

Large Animal Reduction Device (LARD) to reduce non-target fish in gears operating in EU-waters

Door: Dick de Haan, IMARES

Becommentarieerd door Martin Pastoors, PFA

Review: Floor Quirijns, IMARES

Introduction

The new European Common Fisheries Policy (Reg. 1380/2013) introduced a landing obligation in EU fisheries. All catches of regulated species are to be kept on board and need to be landed. For those species, discarding at sea will be prohibited. The regulation also specifies that rules for protected ETP species (Endangered, Threatened, Protected) are maintained and that these species will need to be avoided or be put back to sea as soon as possible.

Avoiding the by-catch of large protected species (e.g. sharks, rays, sea mammals) in EU waters, could perhaps be achieved by technical solutions like a size-selective filter device in the aft part of the fishing gear. The Large Animal Reduction Device (LARD) that has been developed and tested between 2001 and 2008 on pelagic fisheries in Mauritanian waters is an example of such a size-selective filter device. This memo provides a review of the lessons learned from tests carried out on the LARD. The review describes the potential of LARD to reduce shark and ray by-catches in pelagic fisheries in EU waters. An important second issue is to know what the effects of the LARS may be on catch of target species.

Development and testing of the LARD

In the period between 2001 to 2008 a LARD (Large Animal Reduction Device) was tested in codends of pelagic trawls to exclude non-target megafauna from the catch of Dutch freezer trawlers fishing off the Mauritanian coast. This non-rigid filter device was built in the first codend sections and the filtering efficiency progressively improved at sea. This research was commissioned by the Dutch Pelagic Freezer-Trawler Association, PFA.

The project coordination, catch monitoring and underwater observations were carried out by IMARES. Net adaptation and LARD development were carried out by Maritiem trawl manufacturing company, Katwijk (NL). Reports on the efficiency involved three research stages/periods (Excluder I-2004; Excluder II-2005-2007; Excluder III 2007-2008). The research of Excluder II and III also involved by-catch monitoring over a yearly season based on the haul lists of four Dutch trawlers. Results have been summarized in IMARES reports (Excluder I: Haan, 2003; Haan & Zeeberg, 2005. Excluder II: Heessen et al., 2007; Haan et al., 2008a. Excluder III: Haan et al., 2008b) and in a peer reviewed paper (Zeeberg et al 2006). An overview of all underwater observed trials between 2001-2008 can be found in Annex 1.

The filter threshold of the LARD was set to enable the passage of target fish, sardinella (*Sardinella aurita* & *maderensis*), horse mackerel (*Trachurus trachurus*) and Spanish mackerel (*Scomber japonicus*) towards the catch section. These thresholds were optimum by using an inclined panel of 200 mm square meshes. Larger marine fauna, such as hammerhead shark (*Sphyrna lewini*, *zygaena*, *mokarran*), devil ray "manta" (*Mobula mobular*), bill fish (*Maikara*, *Xiphias*, *Istiophorus*) and sun fish (*Mola mola*) are deflected downward towards an escape tunnel separated by 400 mm diamond-shaped meshes leading to an opening in the bottom panel. The LARD was tested in codends of 400 and 600 meshes circumference and replaced three of the most frontal codend sections, with a total length of 19.5 m. The filtering efficiency was observed underwater and catches were monitored over a fishing season, using the catch list of hauls with and without LARD installed.

More details on the LARD design and developments can be found in Annex 1. Since 2008, there have been no further design developments of the LARD.

LARD performance: release efficiency of non-target megafauna

The field trials in Mauritanian waters with the LARD showed a substantial reduction of by-catches of several marine megafauna species. The results showed potential to release larger megafauna, in particular hammerhead and devil ray "manta". Non-target megafauna < 1.5 m length slipped through the device and became by-caught.

Behaviour of Elasmobranchii contributed to release; positive aspects observed were low swimming locomotion heading with the water flow towards the escape hatch. Devil ray, with a wing span > 2.5 m, passed the interior by 90° body rotation. In some cases large rays became entangled, in some cases they were released while hauling the gear. Hammerheads with length ≤ 1.5 m were found in the target catches indicating the threshold range of this species. Smaller ray (*Dasyatidae*, *Rajidae* sp.) < 0.8 m were observed passing along the bottom side of the codend and not observed entangled and incidentally occurred on the by-catch lists of monitored vessels. Billfish were observed in lengths of 2 to 4 m and responded in opposite direction to the escape route with strong body locomotion. Two billfishes of 1.8-2.0 m penetrated a filter grid of 250 mm square mesh (Haan, 2003). Successful releases were observed when the fish arrived exhausted and was flown passively towards the release gate. In 40 % of the cases observed underwater these species were released.

The flattened body profile of sun fish disabled the fish from reaching the escape entrance while swimming. As soon as swimming mode/posture was lost, the fish was forced against the filter grid, increasing the vertical opening of the escape entrance enabling target fish to enter the escape route, reducing overall performance. In many cases sun fish < 1 m were not found in the catch and must have been released during hauling.

A small turtle species (around 0.6 m) was observed clamped against the filter grid meshes. After 70 seconds, the animal climbed downwards using its wings and swam towards the escape tunnel entrance and escaped. Releases of marine mammals were not observed underwater. According to the monitoring of commercial hauls, incidental cetacean by-catch over the years 2005-2008 did occur, but were lowest on hauls with a LARD included.

LARD performance: efficiency of target species

Target species sardinella and Spanish mackerel were efficiently caught in most of the LARD designs. Commercial catches of trawls with LARD implemented were slightly lower than those with a conventionally rigged codend. By-catch monitoring results involving 4 Dutch freezer trawlers showed a reduction of 8.5 % of average LARD catches (46.5 tonnes of 342 LARD hauls and 50.8 tonnes based on 729 hauls with standard codends) in 2006 (Heessen et al., 2007). This comparison, however, is indicative not only because of the unbalanced number of hauls, but also included a number of additional uncertainties, like different trawl and codend sizes and rigging, day- and night hauls.

LARD applicability in European waters

Based on the experiments and expert judgement, we assess the applicability of LARD in European waters. To do this assessment, similarities and differences between caught species and in Mauritanian and EU waters need to be considered. Size, shape and behaviour are relevant.

The sizes and shapes of **target species** in EU waters are similar to the sizes and shapes of target species in Mauritania. This indicates that the mesh size of the LARD interior could probably be maintained, without losing too much commercial catch.

Concerning **megafauna** that should be avoided:

- Shark species. The LARD experiments in Mauritanian waters show that numbers of by-caught sharks significantly reduced with a length ≥ 1.5 m. The observations show that a positive contribution to shorter length classes < 1.0 m is doubtful (Heessen et al., 2007; Haan et al., 2008a, 2008b). It must be noted that these observations are based on the behaviour of single specimen.

- Rays and skates in the length range of 0.5 to 2.5 m were efficiently excluded by the LARD. Rays and skates ≤ 0.6 m entered the escape route in the lower part without being deflected and were efficiently filtered from the catch. Most likely this behavior is common in European and African species. When this behaviour is applicable for species in EU waters, the contribution to reduce bycatches of rays and skates could be significant.
- Bycatch of marine mammals (cetaceans and seals) is likely to occur in European waters. Based on the underwater observed by-catches of common dolphin (*Delphinus delphis*) in sea bass pair trawl fisheries (Northridge et al., 2003a and b) it is unlikely cetaceans will survive a passage through the LARD. Underwater observed cetacean behaviour in pelagic pair trawls fishing for sea bass (Northridge, personal communication, 2005) have demonstrated that common dolphins search for escape possibilities along the top panel of the trawl. An exit in the top panel, in front of the filter grid, could be a method to increase the escape chances of small cetaceans. However, the behaviour of larger target fish like sardinella, mackerel and tuna showed that they react immediately to a reduced water flow (such as while hauling the gear with the fishing doors hauled in) by swimming forward and could escape through sections with larger meshes. This behaviour could be similar in European waters under lower temperature as was observed in horse mackerel (de Haan et al., 2009). This aspect needs further research.
- Sun fish also occur in EU waters and may be by-caught in pelagic fisheries. The interaction of sun fish with the LARD, caused a reduced target catch efficiency: the fish was driven against the grid panel increasing the vertical opening of the escape tunnel entrance, enabling target fish to escape.

References

- Haan, D. de. 2003. Preventing by-catches of protected or endangered species in the pelagic trawl fishery in West Africa. RIVO report Number: C019/03.
- Haan, D. de & J.J. Zeeberg 2005. By-catch of pelagic megafauna off Mauritania, Northwest Africa: observations and gear modifications. Final Report. RIVO Report C025/05 (Confidential).
- Haan, D. de, Burggraaf, D., Heessen, H. J. L., Couperus, A. S. 2008a. Excluder II 2007. Report C042/08, date of issue 28 May 2008.
- Haan, D. de, Burggraaf, Overzee, H. van, Heessen, H. J. L., Couperus, A. S. 2008b. Excluder III 2008. Report C073/08, date of issue 12 December 2008.
- Haan, D. de, Burggraaf, Overzee, H. van, Marlen, B. van. 2009. Technical measures to improve the selectivity of pelagic trawls to juvenile horse mackerel. C002/09 (Confidential).
- Heessen, H.J.L., Tjoe-awie, P.J., Haan, D. de, & Ybema, Y. 2007. Pelagic Project Mauritania 2005-2006 final report. IMARES report C018/07.
- Northridge, S. 2003a. Reduction of cetacean by-catch in pelagic trawls. Final Report to DEFRA & JNCC, Project MF0733.
- Northridge, S. 2003b. Further development of a dolphin exclusion device. Final Report to DEFRA, Project MF0735.
- Zeeberg, J.J., A. Corten & E. de Graaf 2006. By-catch and release of pelagic megafauna in industrial trawler fisheries off Northwest Africa. Fisheries Research 78: 186-195.

Annex 1. LARD design and developments

The Large Animal Reduction Device (LARD) has been developed and tested between 2001 and 2008 on pelagic fisheries in Mauritanian waters. It is an example of a size-selective filter device, which can be used to avoid the by-catch of large protected species.

Development of non-rigid excluder devices

To reduce by-catch in fishing gears, filter sections rigged in the codend section have been successfully introduced since 1980 (ICES, 1996). The Turtle Excluder Device (TED) was first introduced in 1980 (Watson and Seidel, 1980) and became mandatory in shrimp fisheries in the USA, Gulf of Mexico, South America in 1989. TEDs applied in Australian prawn fisheries successfully reduced turtle by-catch (Poiner et al, 1990) and became mandatory in 2001 by Australian Fisheries Management Authority (AFMA). The LARD-design tested in Mauritania is based on the "Nordmøre Grid" device. This device was first tested in 1989 to exclude jellyfish in the shrimp fisheries in the Nordmøre district in western Norway, and later successfully applied to exclude cod and haddock (Isaksen et al., 1992). A review of sorting systems in different type of fisheries is given by ICES (ICES, 1996).

During the years 2001-2008, a fleet of 4-8 Dutch pelagic trawlers targeted pelagic species, such as sardinella (*Sardinella aurita* and *maderensis*), horse mackerel (*Trachurus trachurus*) and Spanish mackerel (*Scomber japonicus*) in top 50 m of the water column off the coast of northwest Africa. It was thought that most of the larger non-target fish species could theoretically be excluded from the catch using a Nordmøre type grid in the aft part of the trawl. However, the Nordmøre- and TED type of grid designs are rigid constructions designed for use in smaller shrimp trawls or in mid-water trawls fished by slipway trawlers. Dutch stern trawlers require a different approach as rigged grids cannot be handled on net winches. Instead, low-weight, flexible filters built of netting were developed to meet the requirement of being able to handle catches of 50 to 100 ton of target fish.

Functional operation of the LARD

The LARD interior panels (Figure 1) are built in the front part of the codend, directly behind the last tapered aft section of the trawl. The interior consists of a sequence of three panels each rigged in a standard codend section of 100 meshes long \approx 6.5 m, with a total overall length of 19.5 m. The most frontal panel is rigged downward to an angle of around 20 ° enabling target fish to pass, while larger non-target fish are forced downward towards the entrance of a separated route leading to an exit gate. The separation panel is built of diamond-shaped meshes of 400 mm stretched length. The panel covering the exit is built of standard codend meshes of 65 mm.

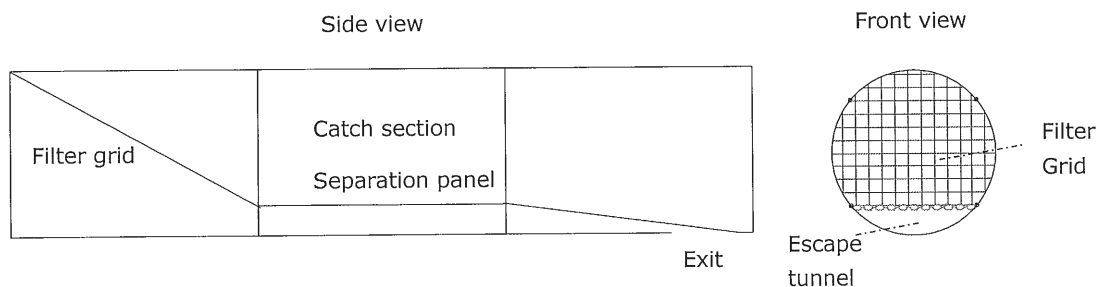


Figure 1 Basic design principle of the Large Animal reduction Device (LARD)

Underwater observations

The overview of underwater observed trials is listed in Table 1 and covers the complete research period 2001-2008, the total number of commercial hauls and the observed part and the observed trawl & main rigging details.

Table 1 Underwater observed experiments in the period between 2001 and 2008. Research effort (days at sea, numbers of hauls against the observation dives, mesh size of the inclined grid panel).

Period	Vessel	Days at sea	Haul (nr)	Dive (nr)	Filter grid Mesh (mm)	LARD Circumference/ Diameter (#/m)	Circumference Trawl (#)
2001-10	SCH302	15	6	1	250 ² /12 mm	400/2.5	4300, 6300
			36	9			
2002-07	SCH302	22	62	1	200 ² /6 mm	400/2.5	4300, 6900, 9300
			126	21			
2002-09	SCH302	23	21	1	250 ² /12 mm	400/2.5	4800, 6900
			86	23			
2004-07	SCH24	15	16	1	200 ² /5 mm	600/3.6	4300
			39	9			
2004-11	KW171	30	10	1	200 ² /5 mm	600/3.6; 400/2.5	5300, 7200
			99	16			
2006-07	H171	14	6	1	200 ² /5 mm	400, 2.5	4300, 4800
			38	7			
2007-08	SCH118	15	9	1	200 ² /5 mm	400, 2.5	4300, 5250
			46	7			
2008-07	SCH81	26	8	1	200 ² /5 mm	400, 2.5	4800
			76	7			

Performance of the LARD

The design of the LARD was tested in codends of 400 and 600 meshes circumference and positioned in the most frontal codend sections. To contribute to overall stability, the design improved by using a Dyneema 5 mm twine diameter instead of the 12 mm nylon twine tested on the first trials in 2001 and adapting the shape to the profile of the tunnel.

The results showed that the progress on achieving a stable performance of the LARD was not achieved if combined with 90 degrees rotated meshes (T90) in the tapered sections, in front of the LARD. The experiments in 2007 and 2008 on board SCH118 (Excluder II, Haan et al., 2008a) and SCH81 (Excluder III, Haan et al., 2008b) included water flow measurements with a set of autonomous instruments (type AquaDopp) mounted on several T90 and LARD positions in and outside the trawl. The results showed a lower water velocity inside the LARD, which linked the mal-functioning of the LARD to T90 meshes in the tapered sections. Under this condition, entanglements of fish in the LARD meshes increased the escape tunnel entrance, reducing the overall filtering efficiency.

Underwater video equipment was eventually executed using battery powered digital video recorders, which limited the underwater observed period to 2 hours at maximum. On the trials in 2007 and 2008 recordings were extended to 7 hours using flash card memory and also involved night hauls by the addition of LED illumination.

References

- Haan, D. de, Burggraaf, D., Heessen, H. J. L., Couperus, A. S. 2008a. Excluder II 2007. Report C042/08, date of issue 28 May 2008.
- Haan, D. de, Burggraaf, Overzee, H. van, Heessen, H. J. L., Couperus, A. S. 2008b. Excluder III 2008. Report C073/08, date of issue 12 December 2008.

- ICES. 1996. Report of the study group on grid (grate) sorting systems in trawls, beam trawls, and seine nets. ICES CM 1996/B:1.
- Isakson, B., Valdemalsen, J. W., Larsen, R. B. & Karlsen, L. 1992. Reduction of fish by-catch in shrimp trawl using a rigid separator grid in the aft belly. *Fish. Res.*, 13: 335-352. ICES. 1996. Report of the study group on grid (grate) sorting systems in trawls, beam trawls, and seine nets. ICES CM 1996/B:1.
- Poiner, I. R., Buckworth, R. C., and Harris, A. N. M. 1990. Incidental Capture and Mortality of Sea Turtles in Australia's Northern Prawn Fishery. *Australian Journal of Marine and Freshwater Research*. 41, 97-110
- Watson, J.W. and Seidel, W.R., 1980. Evaluation of techniques to decrease sea turtle mortalities in the southeastern United States shrimp fishery. ICES C.M. 1980/B:31.