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# A photovoltaic-battery-LED lamp raft design for purse seine fishery: Application in a large Mediterranean lake

George Kehayias*, Dionysis Bouliopoulos, Nikos Chiotis, Pavlos Koutra

*University of Patras, Department of Environmental and Natural Resources Management, G. Seferi 2, 30100 Agrinio, Greece*

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ABSTRACT

This paper describes the construction of a novel lamp raft for the purse seine fishery and its evaluation in real conditions for 14 days during a six-month period in a freshwater ecosystem (Lake Trichonis, Greece). A simple, but durable and inexpensive design was constructed comprising a LED lamp producing green light, powered by a 12 V battery which is charged by a photovoltaic panel to make the device autonomous concerning its electric power needs. The new lamp raft showed very good technical performance in the field and was found to be more effective at attracting fish than traditional lamp rafts, resulting in higher catch rates for the target fish species (*Atherina boyeri*). The increase in catch varied between 33.3% and 157.1%, with an overall increase of 67.3%. This excellent performance, along with simplicity, durability, and the zero operational cost, makes this raft an interesting candidate to replace the traditional lamp rafts used in purse seine fishery not only in the particular lake for which it was designed, but also in other freshwater and marine ecosystems around the world.



## 1. Introduction

Purse seining is a common fishing method capable of harvesting large quantities of epipelagic fish species, predominantly at night using light attraction (Ben-Yami, 1976; Acros and Oro, 2002). The typical process of capture in lakes and coastal regions involves the main vessel, a rowing boat and several lamp rafts (equipped with powerful lamps) that are released to attract fish. Purse seining with light constitutes one of the most important fishing methods in the Mediterranean Sea (El-Haweet, 2001; Papaconstantinou and Farrugio, 2000; Tsitsika and Maravelias, 2008; Tsagarakis et al., 2012), as well as in other ocean and coastal areas of the world (Apte et al., 2007; Mills et al., 2014; Rodhouse et al., 2001). Moreover, this technique is also exercised in inland waters such as the great lakes of Africa (Lakes Victoria and Tanganyika) by many thousands of artisanal fishermen (McHenry et al., 2014; Mills et al., 2014).

In previous decades the main sources of lamp raft light used in coastal Mediterranean Sea fishing were pressurized kerosene lanterns, or lanterns operating with liquefied petroleum gas. In fact, kerosene lanterns are still the most popular sources of fishing light in the developing world, despite their high operation cost (fuel can consume up to 50% of fish sales) and general disadvantages, e.g., difficult to clean, fragile mantle, highly flammable fuel, and exposure of users to fumes and numerous combustion pollutants (McHenry et al., 2014). The above disadvantages have driven the great majority of modern fishermen to turn to the use of battery-powered incandescent bulbs or fluorescent lamps as the light sources for their lamp rafts. Although these sources have improved light intensity and reduced costs, their main handicap is that these lamps draw a great amount of electric energy from the batteries that should then be charged frequently either on land or onboard the fishing boats using fossil fuels. As energy conservation and environmental protection have become focal issues, presently there is an urgent need to develop more efficient lighting methods. LEDs are now the most cost-effective lighting technology when analyzed from a total cost of ownership perspective, as they offer brighter light for longer durations at equal or lower cost than other lighting technology (McHenry et al., 2014). LED lights also do not contain mercury (as opposed to fluorescent lamps), are tolerant of low voltages, are very small and portable, have high optical efficiency, are often submersible, and compare favorably both technically and economically with all other forms of lighting for small-scale applications (McHenry et al., 2014).

Although several attempts have been made to apply LED technology for night fishing onboard large fishing boats by using many high voltage lamps powered by the boat's engine (Okamoto et al., 2008; Shen and Huang, 2012), the application of battery-powered

* Corresponding author. Fax: +30 2641074176.
*E-mail addresses:* gkechagi@upatras.gr, gkechagi@cc.uoi.gr (G. Kehayias), mpouliopoulosd@yahoo.gr (D. Bouliopoulos), chiotisn@gmail.com (N. Chiotis), koutra.pavlos@hotmail.com (P. Koutra).

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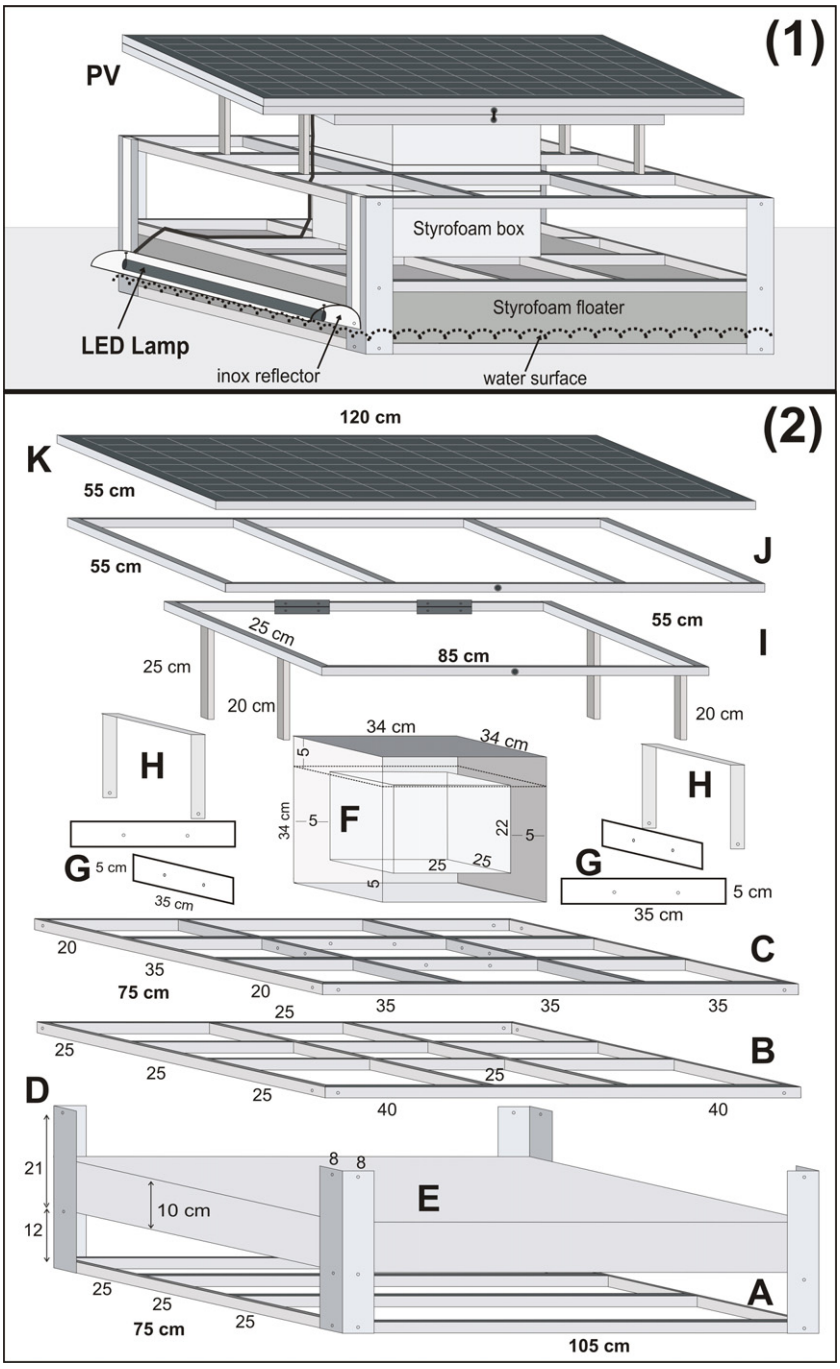


**Fig. 1.** (1) Scheme of the final form of the novel lamp raft showing the LED lamp positioned on one side under an inox reflector, the photovoltaic panel (PV) on top of the raft, the Styrofoam box and the floater. The submersed part of the raft is also indicated. (2) Scheme of the individual parts of the lamp raft: *A, B, C*, inox frames; *D*, angled inox piece; *E*, Styrofoam floater; *F*, Styrofoam box; *G*, plexiglass pieces; *H*, Π-shaped inox pieces; *I-J*, inox frames; *K*, photovoltaic panel.

LED lamps in rafts for purse seine fishery remains in the state of improvisation by the fishermen. Moreover, only a few designs exist where the battery-powered LED lamp rafts are supplied by photovoltaic panels (PVs) in order to be energy-autonomous. Such devices have been experimentally applied in developing countries and focused on cost reduction by the construction of simple traditional wooden floats equipped with several commercially available off-grid lighting devices (McHenry et al., 2014; Mills et al., 2014). In other cases, submersible lights powered by low voltage alkaline batteries charged by small solar PV panels were constructed by placing LED lamps in permanently sealed plastic/glass housings (Apte et al., 2007). The efficiency of these light devices in attracting fish was generally poor (Apte et al., 2007), but in some cases they showed enhanced fish attraction and yielded increased catches (Mills et al., 2014). However, Mills et al. (2014) admitted that none of the LED systems tested were actually adequate for use in real conditions, and concluded that there is need for a modified design or product with improved durability and performance in harsh fishing environments (Mills et al., 2014).

Thus, there is a need to produce an effective, easy to build, inexpensive and durable raft, which can be constructed by untrained fishermen using low level technology, and at the same time it would have no operational cost and it would be even more effective in the attraction of fish than the traditional rafts.