temperature change. Hold VVB in middle of basket and carefully fill basket with sized clean gravel. Make certain gravel "nests" well by gently rocking the basket. Fill to top of wire sides, covering the WVB with gravel.

4. Place cage and WVB level and broadside to current flow in depression formed by digging a redd area as described on Page 24, step 6. Extend the locator anchor line downstream. Use either long trappers gloves or a small rope passed through the top of the sort sides of the basket to lower the unit into the depression. If a rope is used, remove it after unit is irmly seated.

5. With additional sized gravel, or with the gravel mounded by digging the depression, fill in around the unit. Top of the unit should be just at or slightly below streambed.

6. Stretch and set locator anchor in gravel downstream from the basket. This assures the line will remain extended full-length for more efficient recovery.

The basket holds the WVB steady, level to the bottom, anchored firmly in the streambed with a perfect cradle of sized gravel on all sides and the top. It practically eliminates all placement and washout problems and is faster than the other methods.

By varying the size of the cage, two or more boxes can be perfectly planted. In areas where clay or
bedrock or very unstable gravel bottoms exist it can be used with excellent results.

When I began testing this new placement system I was amazed how it simplified the most critical and difficult task of perfect placement and burying the WVB in fast or deep water. Box loss or misalignment is almost eliminated. The gravel in the case and around the WVB is almost immovable. Burrowing predators such as crayfish, sculpin and large aquatic insects cannot tunnel down next to or near the WVB walls.

EQUIPMENT NEEDS FOR PLANTING
1. Ice boxes for WVB temperature control, storage, and transportation.
2. Water thermometers - a nonbreakable type is best.
3. Digging hoes, tools, rakes, and the like for moving and digging the gravel in streams.
4. Small boat, canoe, rubber raft, or float tube for easy water transport of equipment, eggs, and personnel.
5. Several sturdy buckets for carrying gravel and pouring water.
6. Glass-bottom buckets for underwater viewing during box plantings.
7. Special WVB tool to hold WVB in place on redd while covering it with gravel.
8. Box attachments - anchors, locator anchors, and extra line stock.
10. Towel and waterproof containers to keep hands dry and notebook away from water.
11. Map of planting area.
12. Camera for recording events.
13. 3' x 3' pieces of 1/2 inch hardware cloth for cleaning and sizing redd gravel.
14. Tape cassette recorder to use instead of or in addition to the items listed in No. 9.

PERSONAL EQUIPMENT FOR WVB PLANTING TEAMS
1. Clothing to keep warm and dry in weather conditions of season.
2. Chest high waders or hip boots.
3. Work gloves for picking up gravel and digging.

The glass bottom bucket is indispensible for planting incubation, observation, and WVB recovery.
4. Rubber trapper gloves - arm length size Harters).
5. Personal towel.
6. Polaroids for seeing through water.
7. Small pad or pillow for kneeling on stream bottom. Basketball knee guards used under or outside of wader are excellent.
8. Knife for cutting lines.
9. Something to drink and eat.

INCUBATION AND NURSERY OBSERVATION

It is most desirable, informative, and interesting to set up several WVB redds for periodic observation during incubation, hatching, egg sac fry development, and swimup periods.

At one or two week intervals, return to the project area and check one or more WVB redds. This is done by placing them in the most convenient ideal areas of your water. Using a glass bottom bucket, waders, and long rubber trapper’s gloves, WVBs can carefully be uncovered, observed, and then the cover replaced.

Regular observation and temperature monitoring will tell you a great deal about the progress and/or problems of the other WVBs planted. Record these observations! Note whether the WVBs are sitting-in or what predators may be present in the gravels around the WVB area. Such observation will also indicate when to recover WVBs after swimup.

AQUARIUM SETUP SPECIFICATIONS

1. Glass Aquarium - from 10 to 50 gallons capacity. (In construction of my aquariums I achieved a 50 to 70% savings using used, heavy window pane and Dow Corning Silicone Rubber Aquarium Cement. Directions for aquarium construction are on large size tube.)

2. Electric filter and circulation pump - use the type that operates off electric pump inflow and siphon return. This type fits on the outside of the aquariums. It is most advantageous to use an under the gravel type filter in conjunction with the outside filter for establishment of bacteria to break down the ammonia (NH₃) fish wastes to Nitrites (NO₂) and to Nitrates (NO₃) which are then recycled by the algae or plants for growth and oxygen production. Outside tank filter should be filled in layers of materials as diagrammed. (See Filter Diagram, page 27.)

3. Thermometer - 80°F to 32°F range.

4. Electric aeration bubbler - this is used in addition to the filter flow pump to enhance circulation, expulsion of unwanted gases and oxygen saturation. Large bubble “Air Mist” airstones by Kardon are vastly superior to small bubble airstones for proper expulsion of waste water trapped gases.

5. Water - use your stream’s water if possible or other natural unpolluted lake or stream water. Rain or well water is only a fair second choice. Tap water can be used only if allowed to be exposed to the atmosphere for several days. (See listed “criteria for suitable freshwater habitat for salmonoids” for pH and oxygen and water temperature.)
6. Gravel - use 6 to 8 inches of 1/2 to 1 1/2 inch gravel. Natural gravel taken from your stream is best.

7. Salt - sodium chloride - natural rock salt, not iodized table salt. Use 1 tablespoon per gallon. Salt inhibits fungus and other disease that tends to breed in most aquariums, especially in temperatures of 45°F to 65°F.

8. If maintaining lower correct temperatures is a problem in our aquarium there are several water conditioners available on the market that do a superb job of cooling and circulating the water.

Included in this section is a diagram that shows the basic setup. However, you should design your aquarium's contents to closely simulate and maintain all elements of the natural waters during the WVB plant period. One or two WVB's can be planted in the 10 gallon size aquarium. Boxes may be placed above or below the gravels. Make sure circulation and/or current in the aquarium is such that eggs and sac fry will receive ample oxygenated waters.

Water need not be changed if filter, pump, aerator, and water temperatures are controlled properly. Once the eggs begin to hatch, excess albumen will spoil water quickly, so the water must be changed by fractional cycling daily until hatching is complete. Avoid violent turbulence when cycling new water. Watch for foamy, soapy-like bubbles and clouding of water. As long as this condition exists, excess albumen is present.

Temperature control is accomplished by either refrigeration of pump water, ice, pumped water directly from natural stream, or aquarium placement in sheltered but unheated areas. Aquarium water uncontrolled will be approximately 3°F cooler than room temperature due to normal evaporation, salt, and so forth. Eggs incubate faster at highest temperatures (50°F to 60°F). However, temperatures from 50°F to 38°F are most ideal for respiration, development, and disease control.

A. Electric aquarium aerator unit
   a, airstone to increase bubble number and higher oxygenation
B. Electric outside aquarium filter and water circulation unit
   b, Charcoal and glass wool water filter
   b2 Water pump outlet tube-adjusted to give directional aquarium flow and aeration
   b3 Water siphon pump tube into outside filters
   b4 Siphon gravel filter to provide water circulation through the gravel
C. Aquarium thermometer positioned to monitor circulating water temperature
D. Aquarium water
E. Cleaned and sized gravel and water
   WVB 1 - Below gravel plant as in a stream
   WVB 2 - Above bottom mound plant for slow or standing water

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WVB should not be exposed to direct sunlight or ultraviolet electric lamps. Indirect lighting is okay. Direct lighting for momentary observation or photography is not harmful.

Boxes may be placed beneath gravel or on top. You can place the WVB against or near the aquarium sides for best observations and photography.

If you wish to maintain aquariums after swimup fry stage, continue routine water environment maintenance. Fry can be fed most ideally with frozen baby and adult brine shrimp. Start carefully feeding a day or so after fry air swim bladders are filled and fry are free swimming. Be careful to feed only as much as fry will eat. Excess food will spoil water quickly!

You should, if possible, set up the WVB aquarium so that as many natural streamlife forms as practical are present. Such life forms include aquatic vegetation, snails, aquatic insects, a few minnows, catfish, sculpin, crayfish and so forth. These other life forms will serve as indicators of the aquarium’s health and some of the predation problems the little trout must face. Take extreme care not to overstock your mini-environment with either eggs or other life forms!

During these experiments, brown, tiger, brook, and rainbow trout were hatched in VB and WVBs and maintained in a common 70 gallon house aquarium for 1 1/2 years. These same species as well as coho, king, Atlantic salmon and steelhead were all hatched and held for four months in a similar aquarium. With reasonable care and attention it is easy to duplicate these aquarium projects.

Outside Filter Diagram

1. Glass or poly filter wool.
2. Oyster chips.
3. Glass or poly filter wool.
4. Activated charcoal.
The WVBs are ready for removal when test boxes have most or all fry liberated from the nursery section. Orderly removal procedure, observation, and recording is quite important for a proper conclusion to the stocking cycle.

**EQUIPMENT FOR WVB REMOVAL**

1. Small boat, canoe, or rubber raft if needed to gain access to the area
2. Chest-high waders
3. Trappers (rubber, arm-length) gloves
4. Glass Bottom bucket
5. Long handled gaff hook
6. Bag or bucket to carry empty WVBs, lines, anchors, and tags
7. Data book and pen or cassette recorder if used in planting
8. Towel, wash cloths, scrub brush and hand soap
9. Knife with flat blade for unfolding WVBs

**PROCEDURE FOR REMOVAL OF BOXES**

1. Return to the WVB planting site and have one or more persons from each original planting team return to their planting areas. It is far easier for them to recall the location and recover the boxes.

2. Streamside locator tags, which have been placed in numerical order, are first located by sight and data records.

3. After locating tag, line up on WVB area and look for larger marker rocks. Often water changes the bottom shape and color, and these may be gone, covered, or moved. Look closely and carefully.

4. When general WVB area is located, pass gaff hook through to catch the locator anchor line. Once the line and attached anchor is located, carefully pull it up and out to where the WVB is buried.

5. With glass bottom bucket, look below the surface and begin, by hand, to uncover the WVB carefully. Watch closely to see what angle the box is in, whether fry are in the area, how silt has collected, and so forth.

6. Observe and announce to the other members so that they may record observations on the box data sheet.

7. Pull the WVB from the redd area, and watch closely for still trapped fry. If present, allow them to swim free of the box before removal from the water. If excessive numbers of fry seem trapped, try to determine what prevented their escape (such as gravel cementing or slot blockage by silt).

8. Open the incubator lid flap, and count the dead eggs there, or empty it onto a dark-colored pan and count the dead eggs. A lump of fungus and eggs can be separated for more accurate counting. Dead whole eggs will testify to the box's hatching performance when compared to the number it was charged with.

9. Also note the dead egg sac fry present, and try to evaluate the nature of their death if excessive numbers are present (more than 10%). I have observed a natural egg and sac fry mortality that is not related to WVB conditions. This usually runs 3 to 10% of total egg count.

10. The anchors should be removed; and then the WVBs may be unfolded by placing a flat knife blade into the slits and prying; the boxes can be cleaned on the spot or carried back home for cleaning. Dead eggs and fry can be put into a sealed container if further inspection and study is desired. Odor will be unpleasant, so be prepared to take precautions against this.
PLANTING THE WVB IN STANDING WATER

The WVB will, if carefully implanted in standing or sluggish waters, incubate trout or salmon eggs. Until the development of this system, standing waters were not generally used for hatching these eggs either in hatcheries or in the wild. I was often told that trout eggs would not hatch in anything but fast flowing water.

The problem was having eggs cleanly exposed to water that contained ample oxygen. The solution is to elevate the eggs out of the subsurface gravels where circulation is very poor to above the lake floor where water and oxygen are sufficient. By using the improved WVB incubator system and only one or two layers of eggs in the incubator, and by placing the WVB in a mound of gravel above the lake floor, incubation can be accomplished. This was tested, first in still water aquariums, and later in standing water sloughs, ponds, and small lakes. Test results were excellent, pointing to particular methods and places that would hatch the eggs and allow egg sac fry to develop. In some test circumstances, all the eggs died, and in other tests, all hatched. Method and area placement were found to be most critical. It was also found that sac fry assisted greatly in desilting the box and providing circulation as they moved about the nursery.

BEST AREAS TO PLACE WVB IN STANDING WATER

The WVB must be placed in shallow water so that swimup fry leaving the nursery and protective mound can reach the surface to inflate their swim bladders. There is a limit to the distance they can or should cover. More than two or three feet is too great a distance for most of them, and it over exposes them to swimming predators. Most standing waters suitable for, or already harboring, salmonoids have shallow areas that receive good water circulation and have clean bottoms. These are the areas in which the WVB will be most successful:

1. Where wave actions and temperature changes move the water
2. In front of small tributaries
3. Near or over shallow water springs. (Caution: some springs do not have a suitable content of oxygen or have other gases that are harmful for fish life support. If there is doubt and lack of life in the area, cage a fish in the water for a few days, or better still, collect a sample and have it analyzed.)

4. Shallow shoreline flats. These areas are most likely to freeze solid; make sure this is not a common occurrence during WVB incubation.
5. In front of spillways or other outlet areas
6. Inlet areas

When placing WVBs in lakes or streams, give consideration to the possibility of molesting by vandals, foraging animals, cattle crossing, and the like. Each area will have particular dangers.

Just as planting the WVB in flowing streams and waters poses problems, planting them in any standing waters will present unique situations with which you will need to cope. Developing new, successful systems or modifying the ones described will serve to expand the practical application of this program. I cannot emphasize this point or encourage you too much to use your own common sense and faculties to apply the WVB to your waters. Although a site may seem relatively solid underfoot, it may not be uniformly so, causing the gravel pyramid to settle irregularly and to disintegrate, which will expose the WVB to light rays. It is desirable to pre-select the sites and test pyramids on them. When charged WVBs are to be set, the top gravels may be removed into buckets, the WVB placed, and the gravels re-used for covering.

STEPS FOR PLANTING WVB IN STANDING WATERS

Planting WVBs in standing water requires the same basic equipment that is listed for flowing waters. However, you will not be doing so much digging, but will be moving, clearing, and mounding gravel. Tagging boxes and recording data are extremely important!

1. Essentially the water should be no more than 12" to 24" deep, with a 6' to 10' clearing made on the bottom. This means removing aquatic moss, silt, large rocks, logs, and the like. A garden rake is usually ideal for this purpose.

2. Allow the water to clear up after working the area. This takes a few minutes, so during this wait you could also prepare one or more other WVB planting areas.
3. Lay a bed layer of sized gravel that extends some 6" or 8" above the bottom and is 4' or more in diameter in the center of the cleared bed.

4. Place the WVB with the anchor attached to the bottom in the center of the gravel bed, holding it in position with the WVB placement tool. Make sure the WVB is resting upright, level, and solidly on the base gravel.

5. Pour and place more sized gravel over the WVB, forming a mound that covers the WVB at least 4" to 6" and extends to the full diameter of the gravel base bed.

6. Carefully release and remove the placement tool. Set the locator line and anchor just to the outside of the bed. Cover with the same gravel. When the water clears, use the glass bottom bucket to check if the WVB is completely covered and concealed in the mound. If not, add or reposition the gravel. The WVB must be out of direct sunlight and inside the mound shading far enough to be concealed from algae growth on walls.

The WVB can be placed in three-foot diameter chicken wire of 1/2" hardware cloth cyclos with bottoms instead of the open mounds just described. These are considerably more expensive, of course, but are more reliable in maintaining the condition of the gravel and WVB. Cyclos are reusable. Larger cyclos can be made and several boxes put into each, provided the WVBs are not put too far inside them to drastically inhibit water circulation.

**WVB Cyclo**

**RECOVERY OF WVB IN STANDING WATER**

The WVB planted in standing water should be carefully observed during incubation and fry fry development just as described in the flowing water section.

Once the swimup fry are out of the WVB boxes and leaving the mounds, the WVB should be recovered. Use the same general recovery and observation procedures discussed for the flowing water method.

Success and results will normally be more variable in still rather than flowing water, and close observations and records are more critical to future WVB plants in the same area.

**OTHER FLOWING WATER WVB PLANTING METHODS**

A large number of flowing waters have bottom makeups or water conditions that do not ideally suit the standard implemetation of WVBs under natural gravel redds. Here are some you may encounter with suggested WVB placement methods.

1. Sluggish or even-flowing canals, ditches or raceways below lake outlets. Method: Form a diamond-shaped gravel base of 1/2" to 2" diameter stones at least 4' long, 2' wide and 3' to 6" deep. Place the WVB in the middle and cover the box with more gravel to mound around and above, approximately 6" to 12". Make sure the WVB is level and broadside to the current flow.

2. Streams that have hard clay or bedrock bottoms swept clean of gravels. Method: Build a diamond-shaped, 1/2" hardware or 1" chicken wire cage - 4' long, 30" wide, and 10" to 12" deep. Fill half full of 1/2" to 2" gravel, place WVB in middle, and cover over the top of the cage with more gravel. No wire top is necessary though a bottom wire is needed to hold position on bottom.

3. Sand or sand-silt bottom streams. Often with same materials suspended in flow. Method: This is an extremely difficult problem to cope with. Place the WVB in a gravel mound in shallow, rapid flowing water. Just over the top of the box place a 12" by 12"
The present problem with such a scheme is to design a unique gabion that will not create a conflict with the natural stream flow or create a silt, sand and plant particle trap or blockage. Such practical hydrodynamic designs are now being researched and tested. We would like any ideas or comments, or experiences you may have on this subject in order to expedite this new application.

A limited amount of testing has been done using molded plastic milk case boxes designed to be used as a semi-gabion device. Ben Williams who first tried them on spring tributaries of the South Fork of the Rio Grande in Colorado feels they would enable WVB plants in areas where freezing weather and water make the usual methods unpleasant or impractical.

The WVBs, one or more, are placed in the box over several inches of sized gravel and covered by several more inches to fill the case. Then the case is nested on the stream bottom. Its excessive weight holds it in place.

The main drawback to such a neat, simple method is one of obstruction of the mainstream flow in anything but a low gradient small stream such as a spring creek, flow controlled outlet, or irrigation ditch. Practicability and new procedures are being tested for application in larger streams and rivers.

ARTIFICIAL WVB AREAS

The use of large wire cage gabion-like structures show great promise as temporary or permanent artificial WVB planting sites where little or no natural streambed gravels suitable for natural spawn or WVB egg incubation occur. Such structures could be loaded with sized gravels and reasonably accommodate one to a dozen WVBs.
While promoting the original VB system, I was regularly asked if there was a way you could tell which fish were from the Vibert Boxes and which from other sources - especially where natural reproduction existed or stocking of fry was being done. The Project Indicator was developed to provide one means of assessing the WVB and VB plant stocking contribution.

By using eggs from “exotic to the water” salmonoids in the WVB, a unique indicator fish can be provided. These indicator fish can be recovered by shocking, drags, or seining, as well as by underwater observation and actual fishing. Unless large numbers of indicator fish eggs are used, it is most desirable that test sampling take place during the fry or fingerling growth stages. Indicator fish should be chosen carefully so as not to introduce an unwanted, temporary or resident population. Sterile hybrids or fish that migrate or albino strains are most ideal. If salmon were used in a far inland water trout stream, they would self-destruct as they moved downstream to warmer river areas or lakes and so forth. Tiger trout - a durable, beautiful sterile hybrid of brown and brook trout - make an ideal, but expensive, choice for most trout streams with various pure-bred trout, i.e. rainbow, cutthroat, browns. Tigers are easy to identify, very resident, durable to water environmental extremes, provide an added fishing bonus, and will not interbreed with other fish.

This is a list of fish that can be used as indicators for specific situations:

1. Tiger trout (hybrid brook/brown) for use in any trout or salmon stream.

2. Pacific salmon - inland trout streams that do not empty into large bodies of cold water.

3. Atlantic salmon - for use in Pacific salmon waters and/or inland freshwater trout streams that do not end in large bodies of cold water.

4. Virginia golden rainbows - in trout streams that have rainbows, browns, and brooks.

5. Steelhead - in brown or brook trout streams that do not empty into larger cold water rivers or lakes or oceans.

6. Lake trout - for small rainbow, cutthroat, or brown trout streams, that do not empty into larger cold water rivers or lakes.

There are other trout, salmon, and char hybrids that can be used as indicators in specific programs. It must be remembered that the indicator fish is chiefly to prove WVB effectiveness, not necessarily to provide stock in large numbers. Use an indicator fish that does not represent an objectional influence, character, or number on a fishery.

Testing sampling is most reliable when all indicators are fry or fingerlings, as they may move out or lack ability, because of their species, to cope with the stream’s specific environment very long. Remember also that most natural hatching wild-water stocking results in less than 10% of the eggs becoming free swimming fry, and usually the number is more like 4 to 7%.

Salmon and steelhead exhibit the most significant fry survival of all fish I tested. Tiger trout were lowest; only 15 to 20% of the eggs produced fry due to hybridization deformity and an inherent yolk sac white-spot disease.

If you are laying your WVB future on the line with an indicator project, be sure to use enough eggs and to test sample fish produced as soon as practical to assure success.
GLASS BOTTOM BUCKET

If the water is clear enough to see the bottom in WVB plant areas, a glass bottom bucket is extremely helpful in all underwater operations discussed. It is a very simple and economical tool to make. Each team should have one. One or two extras should be on hand in case of loss or breakage.

Use a small or medium size dark colored plastic waste can with a top larger than your head. Cut the bottom out with a sharp, heavy knife. Measure the diameter approximately 2" or 3" above the bottom opening. Have a piece of 3/8" window or auto glass cut to that diameter.

Place glass in the bucket, and cement both edges of glass with Dow Corning Silicone Rubber Aquarium Cement. Allow to set 48 hours.

The glass bottom of bucket will have a 2" or 3" recess from the actual bottom of the walls. This will protect the glass from most scratching or breakage in use. Cut a 1/2" hole in this protective wall so the air trapped between the glass bottom and the wall can vent out for total water-to-glass contact while in use. (See diagram)

In use, the glass bottom bucket is held with the glass bottom just submerged. Bend your head inside the bucket mouth. This shuts out light and reflection on the glass and makes it easy to see beneath darker water for observation of all things of interest concerned with subsurface WVB work.

WVB PLACEMENT TOOL

Since hands immersed in icy water and battered by the pouring of gravels while holding a WVB in position in a redd are uncomfortable, a mechanical means of positioning WVBs is helpful. A simple device is a stout stick, 4' long with a 6" fork at the end. The fork is placed over the locator line at its juncture with the front of the WVB. When the locator line is drawn tightly up the shaft, it holds the WVB firmly against the fork. Held thus, it can be positioned in the redd and the gravels poured over it. It is sometimes difficult, after releasing tension on the locator cord, to remove the stick without disturbing the WVB position and gravel. To overcome this, we used, in our experimental work, an inexpensive frog gig mounted on a broom handle. The gig tine barbs were pressed flat against the tines, and the tines spread like an open hand to better cradle the box. The small tines are easily removed from the gravel without disturbing the set. In some areas frog gigs are illegal; however, substitutes should be easily obtainable.

One group reported the acme in such devices. They used a mechanical device designed to remove small packages from high shelves.

WVB LOCATOR

In order to find and/or recover the WVB, a simple locator line and shallow gravel anchor is used. A 3' to 4' length of 20-pound test leadcore trolling line is tied...
to the center of one of the WVB broad sides at assembly time, or clipped to the side just before the WVB is put into the next area. Leadcore is easier to manage and will hold tight to the bottom. If leadcore is not available, use a strong section of fishing line or cord.

Attach a simple horseshoe-shaped piece of clothes hanger or small concrete anchor to the other end of the locator line. This is to anchor the line extended along the top of just beneath the streambed. The locator line is later picked up by a gaff hook in locate-and-recovery procedures.

Whitlock Vibert Box with Anchor Hook

WVB ANCHOR

The WVB must be held firmly in a specific stationary spot with as level a position as possible when planted in any type of water. The WVB must also be found and recovered at the conclusion of a stocking function for hatch evaluation data and reuse. There are several attachments to be used to anchor, hold, locate, and recover each box.

A simple, economical anchor design is included here. It does not interfere with box assembly, loading, or transporting, but is attached to the WVB just before it is put in the water. It makes the WVB heavier than water, holds it on the base of the nest, and prevents it from freely washing away should cover gravels be lost from it.

Anchors can be made from plastic egg cartons. Fill the bottom of each compartment with 1/4" of sand. Finish filling each compartment with concrete composed of equal parts of portland cement and sand, using sufficient water to make a pourable slurry. Immediately insert the anchor wire vertically with the ends extending 1/2" above the surface of the slurry.

To make anchor wires, obtain lengths of soft steel wire from any crafts shop that stocks it for use as artificial flower stems. They carry different diameters; some is covered, some is bare. You will need bare wire with a diameter just slightly less than that of a "fine" mechanical pencil lead.

Cut the wire into 5" lengths. Fold back the last 3/8" of each end flat against the main wire, but with the tips protruding slightly to form a barb. The desired effect is for the folded area to pass through the square holes of the WVB bottom, but for the "barb" to prevent return passage. When this folding is done, the overall length of the wire is 4 1/4".

From this wire form and open end rectangle 1 5/8" x 1" x 1 5/8".

Let the anchors set 48 hours. Then remove from the carton and brush loose sand from the relatively flat anchor bottoms. Fold the wires down on the anchor surface until ready for use. This facilitates carrying to the redd site.

At the redd site, the wires are straightened up, and the tips are forced through the square holes, approximately centering the anchor under the box. If the barbs have entered the WVB nursery, the anchor will not fall off.

Remove the anchor when the WVB is salvaged and opened. The wire tips are pressed against the main wire and forced out the hole.

In many streams more anchor weight is useful to hold the WVB stationary, especially if the current speed and turbulence is great or highly variable because of rainy seasons, tailwater releases, or snow runoff. Make larger anchors from plastic margarine bowls or plastic cocktail glass molds.