Marine Policy 77 (2017) 23–29

Contents lists available at ScienceDirect

Marine Policy

journal homepage: www.elsevier.com/locate/marpol

Narrowing down the number of species requiring detailed study as candidates for the EU Common Fisheries Policy discard ban

Marie Morfin[a,*], Sonia Méhault[a], Hugues P. Benoît[b], Dorothée Kopp[a]

[a] IFREMER, Unité de Sciences et Technologies halieutiques, Laboratoire de Technologie et Biologie Halieutique, 8 rue François Toullec, F-56325 Lorient Cedex, France

[b] Gulf Fisheries Centre, Fisheries and Oceans Canada, Moncton, NB, Canada, E1C 9B6

ARTICLE INFO

Keywords:
Landing obligation
Discard mortality
Hypoxia
Artisanal bottom trawl fishery
Bay of Biscay
English Channel

ABSTRACT

By 2019, the Common Fisheries Policy will prohibit discarding in all European fisheries of any pelagic, demersal or shellfish species for which removals are managed by TACs and quotas or minimum sizes. However, the regulation allows for exemptions from the prohibition for species for which scientific evidence demonstrates high survival rates associated with discarding. Producing reliable evidence of high survival typically requires long and costly studies involving tagging or captivity. This paper proposes to use the capacity to resist air exposure, a key stressor for discarded animals, as a proxy for survival that can be used to prioritize candidate species for more in-depth discard survival studies. The time required to induce mortality (TM) in air-exposed fish was estimated for ten discarded species under commercial fishing conditions for two artisanal French otter trawlers in the Bay of Biscay and in the English Channel. European seabass, plaice, sole and skates had extended TM values on average, suggesting that these species are good candidates. The three species observed in both regions (plaice, sole and skates) had larger TM values in the English Channel experiment compared to the Bay of Biscay experiment. Among the four measured external conditions that could influence TM (air temperature, fish length, tow depth and tow duration), the air temperature was the most important and the factor that most distinguished the two experiments.

1. Introduction

The discards from commercial fisheries are of particular concern as they can represent a substantial part of the catch. Though the long-term consequences on populations and ecosystems are not well-understood [1], fisheries management policies recommend their reduction [2]. Several approaches are already being used to decrease discards rates such as gear modifications [3,4], area closures [5], acoustic and optical detection [6] and local discard bans [7]. The European Union recently modified its Common Fisheries Policy (CFP) and has enacted a landing obligation under which discarding of species under quota management will be prohibited (Official Journal of the European Union, December 28th, 2013). However, the regulation acknowledges that there may be net benefits to conservation of allowing discarding in certain instances where there is strong potential for successful live release. Specifically, article 15 paragraph 4(b) of the regulation allows for the possibility of exemption from the landing obligation for “species for which scientific evidence demonstrates high survival rates, taking into account the characteristics of the gear, of the fishing practices and of the ecosystem”. While no threshold has been defined for a “high survival rate”, exemptions will be allowed for species and fisheries with the highest discard survival probabilities.

Capture in trawls is known to be highly stressful for fish, involving injury by abrasion and crushing, scale loss and exhaustion by sustained swimming [8], with severity depending on the gear type and how it is fished (e.g. haul duration, towing speed) [9,10]. When the trawl is hauled back, overcrowding of fish in the net, along with changes in environmental conditions such as pressure, salinity and temperature may induce additional stress and injuries [10,11–13]. As a result, many individuals may be already dead upon arrival on deck. For those that survive the catching process, air exposure during catch handling is amongst the strongest stressors contributing to mortality [11,14–16]. Temperature and light conditions have also been found to influence survival [17,18]. Among fish that are still alive when thrown back to the sea, weakened individuals are at greater risk of avian and marine predation [19].

Depending on fishing conditions, species [20] and body size [14,17], individuals may withstand stress and injury very differently [21], resulting in variable post-release survival of discards. The Expert Working Group 13–16 (EWG13-16) from the Scientific, Technical and

* Corresponding author.
E-mail address: marie.morfin@ifremer.fr (M. Morfin).

http://dx.doi.org/10.1016/j.marpol.2016.12.003
Received 11 May 2016; Received in revised form 20 September 2016; Accepted 5 December 2016
Available online 19 December 2016
0308-597X/

Economic Committee for Fisheries (STECF, 2013) established a general methodology to accurately estimate the survival rate and identify the associated external factors, based on captive observation [4,21], vitality and reflex assessments [22–24] and tagging or biotelemetry experiments [25,26]. These methods typically require experiments that can be of long duration, cost-prohibitive or unfeasible for areas where discard composition may be very diversified [27,28]. Thus there is a need for methods for prioritizing cases where high discard survival is likely and where further study can be targeted. Several studies have shown that air exposure is one of the greatest contributors to discard mortality within and among species [14,15,29,30], particularly in trawl fisheries where fish can spend considerable time on deck. Differences in resistance to hypoxia among species and sizes of fish have been shown to be good proxies of discard mortality rates for trawl caught individuals [14]. The time required to induce mortality (TM) in air-exposed fish is therefore a simple metric that can be used to identify candidates for a possible landings obligation exemption.

This study analyzed the TM for a number of discarded fish species from the French artisanal otter trawl fishery. Selected species were those that constituted a large part of the discards in these fisheries [28] and represent a diversity of taxonomic orders (Gadiformes, Perciformes, Pleuronectiformes, Rajiformes and Scorpaeniformes). The association of TM with four external factors (tow depth, tow duration, air temperature and fish length) that have been shown to affect discard survival (reviews in [8,31]) was also investigated in order to identify factors potentially influencing discard mortality in the French fisheries.

2. Material and methods

2.1. At-sea experiments

2.1.1. Fish mortality following capture and air exposure

A first trial was held in the Bay of Biscay (BB; East Atlantic, ICES subarea VIIIa) in June 2014 onboard a 10.3 m long trawler and a second trial was held in July 2015 in the eastern English Channel (EC; ICES subarea VIId) onboard a 10.95 m long trawler (Fig. 1). Both commercial vessels were rigged with a single bottom trawl, which is commonly used to target multispecies fish assemblages. The codend mesh sizes were 70 mm in the BB and 80 mm in the EC, and the headline lengths were 20 m and 17.5 m respectively. The crew aboard each vessel was asked to maintain usual on-board handling practices in order to obtain samples that were representative of normal commercial fishing conditions. The same observers participated in commercial fishing trips aboard these vessels prior to and during the experimental trips and confirmed that there were indeed no changes in fishing or catch handling practices. Furthermore, the protocol for the study is not expected to induce any change practices.

Eight hauls were performed in the EC and fourteen in the BB. For both sea trials, experiments were conducted by the same two experienced on-board observers. Discarded fish were obtained during catch sorting by the harvesters. In both trials the sorting time varied from 10 to 50 min, with a mean duration of 30 min, which is representative of practices in the commercial fishery. The time elapsed between the arrival of the catch on the deck and the first observation times varied between 5 and 49 min. Subsequently each individual was monitored regularly at least every five minutes for body and operculum movements. Unresponsive individuals were manipulated to try to elicit a response, failing which they were placed in seawater to determine if ventilation would resume. Fish that failed to ventilate were considered dead, and the duration of their period of air exposure (i.e. their TM) was recorded, as was their total length (cm). Fish that resumed ventilation were kept out of water for further monitoring.

Data on TM for ten species or groups of species were analyzed: European seabass (*Dicentrarchus labrax*), European hake (*Merluccius merluccius*), whiting (*Merlangius merlangus*), horse mackerel (*Trachurus trachurus*), black seabream (*Spondyliosoma cantharus)*

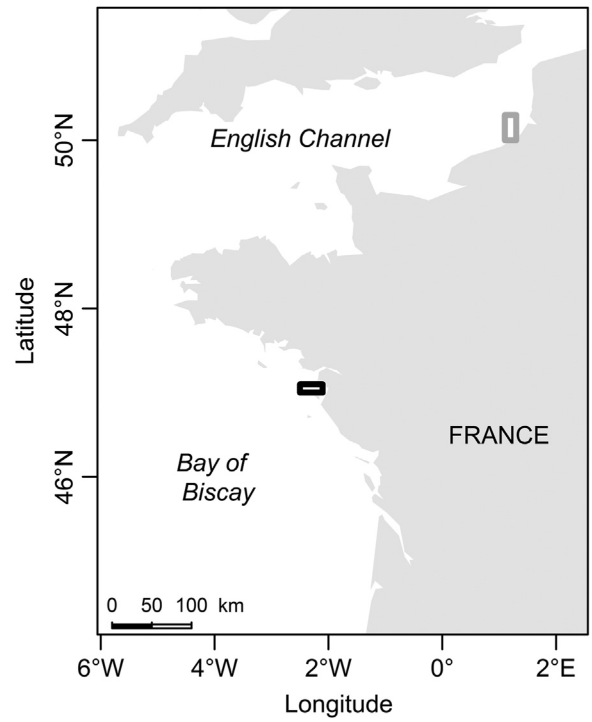

Fig. 1. Study areas. Map of the two study regions along the French coast, in the Bay of Biscay and in the Eastern Channel. Hauls were located in the in shaded lines rectangles.

in the BB; gurnard (Triglidae family) and pouting (*Trisopterus luscus*) in the EC; and plaice (*Pleuronectes platessa*), skates (Rajidae family) and common sole (*Solea solea*) in both areas.

The exact time of death was unknown for 42% of individuals (from 6% for skates in the EC to 100% of hake in the BB) that were dead when first observed. The TM for these individuals is referred to as “interval-censored” in that their time of death is known only to have occurred between the start of the haul and the first observation. Furthermore, two skates and seven plaice in the EC were still alive when the sea trip ended. The TM for these individuals is termed “right-censored” in that their time of death is known only to have occurred after the last monitoring observation.

2.1.2. Environmental, biological and technical covariates

For each haul, a series of potential explanatory variables likely to influence survival were recorded. These included biological (total fish length in cm), environmental (ambient air temperature) and fishing operation factors (tow duration and mean tow depth) (Table 1). The towing speed was maintained at 3 knots (+/-0.5) in both trials and the tow durations varied from 56 to 130 min, at depths varying from 4 to 26 m (see Table 1 for more details). Collinearity amongst covariates is often unavoidable in discard mortality studies undertaken under commercial fishing conditions. Redundant covariates that were highly correlated with other covariates were not included in the analysis. Other retained covariates were associated with moderate levels of collinearity: the deepest hauls were associated with cooler air temperature, longer tows and longer fish in the BB experiment, and with shorter tows in the EC experiment. For both the highly and moderately collinear variables, associations with TM are interpreted in light of the confounding amongst explanatory variables. Details on the variation and covariation of these variables for each species are presented in the Supplementary Material (Figs. S1a–b).

2.2. Analysis

2.2.1. Time to mortality

TM was studied for each species and region separately. The TM