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Marine Fisheries Policy Brief - 4

Fishing Using Lights: How should India handle this new development

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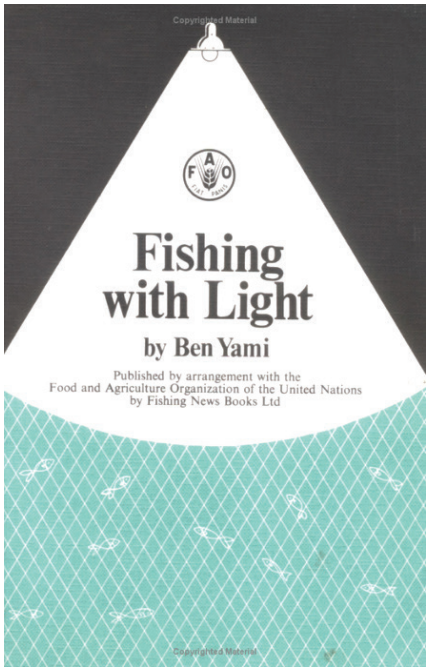
Fishing Using Lights: How should India handle this new development

This policy brief highlights the global status of fishing using lights as an attractant, details the technological aspects of light fishing, the science behind light attraction in fishes and the regulations followed in other countries for light fishing. The genesis of light fishing in India and the conflicts that have developed because of it are discussed. Finally, the brief states the scientific position on light fishing and gives recommendations for it management and regulation in Indian waters.

1. Background



Fishing using lights has been practiced by man from historic times, ever since he became aware of the attraction of many of the fish species toward light. A classic example from India are the more than 200-year old Chinese dipnets (stationary lift nets) in Kerala, which use lights (earlier kerosene lights and now CFL lamps) to attract fish over the dipnet. In 1976, the FAO brought out a manual on fishing with light authored by Ben Yami[2]. This book highlighted the earlier practices and the modern technological advances of fishing with light.

Japan is one of the main nations in the world which practices light fishing. Japan's capture fisheries production was 4.15 million tons in 2009. The most productive fishing methods, in terms of catch weight, are: purse-seines, towed nets, set-nets (fish trap), stick-held dipnets, gillnets, longlines and squid jigging. Among those fishing methods, more than half of the purse-seine vessels and all stick-held dipnet and squid jigging boats use artificial light. Thus, light fishing is quite common in Japan[3]. In purse-seine fisheries (that mainly target chub mackerels, horse mackerels and sardines) surface and underwater lamps are used, while only surface lamps are used for stick-held dipnet targeting Pacific saury and squid jigging fisheries. Since fishers generally believe more light leads to greater catches, to avoid light competitions within sectors and conflicts between sectors the maximum power output for lighting is controlled by regulations, according to: fishing methods, regions, boat sizes, etc.

Other Asian countries which practice light fishing are Korea, Malaysia, Vietnam, Thailand and

[1] Policy brief prepared by K. Sunil Mohamed, Molluscan Fisheries Division, CMFRI, Kochi. May 26, 2016

[2] M. Ben Yami (1976). Fishing with Light, FAO Fishing Manuals. With 64 fig., 121 pp. Farnham, Surrey, England: Fishing News Book Ltd. ISBN 0 85238 078 X.

[3] Report of the ICES-FAO Working Group on Fishing Technology and Fish Behaviour (WGFTFB), 2012

Philippines. In Europe, light fishing is carried out from purse-seines for the Norwegian spring spawning herring (*Clupea harengus*) which belongs to the sardine family. Purse-seining with light is also carried out for schooling small pelagics in North Sea, Mediterranean Sea, France, Turkey and Aegean Sea.

According to the WGFTFB[3], a rough estimate of the global marine catches using lights is 1.09 million tonnes (~1.6% of global catches) in 2010. Since many countries do not report separate statistics for light fishing, this figure is likely to be an underestimate. The main species exploited, the main gears used and the main countries operating light fishing is given in Table 1. It is quite clear that light fishing is widely practiced throughout the world and the catches obtained through such means are substantial. Roughly 16% of the light fishing catches comprise of squids, and the remaining >80%

Table.1. Partial list of gears, species caught and the regions where light fishing is practiced (adapted from WGFTFB[3])

Fishing Gear	Target Species	Regions/ Countries
Squid Jigging	*Todarodes pacificus* *Ommastrephes bartramii* *Loligo bleekeri* *Photololigo edulis* *Nototodarus sloanii* *Dosidicus gigas* *Uroteuthis duvauceli* *Sepioteuthis lessoniana* *Sepia aculeata* *Sthenoteuthis oualaniensis*	Japan, Pacific Ocean, East China Sea, New Zealand, Peru, Korea, Malaysia, Vietnam
Fish jigging	Mackerel *(Scombridae)* Hairtail *(Trichiurus lepturus)*	North Pacific coast of Japan
Purse-seining	Horse Mackerel *(Carangidae)* Chub mackerel (*Scomber japonicus*) Mackerel *(Scombridae)* Anchovy *(Engraulis japonica)* Sardine *(Sardinops melanostictus)* Round herring *(Etrumeus teres)* Indian mackerel (*Rastrelliger kanagurta*) Bonito (*Sarda* sp) Sprat (*Sprattus sprattus*) Norwegian spring spawning herring (*Clupea harengus*) Mackerel (*Scomber scombrus*) Saithe (*Pollachius virens*) Sardine (*Sardina pilchardus*) Anchovy (*Engraulis encrasicolus*) Bogue (*Boops boops*)	East China Sea, Japan Sea, Korea, Malaysia, Philippines, Vietnam, Norway, North Sea, Mediterranean Sea, Aegean Sea

Stick-held dipnet	Pacific saury (*Cololabis saira*) Anchovy *(Engraulis japonica)* Sardine *(Sardinops melanostictus)* Round herring *(Etrumeus teres)* Frigate mackerel (*Auxis rochei*)	North Pacific coast of Japan Korea
Gillnet	Silver-stripe round herring (*Spratelloides gracilis*)	Southwestern Japan
Handline	Chicken grunt (*Parapristipoma trilineatum*)	Western Japan
Cast nets, Scoop nets, Lift nets	Sardine *(Sardinops melanostictus)* Round herring *(Etrumeus teres)* Horse Mackerel *(Carangidae)* Dotted gizzard shad (*Konosirus punctatus*)	Seto Inland Sea, Korea, Thailand

are fish species. A partial global summary of fisheries using artificial light has been reported by WGFTFB[3] in a table indicating the type of light source, its power (in kW), placement (surface or underwater), peak season and landings.

2. Technological Aspects

Several fishery technology institutes and universities around the world are conducting research on technical aspects of light fishing[4,5]. With the advent of cheaper LED (Light Emitting Diode) technology, metal halide and halogen lamps which were in vogue until recently are getting replaced with the cheaper LEDs. Commercial applications of artificial light for fishing have tended to be confined to surface or subsurface lights in fisheries that target pelagic and schooling species. Technological limitations partly explains the lack of application in demersal and deep water fisheries. However, recent technological advances in battery and modern LED light technologies (Inada and Arimoto, 2007[6]) have made available small, robust, powerful and energy-efficient light units that can be used in deeper waters for both static (e.g. pots and longlines) and towed fishing gears (e.g. trawls). Moreover, these new energy efficient light sources are continuing to develop and may be used to develop energy efficient and environmentally friendly fishing technologies for existing light fisheries.

The shift to LED lights has resulted in considerable fuel saving for light fishing vessels. For example, Korean commercial fishing boats use conventional metal halide lamps, which consumes fuel accounting for 65% of the total fuel consumption of the fishing boats (WGFTFB[3]). LED lamps were shown to save 55% of energy use of metal halide lamp in hairtail angling and 26% in squid jigging.

3. The Science of Light Attraction in Fishes

The behavioural/physiological principles of fish attraction to the light has been investigated, but its mechanism has not yet been fully explained, scientifically. For example, the squid jigging boat usually set lamps over the deck to create shadow/dark zone under the boat where squids

[4] T. Okamoto, K. Takahashi, H. Ohsawa, K.- Fukuchi, K. Hosogane, S. Kobayashi, M. Moniwa, K. Sasa, H. Yoshino, H. Ishikawa, M. Harada, K. Asakura, and H. Ishii, (2008) "Application of LEDs to fishing lights for Pacific saury," **J. Light Vis. Environ.** 32(2): 88-92.

[5] M. Marchesan, M. Spoto, L. Verginella, and E. A. Ferrero, (2005) "Behavioural effects of artificial light on fish species of commercial interest," **Fish. Res.** 73(1-2): 171-185.

[6] Inada, H., and Arimoto, T. (2007). Trends on Research & Development of Fishing Light in Japan. **J. Illum. Eng. Inst. Japan,** 91(4): 199-209.

are hooked. In contrast, lamps are set at the outer side of the boat in purse-seine and stick-held dipnet fishing and fish are directly exposed to the light. These aspects have been reviewed by Arimoto et al (2011)[7] and the main principles for light aggregation of fish are outlined below.

- Schooling for feeding
- Conditioned response to light intensity gradients
- Curiosity behaviour and other social behaviour
- Positive phototaxis making them orient to the light source
- Optimum light intensity for feeding and other activities
- Disorientation and immobilization due to high light levels in surrounding dark conditions

4. Regulation of Light Fisheries in other countries

There are conflicts between fisheries and gear types, as well as concerns over excessive power usage in many countries. With respect to the latter, there are examples from Asian fisheries where fishers (with smaller, lower power vessels) have requested government/ legislative intervention to allow for fairer competition between vessels within the fleet. Some of the management regulations adopted by different countries is given below.

- Japan - regional bans on use of light and limits on power output;
- Korea - light banned from inshore fisheries and limits on power output;
- Norway - ban for sprat fishery in Skagerrak because of bycatch of cod and north of 62ºN latitude;
- Spain (Mediterranean) - limits on power output

Quite clearly, in the above countries, management through fisheries regulations has resulted in increased efficiency and production and has also helped to minimize conflicts.

5. Genesis of Commercial Light Fishing in India

Use of artificial lights in commercial-scale Indian fisheries is fairly recent (in the last 2 years) and is mainly prevalent in Karnataka and Goa states. Traditionally, lights have been used to attract fishes in the Chinese dipnets in Kerala and also in the boat seine and trammel net fisheries for carangids (big-eye scads) from motorized crafts in Thiruvananthapuram district of Kerala[8]. A number of experimental light fishing trials have been undertaken by government fisheries institutions such as CMFRI[9] and FSI/CIFNET[10] targeting coastal squid resources. A concerted value-chain project (funded by World Bank, NAIP) to exploit oceanic squids in the Arabian Sea initiated by CMFRI in collaboration with CIFT, NIFPHATT and FSI in 2008-

[7]Arimoto, T., Glass, C. W., and Zhang, X. 2011. Fish Vision and Its Role in Fish Capture. In: Pingguo He (Ed.), **Behaviour of Marine Fish**: Capture Processes & Conservation Challenges (pp. 25-43).

[8] Achari, R B., Joel, J J., Gopakumar, G., Philipose, K K., Thomas, K T and Velayudhan, A K (1998) Some observations on light fishing off Thiruvananthapuram coast. **Marine Fisheries Information Service**, Technical and Extension Series, 152: 9-12.

[9] Nair, K P and Omana, T A (1985) On the cephalopods obtained in experimental trawling and light fishing conducted at Vizhinjam. **CMFRI Bulletin**, 37: 146-151.

[10] **FSI Bulletin** No.23 (1992) Exploratory squid jigging in India with notes on biology of squid.

2013 probably provided the trigger to the current commercial light fishing ventures. Under this project, a commercial 20-metre wooden trawler (*MFV Titanic*) based at Mangalore Fishing Harbour was converted to a squid jigger with a diesel generator powered metal halide lights (total 27kW) and automatic squid jigging machinery[11]. More than 50 light fishing operations were carried out within 2 years, and the salient results of the project are given in Box 1.

For exploitation of oceanic squids from the converted wooden trawler, jigging was found to be not very efficient, on the other hand, purse-seining and gillnetting were found to be the method of choice. Jigging is a highly selective fishing method and only the targeted squids are caught.

Box 1

- It was established that purse-seining and gillnetting with light attraction from converted 20m LOA commercial fishing boats are the most efficient gears for exploiting oceanic squids in the Arabian Sea.
- Three lat/long grids 13°N/71°E, 11°N/72°E and 10°N/71°E had the maximum biomass of oceanic squids among the 58 stations covered. The average biomass was 4.2 t/km^2 and the maximum was 92.8 t/km^2.
- The total biomass was estimated as 2.52 million tonnes and the annual fishable biomass (MSY) was estimated as 0.63 million tonnes.
- The techno-economic feasibility analysis showed that one-boat mini PS operations for 3 months (Dec-Jan-Feb) would have a capital productivity ratio of 0.41 and a rate of return on investment of 87%.
- Three fishing ports along the west coast of India, Kochi, Mangalore and Goa can become the launch pads for oceanic squid exploitation from the Arabian Sea. The lat/long grids with highest abundance are located close to these ports. The number of purse seines in Mangalore and Goa are also overcapitalized, and therefore, the DOFs of the respective states can launch appropriate incentivized schemes to promote such conversions based on the economic analysis.

Purse-seining and gillnetting by contrast, do take in some bycatch of other commercially valuable species. Seeing this advantage, the owner of *MFV Titanic* operated the vessel with lights and purse-seines off Mangalore outside of 12 nm to net considerable small pelagic mix-fish catch[12]. This had a demonstration and salutary effect among other purse-seine fishers, especially those operating large-meshed purse-seines in Mangalore, leading to a scramble to procure fishing lights even from abroad. Within a period of 2 years about 40-50% of such purse-seines operating from Karnataka are using lights in purse-seines for 15 days (7 days pre and post new moon) in a month. They usually operate at 45-50m depth zone (outside 12 nm) and the catch consists mostly of large carangids (queen fishes, horse mackerel and trevallies), seerfish (narrow barred Spanish mackerel), fullbeaks (Flat needlefish), tunas (kawakawa, skipjack, longtail, frigate and

[11] Mohamed K.S., G. Sasikumar, K.P.S. Koya, V. Venkatesan, V. Kripa, P.K. Asokan, N. Ragesh, K.K. Sajikumar, R. Remya, M. Joseph, P.S. Alloycious, M.K. Venu, J. Varghese, K.K. Asha, M.V. Baiju and N. Unnikrishnan (2014). Final report of the **NAIP CN-2 scheme** - Utilization strategy for oceanic squids (Cephalopoda) in Arabian Sea: A value chain approach, CMFRI. 103p.

[12] Ragesh N, Sajikumar K K, Remya R, Sasikumar G, Koya K P S and Mohamed K S (2014) Scope for mechanized fishing of teleosts with light attraction in Southeastern Arabian Sea. **Marine Fisheries Information Service**; Technical and Extension Series 219: 21-23.

bullet tunas), Indian mackerel, barracudas (saw-toothed barracuda), moonfish, wolf herring and bulls eye (P. Rohit, personal communication). While the traditional purse seiners caught one or two species, the light aggregation based fishery landed 11 to 14 species off Mangalore (G. Sasikumar, unpublished report).

A parallel development is the initiation of small-scale squid jigging with light attraction from gillnet boats in southern Maharashtra exclusively targeting the Indian squid (*Uroteuthis duvauceli*), for which there are more than 20 boats in operation in Ratnagiri[13]. Ratnagiri based purse-seines have also started fishing with lights. In Goa too, purse-seining with lights (popularly called as LED fishing) has been initiated in the past year with higher catches (about 60 boats) and heightened intersectoral conflicts.

6. Conflicts due to Light Fishing

The widespread use of lights in purse-seine fishing in Goa and Karnataka has led to conflicts between traditional fisher groups and the operators of light fishing units. The contention of the traditional fishers is that such fishing will affect the marine ecology of the region due to excessive capture of large spawning adults. The conflict has been particularly severe in Goa, and very recently, the Government of Goa has brought out an order banning use of LED and other light attractants in fishing practices within the territorial waters of Goa[14]. In spite of the ban, the controversy continues because considerable new investment has been made by purse-seine fishers in Goa which have come to naught. In Karnataka, also there is growing resentment against light fishing by all other sections, primarily due to the high-value of fishes caught, and the very high incomes obtained by the light fitted purse-seines.

This new fishing method has come into vogue at a time when the overall marine catches along southwest coast has declined by 17% and that in Goa by a steep 55% mainly due to decline in oil sardine catches which is the mainstay of traditional fishers, and this has also compounded the issue.

7. CMFRI's Position on Light Fishing

As is clear from the background (section #1), light fishing is widely practiced throughout the world, particularly in Asia-Pacific countries without categorical reports on negative impacts. Our limited studies (P. Rohit, personal communication) indicate that most of the large pelagic predatory fishes (carangids, tunas, barracuda) that are caught in purse-seines with lights are above their sizes-at-first-maturity, indicating that they would have spawned at least once before they are caught. The primary aim of any fisheries management strategy is to allow fishes to spawn at least once before they are caught. Firm conclusions on any negative impacts cannot be made at the present time. Besides, the WWF[15] has classified light fisheries as a low-impact fisheries with the ability to reduce bycatch and may in addition lead to a cleaner catch, which means faster processing and better fish quality. However, on a precautionary note, this new fishing practice needs to be studied in more detail before allowing its unchecked or planned expansion.

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[13] Sundaram, S and Sawant, D D (2014) Large scale exploitation of Indian squid, *Loligo duvauceli* by jigging from nearshore waters of Ratnagiri, Maharashtra. **Marine Fisheries Information Service**; Technical and Extension Series 221: 12-13.

[14] Government of Goa Order No. DF/ENF/ORDER/2016- 17/ dated 10/05/2016

[15] Broeg, K (2007). Towards Low Impact Fishery Techniques. WWF Report Germany, International Centre for Marine Conservation, Hamburg 2008, 64p.

Since light fishing has led to conflicts among fishers who exploit different resources and realms of the sea, rather than an outright ban on the new fishing practice, it is more egalitarian and reasonable if a regulated fisheries management regime is introduced. The regulatory regimes implemented by countries such as Japan and Korea are good examples (see section #4).

8. Recommendations on Light Fishing

a) Light fishing should not be permitted within the territorial waters (up to 12 nm) in order to protect the interests of the traditional fishers, prevent conflicts and also to protect coastal fish stocks (this regulation is within the rights of the maritime states). However, traditional light fishing practices such as Chinese dipnets and boat seines and trammel nets in certain districts of Kerala maybe kept outside the purview of this direction.

b) In view of scientific study results, resource specific light fishing such as for oceanic squid fishing should be encouraged beyond 12 nm through incentivized schemes by maritime states and the Central Government.

c) Use of lights should not be allowed from towed fishing gears (trawls) and static gears such as traps, pots and long-lines until scientific studies prove the absence of impacts.

d) Use of artificial lights (surface and submerged) should not be permitted from drifting Fish Aggregating Devices (DFAD) targeting tunas as resolved by the IOTC[16].

e) Outside of the territorial waters, light fishing maybe permitted (right of the Central Government - DADF/MoA) limited by the following conditions.

   i. The number of vessels allowed for such fishing maybe restricted to 20-50% of the total fleet strength of purse-seines in respective maritime states.

   ii. The light purse-seines should use only large mesh sizes (>45 mm) nets to discourage capture of juveniles of target species.

   iii. The power of lights used on board the vessels maybe restricted to 25 kW in order to reduce greenhouse gas emissions.

   iv. Underwater lights should not be permitted, and only surface lights should be allowed.

   v. The number of days of purse-seine light fishing operations should be restricted to 10 days in a month (5 days pre and post new moon) during the fishing season.

f) Close monitoring of the light fishing operations have to be made by the enforcement wing of the respective maritime states. In the absence of VMS or AIS systems, patrolling and inspection of vessels by the enforcement wing is highly necessary to ensure compliance.

g) Considering that mackerel forms a good percentage of catches in light purse-seines, their operations should be banned during April and May when mackerels are spawning or preparing for spawning.

h) Maritime state fisheries departments should also get both opposing parties to one table and discuss the issues to reach a consensus agreement in the presence of scientists. This is

[16] Resolution 15/07 of IOTC prohibits the use of lights on DFADs for the purpose of attracting tuna. Although DFADs are not in operation in India, this recommendation is prospectively applied.

particularly relevant for fixing the number of vessels which would be allowed to carry out light fishing.

i) The fisheries research institution should closely monitor the catches and the biology of the main resources caught, particularly with regard to the risk of recruitment overfishing and provide timely feedback to the Central and State governments.

j) The fisheries research institution should also work out a catch quota for light based purse-seining on the basis of historical data and analytical models for the major species exploited.

9. Endnote

The present conflicts and the resulting crisis illustrates one of the banes of Indian fisheries development, which is of uncontrolled innovations made by fishermen to get higher catches. While innovations in craft and gear will always be made by fishermen in the course of their fishing activities, such innovations should be submitted by fishers to the concerned fisheries research institutes to be evaluated and vetted with regard to the impacts on marine ecosystem and resources before it is accepted for widespread use. Such a recommendation has been given in the forthcoming Indian Marine Fisheries Code being brought out by CMFRI and CIFT.

Based on this policy brief, the Secretary, DADF convened a meeting of officials of the Department of Fisheries of all coastal states of the west coast of India at New Delhi on 16-08-2016. Based on the discussions and agreement reached at this meeting, the DADF brought out an Office Memorandum (F.No. 21001/3/2014-Fy (Ind) dated 29-08-2016 containing the recommendations contained in this policy brief as a guidance for regulation of light fisheries in India.

The Central Marine Fisheries Research Institute was established by Government of India on February 3rd 1947 under the Ministry of Agriculture and Farmers Welfare and later it joined the ICAR family in 1967. During the course of over 65 years the Institute has emerged as a leading tropical marine fisheries research institute in the world.

Some of CMFRI's research outputs are transformed into policy briefs on issues which are trending in marine fisheries resource management, mariculture, marine biotechnology and social and economic aspects of fisheries. These policy briefs are meant to be a guidance to research and development organizations and to the government on specific topics.

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