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Testing the effect of soak time on catch damage in a coastal gillnetter and the consequences on processed fish quality

Esther Savina [a, *], Junita Diana Karlsen [a], Rikke Petri Frandsen [a], Ludvig Ahm Krag [a], Kasper Kristensen [b], Niels Madsen [a]

[a] Technical University of Denmark, National Institute of Aquatic Resources, North Sea Science Park, PO Box 101, DK-9850, Hirtshals, Denmark
[b] Technical University of Denmark, National Institute of Aquatic Resources, Charlottenlund Slot- Jægersborg Allé 1, DK-2920, Charlottenlund, Denmark

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ABSTRACT

This study aims at testing how to improve catch quality aboard a coastal gillnetter by looking at an easily controllable parameter known to have an effect on the degree of fish damage, soak time, and investigating if the registered damages on whole fish have an effect on processed products such as fillets. Plaice (*Pleuronectes platessa*) was captured with commercial gillnets soaked for 12 and 24 hours. Damages were assessed using semi-quantitative indices of individual fish condition gathered in a Catch-damage-index for onboard fish and a Processed fish-damage-index for whole, skinned and filleted plaice processed at a land-based factory. Cumulative link mixed modelling allowed the estimation of the size of effects. Damage in fish was significantly more likely for longer soak times but effects were comparable to those of fish length and between-sets, making a change in soak time not so substantial for improving plaice quality in coastal gillnetting. Damage in fish was significantly more likely for whole than filleted fish, but there was substantial heterogeneity among fish. Severe damage in whole fish may not matter in filleted fish whereas some damage may only be visible at the fillet level.

1. Introduction

The gillnet fleet is of importance in Denmark and is gaining interest as an alternative practice towards improved environmental sustainability with regard to energy use and ecosystem effects (Andersen, Ulrich, Eigaard, & Christensen, 2012; Suuronen et al., 2012). The coastal vessels provide the opportunity of daily fresh fish supply, but maintaining profitable is challenging, and calls for solutions to help improve catch production. Raw material is increasingly identified as a key factor in fish quality, and catch damages may result in reduced price or discarding (Esaiassen, Akse, & Joensen, 2013; Lawler, 2003; Margeirsson, Jonsson, Arason, & Thorkelsson, 2007; Santos, Gaspar, Monteiro, & Vasconcelos, 2002). In the gillnet fisheries, more fish are discarded due to poor quality than being below the legal minimum landing size (Batista, Teixeira, & Cabral, 2009; Borges et al., 2001; Gonçalves et al., 2008; Morandeau et al., 2014). Challenges in gillnets are that fish can die in the gear when the net is soaked, the netting can cause marks on the fish skin, and there is an increased risk of injuries due to predation or scavenging of fish in the gear (Auclair, 1984; Perez & Wahrlich, 2005; Petrakis, Cheilari, & Cambiè, 2010; Santos et al., 2002; Suuronen et al., 2012). Improvement in catch quality is important for the coastal gillnet fisheries as it may limit wastage of raw materials, maximize production for the industry and benefit to consumers.

Among the parameters that matter on the quality value of the raw material such as environmental variations or handling and storage methods, capture procedure, especially soak time, is a controllable parameter (Esaiassen et al., 2013; Olsen et al., 2014; Özogul & Özogul, 2004; Özyurt et al., 2007). It might be an advantage for the fishermen to soak for long time periods to maximize catch per unit effort, but previous experiments have shown that the proportion of dead fish and degree of damage increase with the soak time (Acosta, 1994; Hickford & Schiel, 1996; Hopper et al., 2003; Petrakis et al., 2010; Santos et al., 2002; Suuronen et al., 2012). Natural variations such as fish length are also known to influence quality (Esaiassen et al., 2013). As there might be no effect of the registered damage on whole fish in processed products such as fillets, severity of catch damage in whole fish has to be analysed against the quality of processed products

* Corresponding author.
E-mail address: esav@aqua.dtu.dk (E. Savina).

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(Esaiassen et al., 2013).

In the coastal fishery, fish is usually landed less than one day after capture and freshness, i.e., age of the raw material, which is usually perceived as the most important attribute of the quality of fish, is not appropriate (Denton, 2003; Esaiassen et al., 2013; Martinsdóttir, Luten, Schelvis-Smit, & Hyldig, 2003). Instead, previous studies have used semi-quantitative indices of individual fish condition grouped in an index to evaluate whole or processed fish damage in fishing gears (Depestele, Desender, Benoît, & Polet, 2014; Digre, Hansen, & Erikson, 2010; Digre, Tveit, Solvang-Garten, Eilertsen, & Aursand, 2016; Karlsen, Krag, Albertsen, & Frandsen, 2015; Olsen, Tobiassen, Akse, Evensen, & Midling, 2013; Rotabakk, Skipnes, Akse, & Birkeland, 2011). Most studies used hypothesis testing which does not allow for the estimation of the size of effects, unlike model-based methods such as cumulative link mixed modelling which is appropriate for ordinal multi-category responses. It also tolerates random effects which are relevant here to account for within-haul (or set) correlations as well as to tackle scoring subjectivity, i.e., there may be differences in the assessment when all fish in a set are in similar condition or when they show a broader range of damage severities (Benoît, Hurlbut, & Chassé, 2010).

This study aimed at assessing (1) the effect of soak time in comparison with an uncontrollable natural variation, fish length, and set effect on catch damage onboard a commercial gillnetter and (2) the change in quality between whole fish, and skinned and filleted products at a land-based processing factory. Plaice (*Pleuronectes platessa*), one of the main target species in the Danish coastal gillnet fisheries, was taken as a case study.

2. Materials and methods

2.1. Experimental design and sea trials

Trials were conducted on the commercial gillnetter HG5 Skovsmose (11.99 m, 171 kW) in the Skagerrak coastal waters for eight consecutive days in September 2014. Commercial plaice gillnets with 136 mm nominal stretched mesh size and 0.30 mm twine were used in all sets. Each net was 2 m (stretched) high, 82 m long and slackly hung with a hanging ratio of 25%. Three individual nets were attached together by connecting the sink and float lines at the start and end of each net (2 m apart of one another) to form a fleet, i.e., a ganged sequence. In total, nine fleets were constituted. The soak times 12 and 24 hours (h) covered the usual range of commercial practices in Danish coastal waters. Every day, three fleets were soaked for 24 h. Simultaneously, three fleets were soaked for 12 h during the day and three others during the night to account for a possible day-night effect. The nets were located over a single known habitat type, sandy bottom, at the same depth. Fleets were randomly positioned to avoid any spatial effect, and spaced by a minimum distance of 111 m in latitude and 60 m in longitude to prevent competition between them. Fleets were set with the current, parallel to the coast, and anchored at both ends using 6 m bridle lines and 4 kg anchors following commercial practices. Fleets were hauled aboard the vessel using a hydraulically-powered net hauler with top roller.

2.2. Handling of the catch

Two professional fishermen disentangled the catch from the netting on a sorting table during hauling, and put it in open mesh baskets making sure not to overfill them. The same scientist sorted all captured fish from the baskets, measured and assessed whole plaice for catch damage on deck immediately after hauling in a dedicated work station protected from wind to prevent dehydration of fish. Plaice below the legal minimum landing size of 27 cm (E.U, 2013), dead fish or those below the freshness category B according to the European Union scheme (E.U, 1996) and considered unfit for consumption were not landed according to commercial practices. Retained fish were handled following standard commercial practices. Fish were washed to remove debris in the open mesh baskets with an adequate supply of clean seawater from a hose. The two professional fishermen gutted the fish, i.e., the intestinal tract and internal organs were removed, by hand with a knife. Gutted fish were cleaned in a washing tank for a minimum of five minutes with seawater to remove blood and viscera from the belly cavity. The scientist checked for the quality of bleeding by gutting. Fish were discharged down a chute to the cooling room below deck, where the individuals from the three soak times were stored separately in standard plastic boxes in shallow layers surrounded by fine melting ice following standard commercial practices for later assessment at a fish processing factory.

2.3. Quality assessment

All captured plaice were assessed for catch damage onboard the vessel (Fig. 1) using a Catch-damage-index (CDi) initially elaborated for gadoids by Esaiassen et al. (2013) and adapted for flatfish with the following minor adaptations. The CDi scheme lists damages caused by fishing gear and handling onboard together with scores relative to the severity of the damage and its influence on the quality of the raw material (Table 1). Damages were scored according to their position on the fish and were considered moderate when in fin or tail part and severe when in body part. A fish was considered dead if it did not show gill movement and was unresponsive to touch immediately after hauling the catch onboard. As all the individuals were faultlessly bled by gutting and there was no use of gaffs, the two attributes 'poorly bled' and 'gaffing damage' were not included in the assessment scheme. The scores for each attribute in the CDi scheme ranged from 0 for flawless to 2 for most severe (Table 1, see Fig. 2 for examples of ratings). The CDi was then calculated for each individual by summing the scores for all attributes. The CDi scale ranged from 0 for flawless to 12 for most severe.

To limit the variation in factors that could have an influence on the assessment of landed fish at the processing factory, only sets for which similar storage conditions could be guaranteed were included in the analysis. The assessment was exclusively run for the 12 h soaks at night and 24 h soaks, and only for five of the seven days of data collection. Onboard storage of the fish assessed at the factory lasted no more than 4 h. After landing, eight fish from each of the two soak time categories (12 h at night and 24 h) were randomly picked and labelled (Fig. 1). These fish were kept until the next day in a cooling room at 2 °C in two standard commercial plastic boxes. The boxes were kept one on top of the other with an empty plastic box on top to prevent differential drying of the fish. On the day following hauling of the net, fish were brought to the fish factory, and assessed for quality by the same quality representative from the factory using a Processed fish-damage-index developed for the purpose of this experiment. This scheme lists the attributes looked at by exporting companies when fish is evaluated at the fish auction: skin or surface appearance, bruises or discolouration, and texture (Karlsen et al., 2015, Table 2). Such a scheme provides a finer degree of discrimination than the EU quality grading scheme currently in use (E.U, 1996). The scores for each attribute in the Processed fish-damage-index scheme ranged from 0 for flawless to 2 for most severe (Table 2, see Fig. 2 for examples of ratings). Gaping is when the individual flakes of muscle come apart giving the fish flesh a broken appearance. A fish in pre-rigor or rigor stage is considered to be of good freshness by the