

A Simple and Inexpensive Apparatus for Providing Natural Prey in a Laboratory Environment

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Abstract.—We present instructions for an inexpensive feeding apparatus for use in simulated (laboratory) aquatic environments where natural prey is required. We used this apparatus during juvenile salmonid competition trials where it was essential to provide real prey in as natural a manner as possible. We found that this apparatus not only outperformed commercially available feeders (which could not satisfy our research requirements) but could also be built for a fraction of the cost.

The study of fish in simulated natural habitats in the laboratory is effective but can be difficult and expensive. It is especially challenging to simulate in the laboratory natural prey availability. Our research is focused on describing the invasion potential in coastal British Columbia rivers of Atlantic salmon *Salmo salar* that have escaped from aquaculture. We conducted a series of experiments in laboratory stream channels built specifically to simulate natural salmonid rearing habitat to quantify the relative competitive ability of juvenile Atlantic salmon under various conditions in sympatry with wild native Pacific salmonids of similar ages. We identified two major problems with commercially available feeders for our purposes: the invariable feeding pattern and the restriction to commercially prepared feed. We required a feeding apparatus to provide natural prey items in a continuous but unpredictable manner. Our review of the literature suggests that a simple and inexpensive alternative has not been developed. Here we present instructions for building such a feeder designed to provide a supply of live, fresh, or frozen prey with a minimum investment of money and time (Figure 1).

The feeder is quite simple and resembles an upwelling egg incubator. Prey items are added

through the stoppered hole in the lid of the bucket. (If feeders are used indoors lids may not be necessary.) Prey items are kept suspended in the main body of the feeder by bubbles from an air stone. The volume of air required to keep prey suspended increases with prey density. Air pressure can be conserved through the use of an air ring (distributing turbulence more evenly) in the bottom of the bucket in place of the single stone shown in Figure 1. We used air from a dedicated compressor, so pressure was not a limiting factor. A second air stone in the feeding tube creates an upwelling of water, air, and feed for delivery.

The rate at which feed is delivered is controlled by three variables. The amount of water through the feeder ball valve, the magnitude of upwelling (air supply) through the feeding tube and the position of the air stone in the feed tube. Increasing the former two variables increases delivery rate, as does positioning the outflow air stone nearer to the bottom of the tube. Additionally, the size and density of the prey items effect delivery rate. These combined variables make it difficult to define a simple prey delivery curve or equation, and thus optimum operation is likely to be different for each user. For instance, by reducing water flow supplied to the feeder, the equilibrium water level drops, along with the volume of water moving through the outflow tube. However, the reduced flow rate is offset somewhat by the resultant increase of prey density in the bucket (a result of the drop in water level). The net change in feed rate then will depend in part on the ratio of biomass volume to total volume in the bucket, as well as the rate of water flow through the system. An alternative method to reduce delivery rate would be to raise the position of the outflow tube air stone (reducing upwelling rate) and reduce the water flow into the system (to account for reduced outflow). The flexibility of the system is also its most

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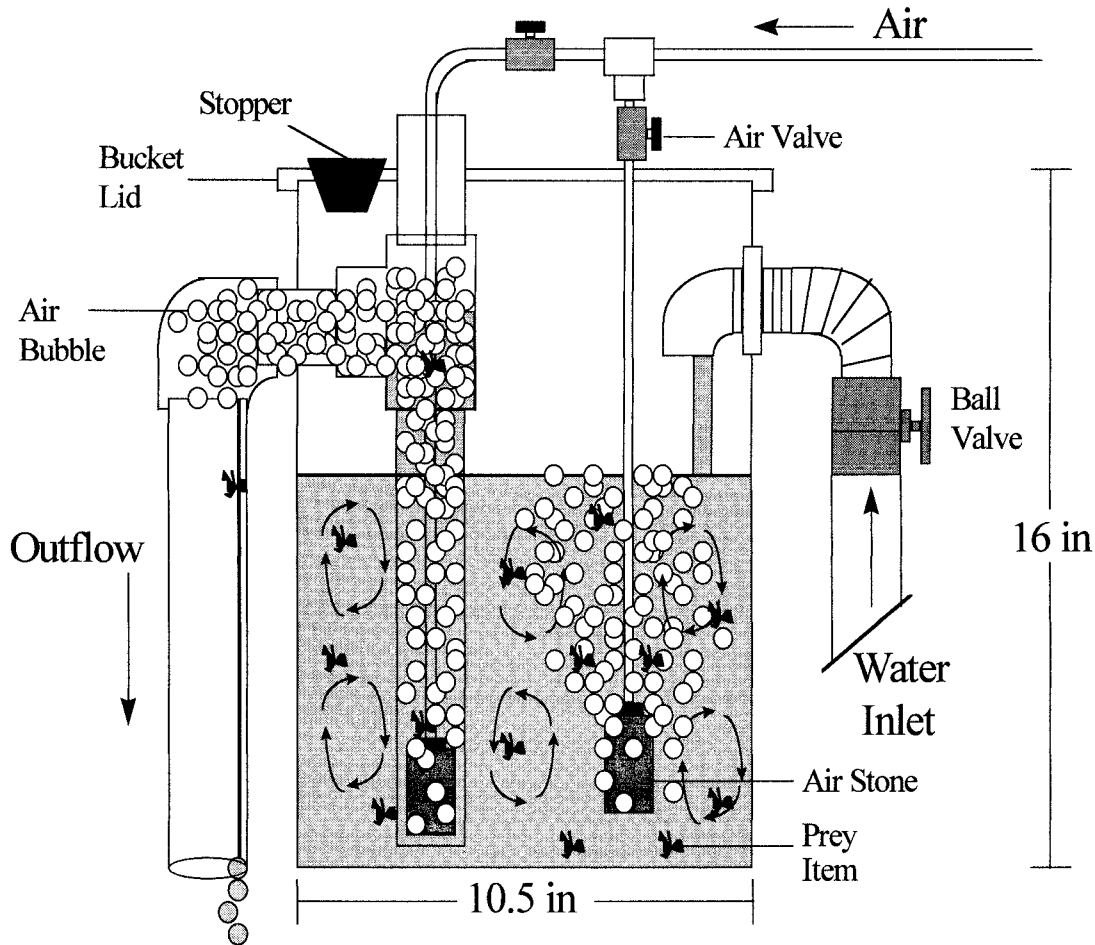


FIGURE 1.—Schematic cutaway of the feeder apparatus. Feeder shown here is based on a common 5-gal (19-L) bucket. Construction may be scaled up or down dependent on needs.

significant drawback; optimum operation is only likely after some “trial and error.” However, once the optimal settings of water flow, air pressure, and air stone position are identified for a given system (i.e., for particular prey items, air source, etc.), the settings can be recorded and remain stable. After an initial optimization period of 2 d, our feeders needed only minor adjustment at the start of each 2-week-long experiment, during which time no adjustments were required.

A variety of prey items may be combined in a single feeder. Operation will be most straightforward if all prey types are of approximately equal density. If there is a significant difference in densities among prey, water turbulence in the bucket should be great enough to suspend the prey item furthest from neutral buoyancy. It is unlikely we could have run our feeders using a standard aquar-

ium air pump; the turbulence generated would have been inadequate to keep our prey in a homogenous 5-gal (19-L) suspension. Two alternatives are possible, the first is to scale the entire system down. Alternatively, prey could be added to the buckets in frozen blocks. As the de-chlorinated ice melts, prey are liberated slowly to the surrounding water thus reducing the need for strong turbulence.

A potential problem with this system is that the prey delivery rate is highest when feed is first added and declines over time. The only way to ensure a linear feed delivery curve (constant rate of delivery regardless of prey concentration remaining in feeder) is to manually adjust the feeder over the appropriate period of time (slowly lowering outflow air stone to increase upwelling over time) or manipulate feed availability (freezing into ice blocks). We used the nonlinear delivery rate to our

advantage to simulate diel fluctuations in forage availability. Prey were added to the feeders during peak availability, in our case chironomid larvae and *Daphnia* spp. at dawn and dusk. The slow dilution of prey (7 h) in the feeders actually enhanced our simulation of natural conditions.

A major advantage to using this system is its price. We assembled a series of these feeders for use in simulated stream channels for less than Can\$22.00 (approximately US\$15.00). Each unit requires only 20 min assembly time. The feeders performed well, and the ability to provide natural drift prey during our experiments allowed us to model a much more realistic natural environment for our research.

Materials List

All 0.5-in (1.3-cm) polyvinyl chloride (PVC) materials are for the inlet water assembly; all 1.5-in (3.8-cm) PVC materials are for the outflow assembly. Needed materials are as follows:

- 1 5-gal (19-L) bucket,
- 1 T-joint (for air tubing),
- 1 1.5-in (3.8-cm) 90° PVC elbow,

- 2 0.5-in (1.3-cm) 90° PVC elbow,
- 1 1.5-in (3.8-cm) PVC T-joint,
- 1 ball valve (0.5-in [1.3-cm] fitting),
- 2 air control valves,
- 1 0.5-in (1.3-cm) through-hull fitting,
- 1 rubber stopper,
- 2 air stones,
- 1.5-in (3.8-cm) PVC pipe,
- Nalgene 0.25-in (inside diameter; 0.6-cm) premium tubing (nontoxic, autoclavable),
- 0.5-in (1.3-cm) flexible PVC tubing (Pac Echo SP1069 B.R.Z.) for water inlet,
- PVC glue,
- tools: saw for tubing, drill and bits, (air and water source).

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