AN EFFECTIVE INEXPENSIVE TRAP FOR UPSTREAM-MIGRATING FISH AND OTHER AQUATIC ANIMALS

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ABSTRACT

Trapping is an important field tool in censusing, tagging studies, assessment of recruitment, and in-stream movement. Whilst many traps are known for lentic and downstream-movement situations, few are suitable for organisms moving upstream. This trap for upstream-moving animals is inexpensive, easy to make, easily to transport, install, or remove. It allows caught animals to remain alive for long periods so that the trap can be left unattended for several days, which is is particularly important for investigating periodic or intermittent migrations. The trap is made from readily available materials: plastic jars, plastic mosquito screen, and hot-melt glue; the materials cost per trap is about $5. The trap has been successfully used with fish (e.g. Gobiidae), decapod shrimps (e.g. Penaeidae, Atyidae), and even an anadromous gastropod (Mollusca: Neritidae). Simple additions would enable sequential samples over time to be automatically separated.

INTRODUCTION

Traps are a key element of field sampling, but design needs to accommodate both the intention and the environment. For example, some waters near reefs are not amenable to trawling and alternative approaches are needed to obtain samples (Doherty 1987). Similarly, many taxa , including fish (e.g. Gobiidae, Eleotridae), decapod shrimps (e.g. Penaeidae, Atyidae), and even an diadromous gastropod (Mollusca: Neritidae), migrate upstream at a particular part of their life cycle, but no suitable design was available for efficiently sampling migrants.

Work on recruitment processes of stream gobies (Bell 1994; Bell et al 1995; Bell 1997; Bell et al 1997) required sampling of fish on their upstream migration from the sea into rivers. While various traps, fyke nets, gill-nets, barrier nets, plankton nets, etc. are known in the literature for sampling lotic, lentic or oceanic environments, most for lotic situations are for downstream-moving organisms and there are few solutions for trapping upstream-migrating fish. In principle a fyke net could be installed facing in any direction, but fyke nets are generally too large for use in the typical rivers into which diadromous gobies recruit.

Traditional trapping of upstream-migrant fish is best known from goby fry fisheries

(Bell 1999) which in turn were probably best developed and most sophisticated in the Philippines (Manacop 1953). The traps used are beautifully documented (Montilla 1931) with fascinating diagrams and photographs of the complex devices used in various places in the Philippines to harvest diadromous goby post-larvae migrating from the sea into rivers and upstream. Many of these are handsomely woven bamboo traps in a modular design that fits onto a bamboo or reed fence that is staked into the substrate, and these were a key part of the infrastructure of a commercial fishery that used to yield 20,000 tonnes per year in N. Luzon alone (Manacop 1953). Traditionally (Bell 1999) in Dominica, W.I. goby postlarvae are fished using a 'bag and stones' trap, which is simply a torn mesh bag (fertiliser bag being common) loaded with stones and placed with the open part facing downstream.

I designed a trap that shared features of these traditional traps, but was more portable and less expensive than the Philippine tradition, and easier to operate and more effective than the tradition in Dominica. It also shares features with a fyke net, but differs in having a single stage trap chamber, and in having the wings supported by stones rather than anchors, poles, and frames.

The result was an effective and inexpensive trap for positively-rheotactic animals. The trap was designed to be easy to make, easy to install or remove, and light and portable. Installation and removal require only a few minutes, allowing for brief sampling of rivers that might be only occasionally sampled, or long-term sampling if the trap is left in place. The removable collector system allowed retrieval of the sample out without lifting the entire trap, thus eliminating changes in installation configuration as sources of variation in catch per unit effort. It also turned out to be effective for other taxa including several diadromous crustacea and at least one diadromous gastropod (Neritidae).

The trap was designed (Bell 1994) to keep the sample alive in a chamber with flowing water until removal. The trap is effective because the current flows through it, providing the stimulus for positively rheotactic behaviour, and fish (or crustacea, or snails ...) do not avoid loose stones but seem to prefer them (shelter from predation, perhaps).

The trap consists of a fence module that is installed on the substrate, and a collector jar which attaches to the fence module. The fence module is of made of nylon or plastic mosquito mesh, with angled mesh wings that herd upriver-migrating animals to the center, where they turn upstream and pass through a threaded collector attachment, then through a mesh cone leading inside the collection jar. The collection jar has mesh panels so that water can flow through.

Installation of the fence module takes only a few minutes and consists of ballasting the fence module with large stones, fixing an anchor and safety line. Removal of the fence requires even fewer minutes. The collector jar is installed or removed in seconds. The collector is essentially a self-contained trap itself, so the fish do not spill out when it is removed from the fence part of the trap, and it can be carried to any convenient place to transfer the sample to another container. The collector design allows caught animals to remain alive for long periods so that the trap can be left unattended for several days. Because the trap could be left for long periods, it had the advantage of providing quantifiable catch and effort data over variable times; this is especially useful for species which migrate in unpredicable pulses. This allowed sampling to continue at little expense, even through periods when the artisanal and subsistence fisheries ceased for lack of fish.

Over 18 months, one trap was kept operating as continuously as possible (some people evidently liked the trap well enough to occasionally borrow parts). Over 35,000 gobies (3 species), over 40,000 decapod shrimps (several species), 153 Gobiesocids (probably all the same species), 374 Neritid gastropods, and 79 Thiarid gastropods were caught. Other minor species also were caught; another goby, a few anguillid eels, and a few syngnathids (pipefishes). The trap thus gathered a more complete characterisation of the recruitment periodicity than the fishery which typically discarded the shrimps and did not catch gastropods at all.

Simple modifications would enable sequential samples over time to be automatically separated.

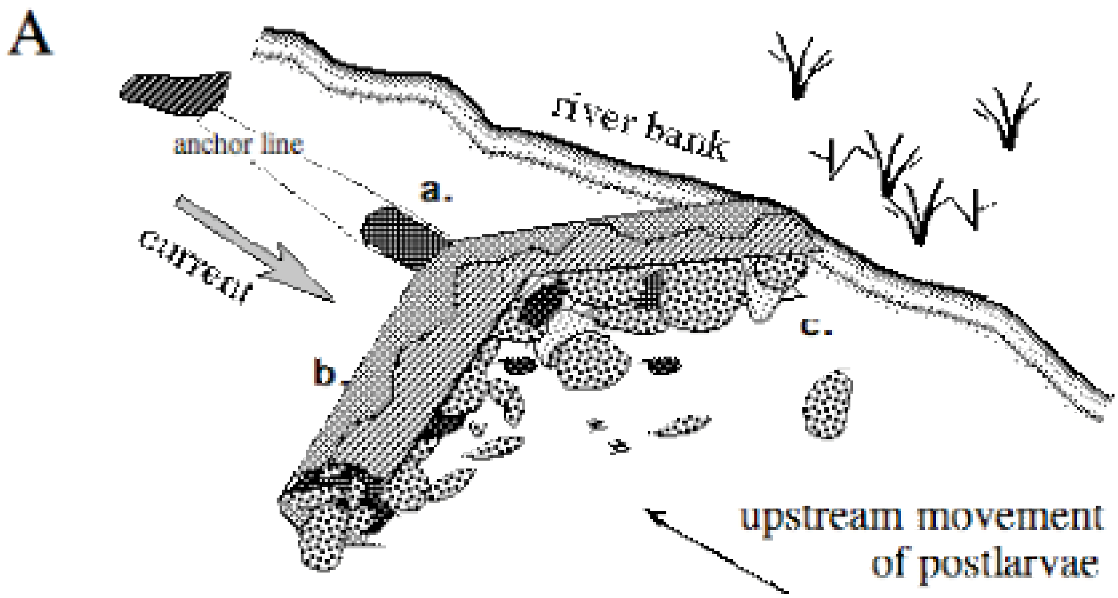

Figure 1. Trap, view as installed in water about 0.3m deep. Main parts are the collector jar (a), fence module (b), and rock ballast (c); stabilising ring (d) is not shown. See Figure 2 for details.

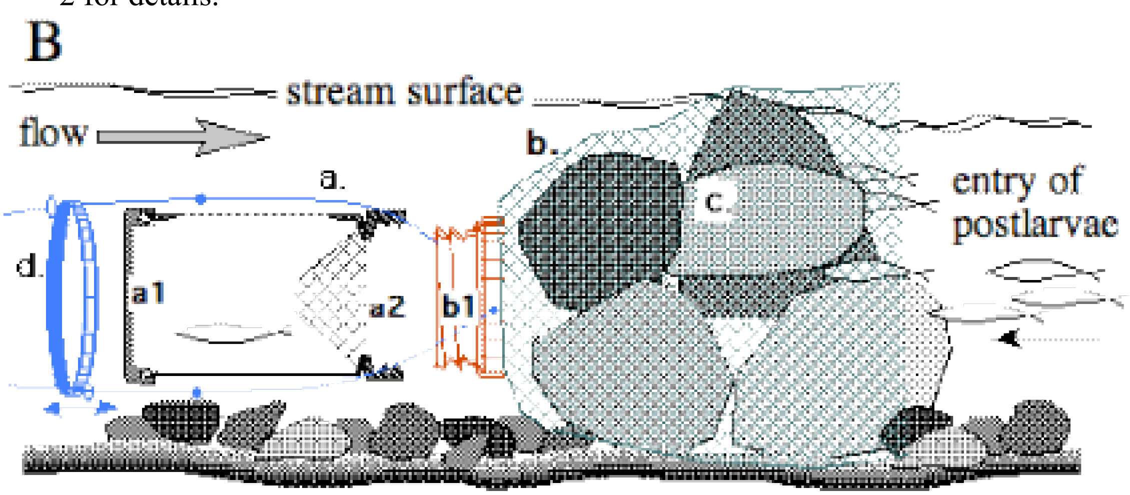

Figure 2. Section through trap. a: **Collector jar** with large screened panels to allow water to flow through. a1: lid (pop-on type shown, but screw-on is easier to get) of collector jar. a2: **Funnel assembly** with **threaded ring** (lid with middle removed, lid coming

from same jar as part b1) that fits collector attachment. b1: **collector attachment** (matching threads on ring a2). b: **Fence assembly** with collector attachment b1.. Fence assembly and wings of trap are installed with large **stones** (c) resting on bottom of mesh to hold it on the bottom, and supporting top of mesh above water level. c: ballast of large stones. d: **stabilising ring** that slides on anchor rope (loop) to stops (dots) that keep it in position around collector jar to keep it straight. **Collector jar** (a) is removed by sliding the **stabilising ring** (d) out of the way (upstream), grasping the collector jar (a) and rotating is to unscrew (a2) from (b1); the sample is accessed by removing the lid (a1).

METHODS

Materials

The main materials are mosquito mesh, and nice large plastic jars. For jars, a good source is pharmacies (bulk pills come in large durable jars), and some foodstuffs (e.g. peanut-butter). The threaded jar top and lid are important components.

To build one trap you will need:

i. 2 large plastic jars. Jar 1 is the openable collector jar with funnel, jar 2 provides a threaded attachment to the wings and the matching ring for the funnel assembly (a2).
ii. 1.5 m X 1.0 m of sturdy plastic mosquito mesh (1 to 2 mm mesh size is typical)
iii. poly or nylon rope to anchor the collector jar to a point upstream so it is oriented into the current rather than letting the current fold it over. It's also a good idea to also have a safety rope to something on shore so you don't lose your trap in a sudden flood.
iv. extra pieces of plastic jar, or pipe, for stabilising ring etc.
v. hot melt glue
vi. (advisable for durability) synthetic string for binding and reinforcing joint of mosquito fabric to collector attachment.
viii. newspaper for work surface.

tools:

i. hot-melt glue gun (with hi/lo setting is better)
ii. scissors, knife, awl or drill or knife point for making small holes in plastic jars, cutting out lids, etc.

Making the parts

FENCE MODULE

Between 1.0 to 1.0 m total width of trap seems to be good, though I have made them smaller. The wings are angled (as viewed from above) about 20-30 degrees. Too small an angle, with the inevitable irregularity in the shape as installed, will interfere with the smooth movement of the fish toward the funnel.

Mosquito screening (fibreglass reinforced plastic mesh) typically comes on a roll about 1m wide. For a 1.5m wide trap, cut that much screening, and the collector attachment (the upper 6-10 cm of a plastic jar, the lid of which will be used to attach the collector jar, see Figure B) will be mounted in the center (vertically and horizontally). To attach mesh to the collector attachment, do not cut a hole in the mesh but instead mark the center and make a series of short cuts, equal to the diameter of the jar, across the center. The jar portion will slip through and the flaps of mesh will be easy to glue to it, but there will be a tendency for it to peel away near the ends of the cuts; so, once you have it initially glued in place, bind a few turns of nylon string around it at that point and secure them with glue. This will make a durable joint that won't 'leak fish'.

The collector attachment is also a good place to secure [a] your safety line which will be tied to some object on shore, and [b] the anchor loop which will be secured to a heavy stone upstream.

To make the angle in the fence, do a little tailoring: above and below the collector attachment, make a cut about 2/3 the way from the edge to the collector attachment. Make the parts overlap by about 20-30° and fasten with HMG.

Tears and holes in mesh are easily patched using scraps and HMG.

Collector jar

As in Figure B, the collector jar will be a large (0.5 to 1 L) plastic jar. If it is too small, it can get overfilled quickly, and if it is too large, it is difficult to grip and rotate when attaching or detaching from the wing assembly (a very large jar might require a special jar wrench to be made, or a different kind of attachment to the fence module, etc.).

Cut panels out of the side (about 50% of the circumference) and replace with mesh so water can circulate and also maintain a flow downstream through the trap (the fish you want to catch are positively rheotactic). If you find this weakens the jar too much, you can strengthen the remaining portion of the jar wall by gluing more material onto it. Remove most of the bottom of the jar, but not the edge, where the funnel assembly (a2 in Figure 2) will attach. Don't lose the lid (a1 in Figure 2).

Make a mesh cone for the funnel assembly (a2 in Figure 2) with an opening that you should make small initially (5 mm) and enlarge it only as needed with scissors. It doesn't need to be large, and keeping it small is best if you want to exclude predators that might eat some of your catch. It's a good idea to reinforce the funnel by gluing on a few straight strips of rigid plastic, and possibly a small ring of rigid plastic (cut from a small bottle, or simply use a heavy bead of HMG) about 2/3 the way to the small opening, because an unsupported cone can turn inside out in a strong current, and that could release fish.

Find the jar lid that matches the threads of the collector attachment (b1 in Figure 2) that is glued to the fence part. Cut almost all the center out of it to make a threaded ring. Glue the cone to the threaded ring, as in Figure 2. Finally, glue the ring-and-cone assembly to the jar base (of which the center was already cut out).

Finishing

Add a looped anchor rope. Ideally the loop is threaded through two little holes on opposite sides of a sliding collar (part d in Figure 2) made of a piece of pipe, or piece of jar, etc., that is slightly larger in diameter than the collector jar. The little holes let the anchor rope slide until the collar reaches knots that keep the collar in a useful position to support the collector jar, and prevent it from being washed sideways, folding into the fence portion, and losing effectiveness. Fasten the downstream ends of the anchor loop securely to the fence module, e.g. by passing them through a small hole in the collector attachment, then knotting and gluing on the inside. Also add a safety rope (not shown) fastened to some point on the shore, so that if there is a flood the trap might not be lost.

Tool and technique tips:

Adhesive: hot-melt glue [HMG], a thermoplastic that is typically used with an electric device that heats it and extrudes melted glue. The brown-coloured “heavy duty” HMG is better (and cheaper) than the pale softer kind. It sticks quite well to smooth plastic, but roughening the surface probably helps. HMG adheres excellently to plastic mesh (mosquito screen or Nitex™; I never had a failure). In-field repairs are often possible with a disposable butane lighter, either directly or using it to heat a piece of metal.

The strength of joints made with hot-melt glue is determined by the surface area covered and the cleanness and suitability of materials to be joined. Butt joints of cylindrical parts can be made strong enough by gluing fabric, either mosquito mesh or scraps of nylon mesh, on either the inside or outside. Fiberglass/plastic mosquito mesh is suitable for the mesh wings, funnel, and collector jar panels, and for reinforcement of glued joints that will experience high stress.

Take extra care to lay on a good contact area when gluing screen to hard plastic like jar parts; if possible, first glue and then use a lashing of nylon twine or plastic packing strap (that will ensure that the screen can only come off by shearing which requires a lot of force, as opposed to peeling which requires much less). A piece of cold metal is handy for quick-cooling joints (I'm not very patient). The HMG is pretty good, but on a small area it can easily let go.

The most convenient way to make parts removable is a screw thread. Suitable plastic lids and jars from household foodstuffs are easily obtained for free. A lid with the center removed, and its jar with the bottom half removed, make a good connection system.

Avoid sticking work to the work surface: when gluing layers of screen together, work on top of newspaper; a little paper will remain on the glue joint for a while, but that is okay.

CAUTION and FIRST AID: HMG can give surprisingly nasty burns (because it's hot and it sticks — it is not called hot glue for nothing), so when working with it always keep a bowl of cold water to cool it fast. Dry sugar thrown liberally on a wet area of skin that's just been burned will dramatically reduce blistering. Pour the dry sugar onto wet/moist skin and leave it until it dries off. Search me why it works, I discovered it by accident. Prof. Bill Threlfall said he seemed to remember sugar was used in this way in the first world war.

Installing the trap

Installation takes just a few minutes. Situate the trap in 0.2-0.3 m water depth, but not water deep enough to flow completely over the fence. I usually placed it at the river bank. Keeping the threaded collector attachment facing upstream, clear the space and lay out the fence module almost flat using a few temporary stones. Bury the bottom/downstream edge into the substrate with fine material so fish will not be able to go underneath the trap, then place heavy boulders on the downstream half of the fence mesh. When you have a wall of stones covering 1/3 to 1/2 of the width (upstream-downstream direction), and high enough to support the mesh above the water surface, release the temporary stones and fold the fence over the wall of stones. Stones used should be large enough to leave large gaps through which the fish can pass easily. If the top of the fence module is below water, ensure that the water flow keeps it trailing downstream, and consider fixing floats to the trailing mesh edge. When installed, each wing should be angled with respect to the current so that positively rheotactic fish will be guided to the upstream outlet.

Once the wings are installed and ballasted, fix the anchor line to some point upstream, with enough tension to help keep folds out of the wings (folds may retard the progress of fish toward the collector jar). The anchor line can be fastened indirectly to points on shore to reduce the chance of losing the trap in a freshet. The collector jar can then be screwed onto the collector attachment to begin sampling. The stabilising ring is then positioned to prevent the jar being pushed sideways and downcurrent (this would cause a fold in the fabric of the wing assembly and reduce trap effectiveness). In sunny areas a flat stone (supported on other stones) above the collector jar may reduce activity in the captured fish.

If the trap is installed for long periods, it may occasionally be necessary to remove leaves, silt and debris from the wing meshes, and to clean the panels on the collector jar.

If a wider trap is needed temporarily, wings can be extended outward by extra pieces of plain mesh overlapping on the inside or downstream side.

Options and variants

There are many ways of arranging the parts; what is shown here is just one example. The collector jar can be varied in size or configuration; the anchor rope can be made attached directly to the collector jar (quicker to make than the stabilising ring); the collector jar can be made with the funnel assembly on the openable lid of the collector jar, instead of at the opposite end; etc. The fence module can be tailored somewhat to provide for an angle of about 20-30° so each wing guides fish to the central collector attachment, as most traps were made, or that tailoring can be omitted if a little more trouble is taken in installation.

To automate the separation of samples over time, an interchange could be installed in the upstream outlet of the wing assembly, so that several gated collector jars could be accessed as the gates opened, or moved, sequentially.

Responsible use of the trap

Whenever possible, gather your data and then release the fish, especially for the larger ones. Un-necessarily taking older Sicydiine gobies is irresponsible because they seem to be very slow-growing, and a 50-mm fish might be several years old (e.g. fish in captivity grew very slowly after becoming adults, and one fish in captivity is, as of 2006, 16 years old and only 67 mm SL) — in fact the maximum size of fish in a location is probably an indication of when the location was last poisoned. Archive your specimens and otoliths (preserve dry or buffered, no formalin).

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