MINOUW

Case study results

2.2 - Algarve Purse seine fisheries, Portugal

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SUMMARY

Off the Algarve coast, methods to minimize slipping delayed mortality of sardines after purse seine capture were tested. Fishing trials to test the practicability and efficiency of different slipping techniques for the sardines were carried out. One survival experiment was performed by obtaining sardines from one commercial fishing trip comparing two different slipping methods (standard and modified) and a control. Fish were transported to be monitored in captivity for 28 days. Survival, scale loss, physiological and biological (weight, length) parameters were measured. The results of this survival assessment demonstrate that using a modified slipping technique during purse seine operations may significantly improve survival of slipped pelagic fish as also decrease scale loss of escapees.

CASE STUDY RESULTS

Type of intervention

Modified slipping technique

Aim of the experiment

To test methods to minimize slipping delayed mortality of sardines after purse seine capture off the Algarve coast (Portuguese Southern coast)

Main activities carried out

Two slipping procedures for the sardines (Sardina pilchardus) were evaluated: the first one is based on the fastest, easiest and most used technique in the purse seine fleet in the Algarve (Standard slipping), and second is based on a more complex technique that uses weights to lowering the float line which is used by some fishing captains in the Algarve (Modified slipping).

Live sardines were collected after being captured following commercial purse seine fishing operations in a trip that took place in late April 2016 off the port of Olhão, at night and in relatively good sea conditions (wave height 0.5 - 1m). Fishing operations followed the typical commercial purse-seine practices (Stratoudakis and Marçalo, 2002). Live sardines were then sub-sampled in three different scenarios:

standard slipping operation; b. modified slipping operation and c. control

Capture and Transfer of Live Fish

To obtain sardines for controls (less crowded fish), drying up of the net was interrupted at its final stage to avoid additional damage. To facilitate fish transfer, crew members and researchers collected fish swimming within the netted area and transferred them from the net directly to the transport tanks of the fishing vessel using 10 l buckets and 15 l vinyl scoops. Following this process, the net was bunted and 4-5 sets of 10 Kg weights were put along the headline in order to allow an escape window to form (Figure 1a). This operation was called the modified slipping operation, and sardines freely swimming out of the net were collected. Next, within 10-15 minutes, bunting was completed and fish were made to roll over the headline and slipped back into the water (standard slipping, Figure 1b) and collected. Fish transfer was fast (~5-10 min for each treatment) and sardines were collected for each treatment and placed into three 600 l transport tanks (3 replicates per treatment) previously filled with oxygenated sea water (100–150% saturation). Fish stocking densities were visually adjusted and deviations from intended transport densities occurred, but in most cases densities <5 kg m3 were achieved (Table 1) as suggested in Marçalo et al.(2008). On arrival at the port, each tank was transported to the Aquaculture Research Station of IPMA in Olhão (5 min per trip).

Maintenance in captivity

At the Aquaculture Research Station, sardines in each transportation tank were rapidly transferred into 3000 litre outdoor holding tanks. An open-system water circulation and variable water flow (minimum of 1.8 m3/h) was used, with an aeration inlet placed at the centre of the tank to facilitate the circular movement of fish. Nets were used to cover each tank to avoid accidental deaths from fish jumping out. In all cases, fish were kept under a natural light regime and photoperiod. The monitoring study period lasted 28 days. Fish were fed with dried pellets at a daily rate of 1–2% biomass (wet mass). Gilthead seabream (Sparus aurata) and meagre (Argyrosomus regius) eggs when available (in the first two weeks in captivity) at the aquaculture station were also provided and fed to the sardines.

Monitoring

The holding tanks were monitored daily, recording water temperature, fish behaviour and the number of deaths. Dead fish were removed from the tank twice daily (in the morning and late afternoon) to maintain good water conditions, placed in individual plastic bags and frozen for subsequent biological and scale-loss analysis, and to tabulate daily mortalities. In addition, blood samples from a sub-sample of fish from the three treatments (control, modified slipping and standard slipping) were taken immediately after capture at sea, as well as during the monitoring phase, to describe early post-capture evolution of physiological variables.

Data Analysis

The survival of sardines over time was modelled using a parametric Weibull mixture distribution model that has previously been applied to data for discard mortality (Benoît et al., 2012; 2015). This model has been shown to be well suited to these types of data as it models survivorship as a decreasing function of time for an initial period post release, followed by an asymptote at which the mortality associated with capture and handling is assumed to have been fully expressed. The model is fit to observed times of mortality for individual fish and can accommodate censored observations, in the present case, right censored observations for fish that were removed alive from the experiment when it was terminated at 28 days and for which the time at mortality is known only to occur after the time of censoring.

Benoît, H.P.; Hurlbut, T.; Chassé, J.; Jonsen, I.D. (2012). Estimating fishery-scale rates of discard mortality using conditional reasoning. Fisheries research 125-126: 318-330.
Benoît, H.P.; Capizzano, C.W.; Knotek, R.J.; Rudders, D.B.; Sulikowski, J.A.; Dean, M.J.; Hoffman, W.; Zemeckis, D.R.; Mandelman, J.W. (2015). A generalized model for longitudinal short- and long-term mortality data for commercial fishery discards and

recreational fishery catch-and-releases. ICES Journal of Marine Science, fsv039. doi:10.1093/icesjms/fsv039
Marçalo, A.; Pousão-Ferreira, P.; Mateus, L.; Correia, J.H.D.; Stratoudakis, Y. (2008). Sardine early survival, physical condition and stress after introduction to captivity. Journal of Fish Biology 72: 103–120.
Stratoudakis, Y.; Marçalo, A. (2002). Sardine slipping during purse-seining off northern Portugal. ICES Journal of Marine Science 59: 1256–1262.

Main results

Survival at asymptote (with 95% CI) was estimated at 43.6% (CI: 38.0 to 49.3) for the control, 44.7% (CI: 39.3 to 50.1) for the modified slipping and 11.7% (CI: 8.9 to 15.2) for the standard slipping treatments (Figure 3).
The estimated time to asymptote was shorter for the standard slipping treatment at 9.8 days (8.9 to 13.0) compared to the other two treatments 14.6 days (10.8 to 16.2), confirming that all delayed mortality had been observed.
Median sardine scale loss for the first two days in captivity for both of the two slipping treatments was of 48.8 and 70.6 % for the modified and standard slipping respectively, with the standard treatment showing significant differences from the control (42.3 %) and modified treatment (Kruskal-Wallis: H =73.3, d.f. = 2, P<0.001; Dunn´s test: P>0.05 for the relevant pair groups.

Discussion of the results

The results of this survival assessment demonstrate that using a modified slipping technique during purse seine operations may significantly improve survival of slipped pelagic fish. Off Portugal, commercial purse seining operations typically end with complete bunting/crowding and thus any slipping would constitute a stressful event, leading to physiological, physical and behavioural alterations, culminating in variable delayed mortality of escapees (Marçalo et al. 2006, 2010, 2013). This assessment showed that mortality and scale loss of sardines slipped using the standard method after fishing operations was significantly higher than the observed in the control (not bunted/crowded) and modified slipping groups. The number of replicates (three replicates for each group) provided consistency in the evidence that the modified slipping method is a reliable technique to reduce substantial and unaccounted mortality, which directly relates to levels of physical damage (scale loss) after crowding when standard slipping is applied (Lockwood et al. 1983; Olsen et al. 2012; Marçalo et al. 2008, 2010).
There are obviously other factors not considered in this work, such as fishing duration, catch size, and environmental variables like water temperature or sea conditions, all important variables that may modify survival because they are known to significantly affect physiological, physical and behaviour of escapees (Marçalo et al. 2008, 2010, 2013). However, our results consolidate previous findings using laboratory fishing simulations with sardines (Marçalo et al. 2010). Most importantly, this assessment has demonstrated that the modified slipping technique not only promotes a quicker and spontaneous escape of unwanted catches after purse seining, but also reduces the likelihood of injury and mortality of released sardines. Therefore, modifications to commercial fishing practices that lead to a higher probability of survival should be adopted and implemented in purse seiners operating off mainland Portugal.

As finding ways to mitigate mortality of escapees due to slipping and to improve release techniques becomes a priority, decisions should take into consideration the functionality of the fishery. Direct guidance from the purse seine fishing sector, which is known to be proactive in collaborating with the scientific community, will greatly facilitate the development of strategies to reduce bycatch and/or discarding (Marçalo et al. 2015). In addition, a code of good practice (CoP) should be adopted, implemented, spread and followed. Future work should rely on delivering the CoP information to the fishing community.

Lockwood, S. J.; Pawson, M. G.; Eaton, D.R. (1983). The effects of crowding on mackerel (Scomber scombrus L.) physical condition and mortality. Fisheries Research 2: 129–147.

Marçalo, A.; Mateus, L.; Correia, J.H.D.; Serra, P.; Fryer, R.; Stratoudakis, Y. (2006). Sardine (Sardina pilchardus) stress reactions to purse seine fishing. Marine Biology 149: 1509–1518.

Marçalo, A.; Pousão-Ferreira, P.; Mateus, L.; Correia, J.H.D.; Stratoudakis, Y. (2008). Sardine early survival, physical condition and stress after introduction to captivity. Journal of Fish Biology 72: 103–120.

Marçalo, A.; Marques, T.A.; Aráujo, J.; Pousão-Ferreira, P.; Erzini, K.; Stratoudakis, Y. (2010). Fishing simulation experiments for predicting effects of purse seine capture on sardine (Sardina pilchardus). ICES Journal of Marine Science 67: 334–344.

Marçalo, A.; Araújo, J.; Pousão-Ferreira, P.; Pierce, G. J.; Stratoudakis, Y.; Erzini, K. (2013). Behavioural responses of sardines Sardina pilchardus to simulated purse seine capture and slipping. Journal of Fish Biology 83: 480-500.

Marçalo, A.; Feijó, D.; Katara, I.; Araújo, H.; Oliveira, I.; Santos, J.; Ferreira, M.; Monteiro, S.; Pierce, G.J.; Silva, A.; Vingada, J. (2015). Quantification of interactions between the Portuguese sardine purse seine fishery and cetaceans. ICES Journal of Marine Science 72 (8): 2488-2449.

Olsen, R.E.; Oppedal, F.; Tenningen, M.; Vold, A. (2012). Physiological response and mortality caused by scale loss in Atlantic herring. Fisheries Research 129-130: 21-27.

How practical is it for a fisherman to implement this improvement, technically and financially?

The use of the modified slipping technique during purse seining operations implies an application of the weights to submerge the floating line prior to the complete bunting, the fish escapes freely out of the net, the number of weights depends on the size of the window needed which is directly related to the size of the catch to be released. The cost of the weight sets could probably vary between 30-60 euros

Is there sufficient evidence to support wider adoption of the method/technology?

Our experiments have shown that the use of the modified slipping technique can significantly reduce the mortality of slipped sardines, thereby improving survival of escapees. Also, the method is very practical and easy to use which favours the acceptance of the fishermen to use it to obtain cleaner catches or release excess or unwanted catch (when mix schools are present, usually sardines swim on top and chub mackerel at the bottom; during the sardine ban, sardines must be released, but fishermen target the chub mackerel).

CONCLUSION

The results of the present study demonstrate that using a modified slipping technique during purse seine operations, may significantly improve survival of slipped pelagic fish. Mortality of sardines slipped using the standard method after fishing operations was significantly higher (3 times higher) than the observed in the control (not bunted) and modified slipping groups. This pattern was also observed in the level of scale loss observed. The use of replicates provided consistency in the evidence that the modified slipping method is a reliable technique to reduce substantial and unaccounted mortality, which directly relates with levels of physical damage (scale loss) after crowding when standard slipping is applied. The most important outcome is that complete bunting and ultimately slipping over the headline, causes more physical injury and reduces the probability of survival of slipped fish.

ADDITIONAL RELEVANT RESOURCES OR LINKS

EU Common Fisheries Policy (CFP) Reform: https://ec.europa.eu/fisheries/cfp_en
International Guidelines on Bycatch Management and Reduction of Discards: http://www.fao.org/fishery/nems/40157/en

Table 1. Summary information for the field and monitoring/maintenance operations. Mean values and ranges (in parentheses) are provided for transport density at sea, holding temperature, number of fish, length, weight and condition factor.

At Sea								Captivity				
Date of capture	SST (°C)	Depth (m)	Catch (tons)	Treatment	N Replicates	N fish	Density (kg/m3)	T (°C)	Length (cm)	Weight (g)	Condition factor	Days of monitoring
29 April 2016	16.9	39.1	1.2	Control	3	106 (89-126)	3.8	19.1 (18.4-22-1)	14.1 (13.2-14.9)	21.7 (15.7-27.6)	7.7 (6.1-9.3)	28
				Modified slipping	3	118 (108-127)	4.2	19.1 (18.4-22.3)	14.0 (12.2-15.1)	21.6 (16.6-28.3)	7.8 (6.5-9.1)	
				Standard slipping	3	143 (134-149)	4.9	19.5 (18.4-22.2)	14.0 (12.6-14.9)	20.7 (15.1-26.8)	7.5 (5.5-11.1)	

Figure 1. Diagram showing the two slipping methods

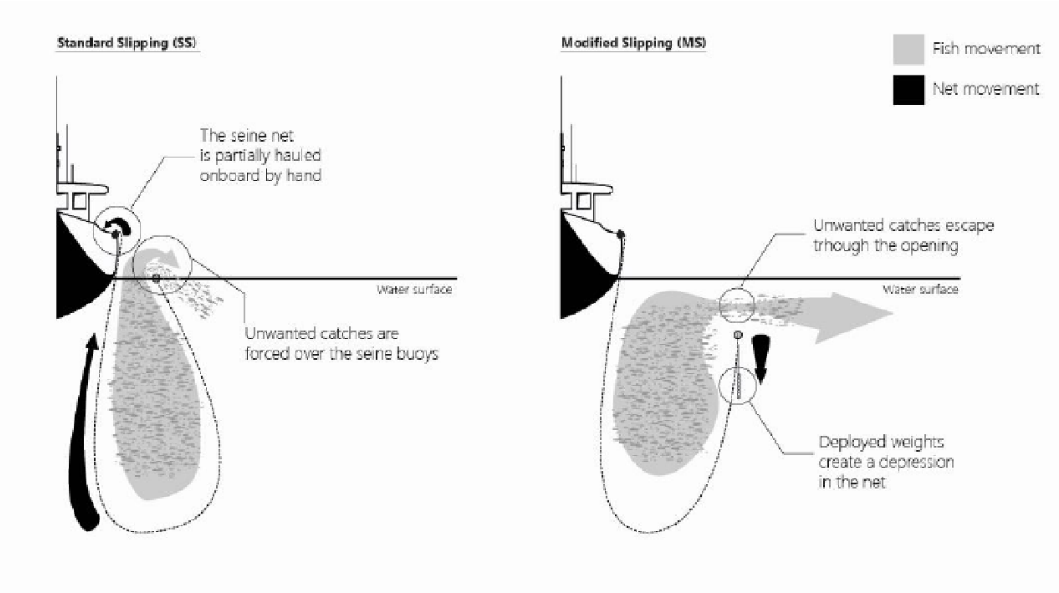
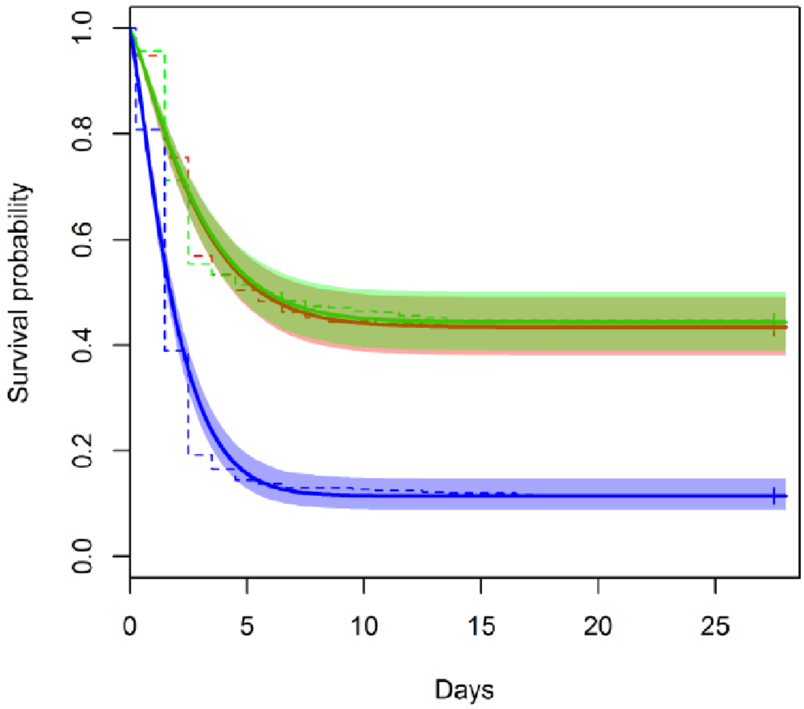


Figure 2 Kaplan-Meier survival curves (dashed lines), overlaid with Weibull mixture-distribution model survival estimates (solid lines with 95% confidence bands) for Sardine in CS2.2 from three treatments: Control (Red), Standard slipping (Blue) and Modified slipping (Green).

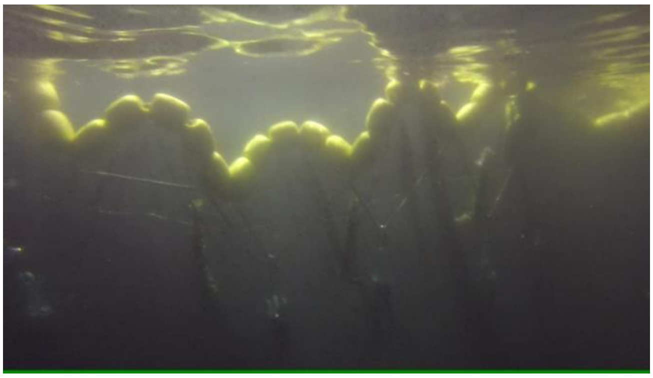


Examples of photos of the experiments

Fig. 1 – Weights used for the modified slipping technique

Fig. 2 – Application of the weights by the crew of the auxiliary boat

Fig. 3 – Formation of a fish escape window in the purse seine floating line by using weights



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