



Bridges to best management: Effects of a voluntary bycatch avoidance program in a mid-water trawl fishery



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ABSTRACT

The catch of non-target species or discarding of target species (bycatch) in commercial fisheries can result in negative species level and ecosystem wide impacts as well as adverse social and economic effects. Bycatch has become one of the foremost, global issues of fishery managers and conservationists, especially when the non-target species is from a protected or threatened population. However, the impact and spatial distribution of bycatch is frequently unknown making it difficult to develop effective, justifiable mitigation regulations. This challenge is exemplified by the bycatch of river herring (alewife, *Alosa pseudoharengus*, and blueback herring, *A. aestivalis*) and American shad (*A. sapidissima*) in the northwest Atlantic mid-water trawl fishery targeting Atlantic herring (*Clupea harengus*) and Atlantic mackerel (*Scomber scombrus*). As an alternative to immediate management action, a voluntary bycatch avoidance program was established through an industry, state government, and university partnership. Here the program is described and its impact is evaluated by comparing fleet behavior and bycatch prior to and during the program. The combined results suggest that consistent communication, facilitated by the avoidance program, positively influenced fishing habits and played a role in the approximately 60% decrease in total bycatch and 20% decrease in the bycatch ratio observed during the program. However, the success of small scale move-along strategies to reduce bycatch ratios varied greatly in different areas of the fishery and years. This suggests the program is best viewed as an intermediate or complimentary solution. Overall, this project exemplifies of how collaborative programs can help alleviate difficult management scenarios.

1. Introduction

Reducing the catch of non-target species or discarding of target species (bycatch) in commercial fisheries has become one of the foremost, global issues facing fishermen, fishery managers and conservationists. These catches can result in substantial negative species level and ecosystem wide impacts and adverse social and economic effects. To reduce bycatch, managers often mandate gear modification, time/area closures, and bycatch quotas [2,15,16]. However, if such approaches are poorly designed, mitigation tactics can result in ineffective regulations that have unintended negative impacts on the target and non-target species, in addition to lost fishery revenue [10,14,23,34]. This situation frequently occurs when protected or threatened species are caught as bycatch. In these cases limited data often prevent a thorough understanding of the patterns and impact of bycatch, but management action is still often taken because any measurable reduction in mortality is perceived as a benefit to the impacted population (see [13,26]). In addition, managers must avoid implementing

contradictory or inadequate management schemes that can cause stakeholder or public resentment such as approaches that prohibit directed fisheries of threatened species, but neglect to adequately address bycatch.

The bycatch of river herring (alewife, *Alosa pseudoharengus*, and blueback herring, *A. aestivalis*) and American shad (*A. sapidissima*) in the northwest Atlantic mid-water trawl fisheries for Atlantic herring (*Clupea harengus*) and Atlantic mackerel (*Scomber scombrus*) (hereafter the mid-water trawl fishery) exemplifies the conundrum of limiting bycatch of threatened species in the face of a poor understanding of its impact [4,18]. River herring and shad are anadromous fishes that serve important ecological roles as prey species for a variety of riverine, estuarine, and oceanic fishes, birds and mammals [8,38] and as transporters of nutrients between their freshwater and marine habitats [24]. In addition, these fishes once supported productive fisheries resulting in their cultural significance along the U.S. and Canadian Atlantic coasts [9]. Currently, river herring and American shad populations along the U.S. Atlantic coast are considered depleted, with river herring

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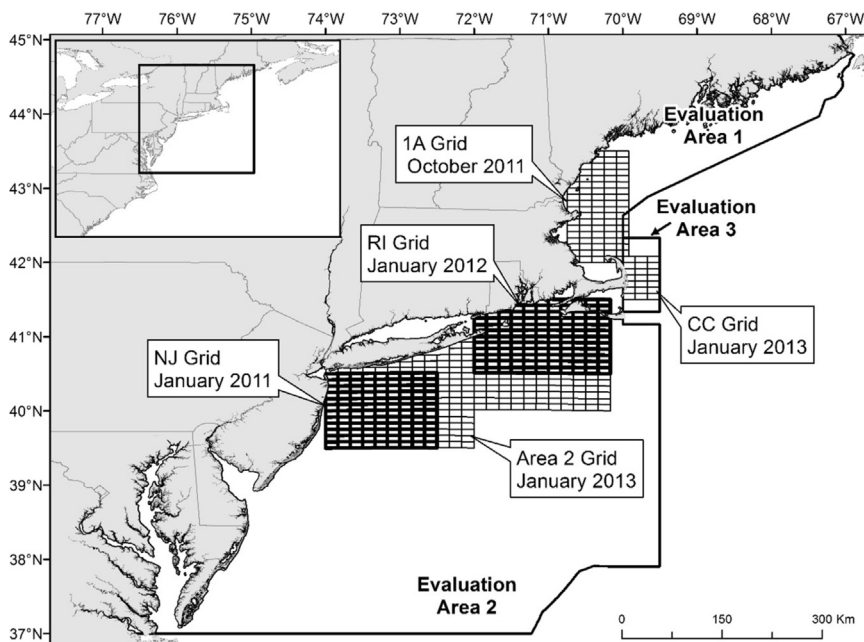


Fig. 1. River herring bycatch avoidance program grids and evaluation areas. The date of establishment is listed for each bycatch grid. The Area 2 grid includes the RI and NJ grids. Grid cells were 10' longitude by 5' latitude.

considered Species of Concern by the National Marine Fisheries Service (NMFS) [33]. Due to this status, many states have implemented moratoria on commercial and recreational harvest and marine fisheries for river herring and American shad are banned [3]. The coast-wide decline of these fishes was likely caused by a myriad of factors including overfishing, habitat loss, pollution, increases in predator populations, environmental factors, and at-sea bycatch [3,33]. Inconsistent signs of recovery despite significant freshwater-focused restoration have led to an increased focus on limiting bycatch by commercial fisheries in the northwest Atlantic.

Of the U.S. northwest Atlantic fisheries, the Atlantic herring and Atlantic mackerel fisheries have been identified as the most likely to have substantial river herring and shad bycatch [41]. Neither Atlantic herring nor Atlantic mackerel are considered overfished, and the two species have considerable economic importance, with annual landing values averaging about US\$27 million and \$2.6 million, respectively, from 2010 to 2014 [29]. Atlantic herring are also the primary bait species used in the lucrative U.S. fishery for American lobster (*Homarus americanus*) [28]. The dominant gear type of both fisheries is the mid-water trawl, which has accounted for over 70% of all landings over the past five years (NMFS vessel trip report data 2011–2015). While the overall bycatch ratio of the mid-water trawl fishery is less than 0.01 [43], hundreds of metric tons of fishes can be caught per trip, making the fishery the focus of management actions regarding the bycatch of river herring and American shad at sea [25,28].

Though the impact of river herring and American shad bycatch in the mid-water trawl fishery is still unknown, regulations have been created to limit this bycatch. In 2015, fleet wide bycatch limits in three areas of the Atlantic herring fishery were implemented based on past river herring and shad bycatch levels in each area [27]. Prior to this, with support from fishery managers, a voluntary bycatch avoidance program was established through an industry, state government, and university partnership [25,28]. The program aimed to intensively sample landings of mid-water trawl vessels and assist fishermen in identifying and avoiding areas with river herring and American shad bycatch [5].

Bycatch avoidance programs in the form of near-real time fleet communications have been implemented in a variety of fisheries with varying success and, in general, these programs have been most effective when coupled with existing or impending regulations [1,17,23,34]. Thus, voluntary programs could play an important role in limiting

bycatch of threatened species, while economically and biologically appropriate bycatch mitigation regulations are developed [21]. However, positive impacts of a program must be shown to justify their use as a bridge solution. Though the bycatch avoidance program in the mid-water trawl fishery has been reviewed favorably in the past [21,23,34], this study represents an in-depth, program-specific evaluation of its impact on the mid-water trawl fleet. Here the impact of the program is evaluated by comparing fleet behavior, total bycatch and bycatch ratios prior to (2007–2010) and during the program (2011–2014), before the creation of bycatch limits. The results of these comparisons are then discussed to determine if they suggest the program influenced fishing behavior and if observed behavioral changes could explain variations in bycatch levels.

2. Methods

2.1. Program background

In October 2010, the Massachusetts Division of Marine Fisheries (MA DMF), the University of Massachusetts Dartmouth School for Marine Science and Technology (SMAST), and several members of the mid-water trawl fishery designed a program with the goal of reducing river herring and shad bycatch in the mid-water trawl fishery. A general overview of the program is provided in this manuscript, but details about the initial design and functionality of the program are described in [5].

Initially 9 mid-water trawl vessels were recruited, with 5 additional vessels joining the program by the end of 2012. Collectively, these 14 vessels accounted for over 95% of the total landings by mid-water trawl gear during the study period (2007–2014 NMFS vessel trip report data). Working collaboratively, the MA DMF, SMAST, mid-water trawl captains, crew members, and on-shore personnel designed and implemented coded grids that overlapped fishing areas with historical river herring interaction. These grids facilitated the communication of the location and timing of bycatch events (Fig. 1). An initial grid was introduced in January 2011 in a 60 × 70 nmi area off of New Jersey, within herring Atlantic herring Management Area 2 (NJ Grid). In October 2011, a second grid was established in a portion of Atlantic herring Management Area 1A (1A Grid). In 2012, an additional grid was added to herring Management Area 2 in the vicinity of Rhode Island Sound (RI Grid). In January 2013, the NJ and RI grids were

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