

Low Cost Light Traps for Coral Reef Fishery Research and Sustainable Ornamental Fisheries

M. Watson, R. Power, S. Simpson and J.L. Munro

Abstract

Two relatively inexpensive light traps to capture pre-settling reef fish and invertebrates are described. A trap made from a plastic bucket (with plastic bottles, a small plastic waste bin and two sheets of plywood) that costs US\$15 appears to be just as effective as a large aluminium and plexiglass trap that costs US\$275.

Introduction

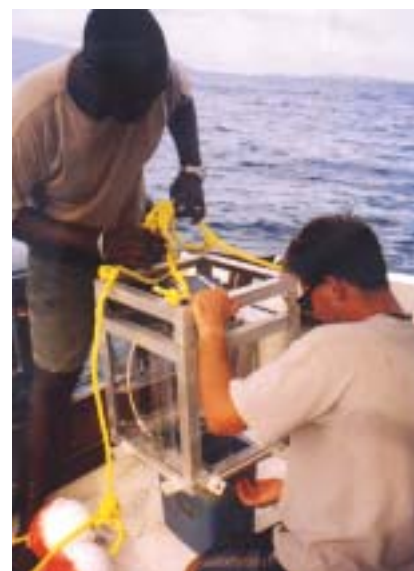
Almost without exception, coral reef fish spend the first few weeks of life as pelagic larvae. For reasons that are not yet fully understood, many aquatic organisms, including coral reef fish larvae, are attracted to light. Light traps can selectively sample older larvae (Doherty 1987, Choat et al. 1993), and have proved valuable in assessing spatial and temporal patterns of recruitment. Light traps are generally regarded as expensive research equipment, but they also have more practical applications. They can provide a sustainable alternative to destructive fishing practices in the aquarium fish trade and offer a way of collecting juvenile reef fish for stock enhancement (Doherty 1994, Watson et al. 2000). However, cost is an issue. The design originally popularized for reef fish by Doherty (1987) costs approximately US\$3000 and would prove prohibitively expensive for any project requiring a large number of traps. Various researchers have produced cheaper versions, either for sampling very small freshwater fish and invertebrates (Faber 1981, Floyd et al. 1984, Ponton 1994), marine invertebrates (Holmes and O'Connor 1988) or marine fish (Riley and Holt 1993, Brogan 1994, Sponaugle and Cowen 1996,

Stobutzki and Bellwood 1997, Hernandez pers. comm.). ICLARM - The World Fish Center's recruitment monitoring project in the Caribbean has received numerous queries about how light traps are designed and built. In this article, we describe one low cost and one minimal cost light trap modified from published designs. Detailed construction diagrams are provided. Costs, where given, are intended only as a rough estimate, since they will vary geographically.

Design of Light Source

Creating a waterproof electrical light source at reasonable cost is the main challenge for designing light traps. Although Holmes and O'Connor (1988) had some success in catching invertebrates using chemoluminescence, our research found that white 'glow sticks' caught negligible numbers of reef fish. Small, low-power incandescent bulbs may be suitable for some applications (e.g., Floyd et al. 1984) but are unlikely to be powerful enough for reef fish. Traps tested during the present study were fitted with a modular light source constructed from readily available components. Our light unit, including batteries, all circuitry and components, cost approximately US\$85.

The separate light unit made recharging and repairs relatively straightforward. Early attempts to build a plexiglass (also called perspex) housing on top of a trap modified from designs by Stobutzki (Stobutzki and Bellwood 1997; Stobutzki pers. comm.) were abandoned due to leaks at the many joints. Electronics were therefore housed in a plastic box approximately 22.5 x 16 x 9 cm manufactured as a diver's dry box. The box was made by Pelican or Underwater Kinetics. The box comes with an O-ring seal around the lid, which we coated in silicon grease and kept shut tight with hose clamps. The box costs approximately US\$20. The



Setting up a light trap to catch pre-settlement reef fish

electronics were taken from 12V fluorescent cabin lights commonly sold in yacht chandlers or available by mail order. These lights come complete with circuit board and ballast and cost around US\$18. The 30.5 cm (12 inch) bulb was sealed into clear vinyl hose available from marine suppliers and attached to the bottom of the box with silicone sealant or epoxy resin. A slide switch was set on the lid and sealed under a flexible primer bulb from a garden strimmer. This allowed units to be switched off when not in use without opening the box. Earlier designs used a push switch mounted at the end of the bulb which was squeezed on and off through the vinyl hose. However, water pressure occasionally squeezed the hose enough to trip the switch.

A light-dependent resistor mounted on the lid automatically turns the light on at dusk and off at dawn, providing important time saving as traps can be cleared and re-set in one trip. The resistor was sealed under a plexiglass cover. All components for the resistor circuit were bought from a local electronics shop for approximately US\$20. The circuit (Fig. 1) had positive and negative sides with a central operational amplifier (Op. Amp.) switch. The current on both sides of the switch was maintained at an equilibrium by five resistors and the photoresistor, with the latter wired to the positive side of the Op. Amp. In darkness, the Op. Amp. is positively activated and drives a Field Effect Transistor (FET), completing the ballast/capacitor circuit to power the fluorescent bulb. The circuit was mounted on copper heat sinks inside the box lid and covered in silicone sealant to minimize damage to components in the event of flooding.

Power was provided by 16 D-cell alkaline batteries or two sealed lead acid 10 amp-hour, 6 volt, rechargeable batteries. Alkaline

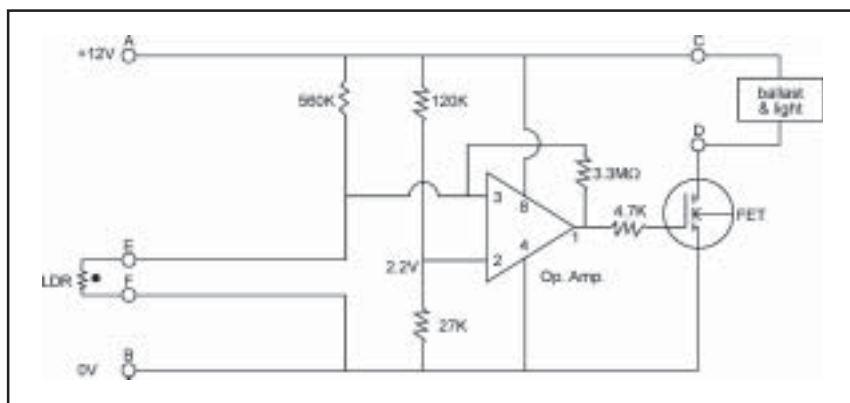


Fig. 1. Circuit diagram for the light box. Numbers around the operational amplifier (Op. Amp.) are pin numbers of the integrated circuit as follows: 1 - output, 2 - inverting input, 3 - non-inverting input, 4 - ground and 8 - supply. Pin 5, 6 and 7 are not used. The letters A to F of the diagram refer to external connections, namely A - power in, B - ground, C - power out to the load, D - ground of the load E and F are connections to the light-dependent resistor. The light-dependent resistor is mounted on the external surface of the light box with a waterproof transparent cover and leads coming through two tiny holes. (Note that D does not go directly to supply 0V but is switched by light sensitive switch). See text.

batteries are more widely available, but proved more expensive. Despite a higher initial outlay, sealed lead acid batteries were at least five times cheaper than disposables. Sealed batteries resisted occasional partial floods better and required fewer error prone connections. This made changing batteries and finding faults easier. The positive and negative terminals connect to the waterproof switch and the photo switch circuit, respectively.

Up to 18 lead acid batteries (9 sets) can be recharged simultaneously using a low-tech connection board connected to an 8 amp car battery charger. The connection board was made up of a negative terminal connected to the charger lead and a positive connecting stub attached to a series of nine sets of paired car headlamp bulbs which acted as positive terminals, current limiters and charge indicators. The negative terminals of the nine sets of car lamp bulbs were connected via a bridge to the positive power supply from the charger. Pairs of batteries to be charged were wired in series. The free positive terminal from the battery pair was then connected to the positive terminal on the end of the bulb.

The free negative terminals of

the battery set were connected to a common negative stub. Current exceeding that needed for optimum recharging illuminates the bulbs. Thus, the bulbs glow brightly when battery charge is low, but dimly, if at all, as the charge is topped up. Faulty connections can be identified by dim bulbs at the start of charging. Battery sets were fully charged after 15 hours.

Designs of Light Traps

Stobutzki and Bellwood (1997) built a smaller and simplified version of Doherty's light trap using moulded plexiglass and four horizontal entrance funnels. A single fluorescent bulb powered by 16 D-cell batteries is housed in a built-in plexiglass box and light tube. A collection bucket is strapped to the underside. We have modified this design using flat sheets of plexiglass in a 40 cm x 40 cm x 40 cm aluminum frame. Two horizontal and two vertical entrance funnels taper to 12 mm (Fig. 2). We replaced the electrical compartment with a modular light unit as described above. The collection bucket is a 23 liter waste paper bin with mosquito mesh drainage panels. Approximate cost per unit of this modified

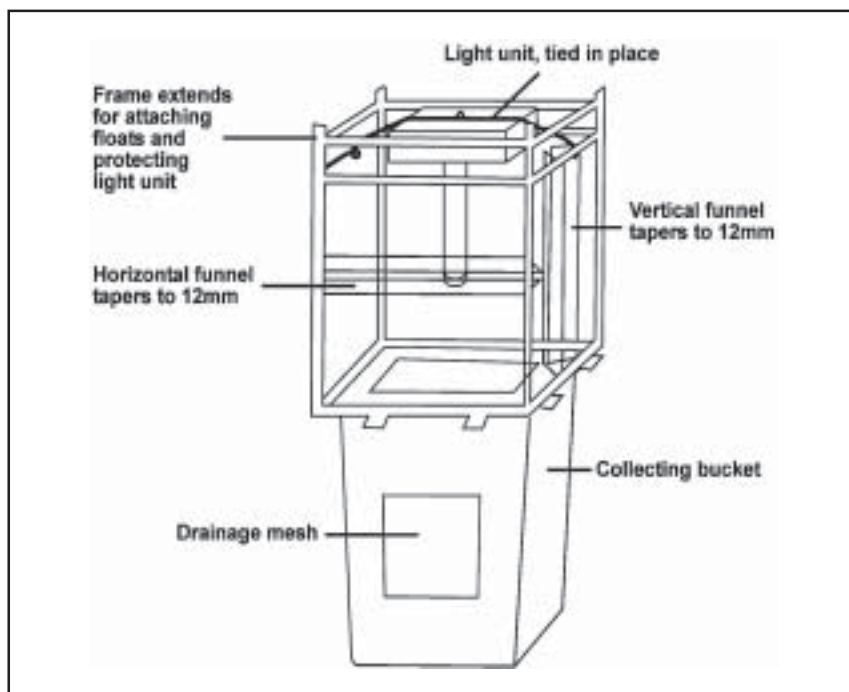


Fig. 2. Diagram of the modified Stobutzki light trap. Only one horizontal and one vertical funnel are shown for purposes of clarity. The main trap is 40 cm on all sides. Funnels taper to 12 mm. Frame extends 10 cm above the main trap. The collecting bucket is attached by shock cord looped tightly over tabs on the frame. See text.

Stobutzki trap (excluding the light unit) is US\$275, but might be less where components are cheaper.

Riley and Holt (1993) constructed a light trap by setting four large plexiglass funnels into a frame cut from a 19 liter bucket. Sponaugle and Cowen (1996) made a trap from plankton mesh set with the necks of three plastic bottles as entrance funnels. We combined these two designs to reduce costs and increase robustness, setting the necks of 18 plastic bottles into a 19 liter bucket (Fig. 3) to form the 'bucket' trap. The bucket itself was set between plywood top and base plates to which the light unit and collecting compartment were attached. This trap was quick to make, robust and cheap (below US\$ 15).

Preliminary Test of the Light Traps

To test the light trap designs, we set two modified Stobutzki traps and

one bucket trap five times over two nights around the new moon in August 1999. For each sample, a lottery draw was used to randomly position the traps on 6 moorings all within a few hundred meters of the reef crest. Traps were set between 1 hr 45 min and 5 hr on 15 August and between 4 hr 45 min and 6 hr 30 min on 19 August. Light trap catches show strong lunar periodicity, so catches on different nights could not be combined.

Horizontal visibility at night was assessed by swimming away from the trap with a tape measure. To avoid burning an image of the trap on the observer's retina, the swimmer looked away every five fin kicks. Once the light was gone, a further 5 m of tape was laid out and the trap approached until the light was seen. The average of the two measurements was taken.

Total catches are expressed as number of fish caught per hour including small pelagics (Clupeidae, Atherinidae and Engraulidae), which

made up the bulk of the catch. On the 15 August, the modified Stobutzki and the bucket trap caught an average of 417 and 504 fish/hr, respectively (n=6 and n=3). Actual catches ranged from 49 to 552 fish/hr and 34 to 1 008 fish/hr for the modified Stobutzki and bucket trap, respectively. On 19 August, the modified Stobutzki and bucket trap caught an average of 29.4 and 29.8 fish/hr, respectively. Actual catches ranged from 5.4 to 42.1 fish/hr for the modified Stobutzki trap (n=4) and 29.1 to 30.4 fish/hr for the bucket trap (n=2). Peak catches did not correspond with any particular time of night.

The results highlight the high spatial and temporal variability in catches. Despite the fact that the modified Stobutzki trap had over eight times the illuminated area of the bucket trap (5184 cm² and 597 cm²), both traps were visible to the human eye at 47 m and 50 m, respectively. The ratio of illuminated area to entrance area was 30.5:1 and 10.5:1, respectively. For comparison, Choat (1993) caught 293.2 fish/hr (>93% pomacentrids) using a Doherty light trap, whilst Brogan (1994) caught 313.5 fish/hr in a simpler two-chamber light trap built from PVC piping. Brogan compared his trap with Doherty's design. Doherty traps caught more than twice the number of fish; however, they were approximately 10 times as expensive (US\$3 000 versus US\$300).

Conclusion

Although both designs presented here worked, limited field trials make it inappropriate to statistically compare efficiency at this stage. Rather, the ease of construction and cost are what we wish to highlight here. While the modified Stobutzki trap costs approximately US\$275 for

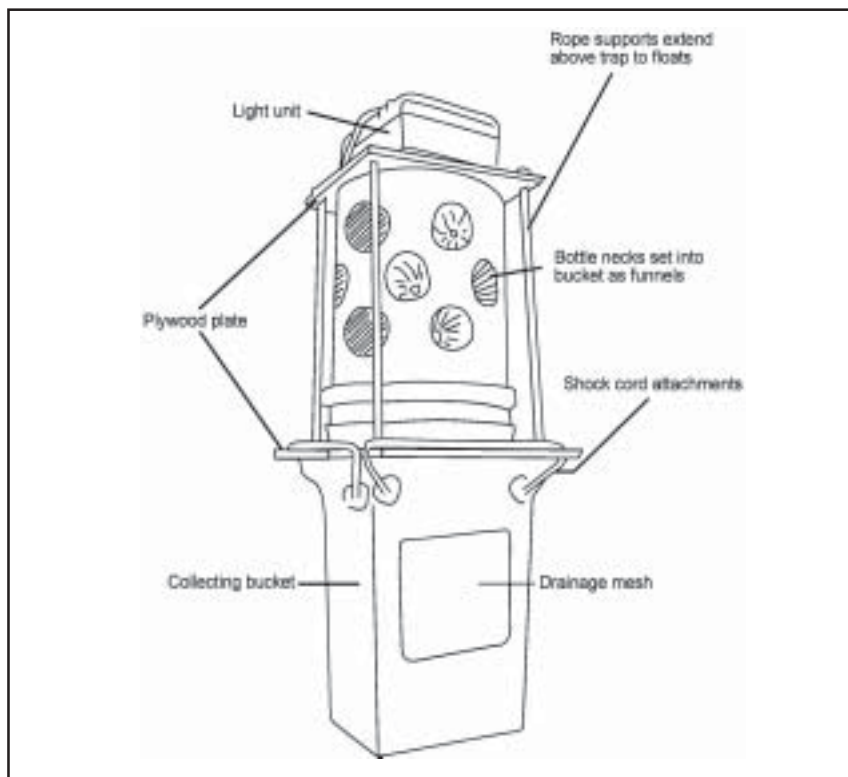


Fig. 3. Diagram of the bucket trap. The funnels are necks of transparent plastic bottles set into the bucket. Collecting bucket is attached by shock cord to the plywood base plate. See text.

the frame and plexiglass, the bucket trap costs less than US\$15, excluding the light box, collecting bucket and moorings. We will be comparing statistically the relative efficiency of these traps in the next phase of our work.

The main advantage of a cheaper trap is that more can be deployed, and applications can extend beyond scientific research. For example, light traps can be used to supply sustainably caught ornamental reef fish to the aquarium trade. Catching fish in light traps before they reach the reef avoids losses from high post-settlement mortality. Thus, taking a few pre-settlement fish probably has less impact on the reef than removing settled fish. Widespread use of destructive collecting techniques such as sodium cyanide often leads to high mortality in captured fish, does substantial harm to the reef ecosystem, and has made development of sustainable

collection techniques an international concern. However, growing consumer demand for 'eco-labelled' fish suggests sustainable aquarium fisheries could provide a valuable alternative income for fishers, particularly where overfishing is currently degrading coral reef resources.

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