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REPLY COMMENT

# Discard mortality played a major role in the loss of 10 billion juvenile scallops in the Mid-Atlantic Bight: Reply to Hart & Shank (2011)

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ABSTRACT: An exceptionally large year class ($1.31 \times 10^{10}$ sea scallops) was observed in 2003 in the Mid-Atlantic Bight. Over half of these scallops vanished by 2004. At this time the majority of fishing effort was focused in the Mid-Atlantic due to large closures on Georges Bank. We concluded that this mass mortality was likely the result of incidental fishing mortality. During harvest, scallops were exposed to lethal surface water and air temperatures. Fishermen reported large bycatches of small scallops which were discarded in the 2003–2004 fishing year. Hart & Shank (2011; MEPS 443:293–297) argue that this hypothesis was not likely, as the mortality patterns observed were not consistent with those expected from high discard mortality, and suggested the alternative hypothesis that the mortality was caused by crab predation. After examining estimated retention rates of juvenile scallops collected in scallop dredges with 89 mm rings, prey size preference of crabs, and the limited observer data (5% of 2003 fishing trips), we maintain that discard mortality, due to exposure to lethal water and air temperatures, played a major role in the decrease of juvenile scallop abundance in the Mid-Atlantic Bight.

KEY WORDS: Sea scallop · *Placopecten magellanicus* · Incidental fishing mortality · Crab predation



## Introduction

Between 2003 and 2004, 10.4 billion sea scallops *Placopecten magellanicus* of 30 to 80 mm shell height disappeared in the Mid-Atlantic. We hypothesized that this disappearance was caused by incidental fishing mortality, specifically discard mortality where small scallops were captured, exposed to lethal surface water and air temperatures, and then discarded (Stokesbury et al. 2011). Hart & Shank (2011) argue that this was not likely, as the mortality patterns observed were not consistent with those expected from high mortality due to discarding. They suggest that observer data supports their conclusion and that crab predation is more likely the cause of the mortality.

## Scallop retention in dredges

From March 2003 to February 2004, 81% (23 533 t) of the total US scallop landings were harvested from the Mid-Atlantic using a New Bedford style dredge with an 89 mm (3.5 inch) ring. Hart & Shank (2011) state that scallops larger than the dredge ring size are retained while a substantial proportion of small scallops escape through the dredge rings, citing Yochum & DuPaul (2008). However, Yochum & DuPaul (2008) examined catch selectivity of a 102 mm ring compared to the National Marine Fisheries Service (NMFS) lined dredge and did not examine an 89 mm ring dredge. Brust et al. (2001) estimated that a dredge with 89 mm rings has 57% retention for

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scallops 50 to 55 mm and 90 to 100% retention for scallops 100 to 105 mm shell height. Further, this was under normal fishing conditions with relatively low densities. In cases of extremely high densities, there is a higher likelihood that the rings and inter-ring spaces will become clogged by scallops or debris, resulting in increased retention of smaller scallops (Yochum & DuPaul 2008). To reduce such retention, a 102 mm ring was implemented in 2004 (NEFMC 2003).

## Limited observer data

Reports from scallop fishermen about large quantities of small scallops on deck (Figs. 1 & 2) differ from the observer data on juvenile scallop bycatch that is cited in Hart & Shank (2011). During the 2003 fishing year, there were 310 full-time equivalent vessels in the limited-access scallop fishery that spent a total of 31 864 d at sea (NEFMC 2010a). A typical trip lasted 12 d, resulting in approximately 2655 trips, of which roughly 80% were conducted in the Mid-Atlantic. Of these trips only 108 had observers on board from March 2003 to February 2004 (NEFSC 2010, Table 1B in their Appendix B2). Thus, there was only 5% observer coverage in the Mid-Atlantic throughout the entire fishing year, while the critical discard mortality would have occurred in July, August and September when water and air temperatures exceeded the scallops' lethal limit.

## Averaging confounds exceptional year class numbers

To estimate incidental fishing mortality, Hart & Shank (2011) examined the mean size frequency patterns of the population. They averaged the trend of the numbers of scallops per shell height bin over a number of years to reduce artifacts due to individual year classes. However, the point of our study is that the cohort of scallops observed in 2003 was exceptional; it was the result of a recruitment event that might occur once every 10 or more years. Averaging the year classes from 2003 to 2010 confounds the data and combines the high observed mortality of juvenile scallops during 2003–2004 with the increased fishing mortality resulting from large harvests after the Hudson Canyon, Elephant Trunk and Delmarva closed areas were opened to rotational fishing (NEFMC 2005, 2007, 2010b).

Fig. 1. New Bedford offshore dredge containing scallops *Placopecten magellanicus* captured in the Mid-Atlantic in 2003. New England fishing vessels (25 to 30 m) typically deployed 2 dredges, each weighing about 1870 kg with a width of 4.5 m, a series of vertical and horizontal sweep chains preventing large rocks from entering the bag, a 20.3 mm diamond mesh twine top for fish escapement, a 4.5 × 0.8 m bag knit of 89 mm steel rings and rubber chaffing gear. (Photo by A. Cass)

## Crab predation

Hart & Shank (2011) point out that high densities of small scallops may attract predators as demonstrated in the seeding experiments of Hatcher et al. (1996) and Barbeau et al. (1996, 1998). Crab predation can lead to considerable reduction in the number of small scallops (Stokesbury & Himmelman 1995). However, the densities of crabs observed in the areas of high scallop aggregation (Fig. 1 in Stokesbury et al. 2011), averaging (±SE) 0.05 ± 0.016 crabs $m^{-2}$ in 2003 and 0.03 ± 0.013 crabs $m^{-2}$ in 2004, were lower than the overall densities for the Mid-Atlantic (843 stations with 0.78 ± 0.157 crabs $m^{-2}$ in 2003 and 0.29 ± 0.032

Fig. 2. Dredge contents of a tow from the Mid-Atlantic in 2003, including scallops *Placopecten magellanicus* of varying sizes and species that may clog the dredge. Scallops are processed at sea; the catch is sorted, and rocks, small scallops, and unwanted fish are removed by hand. Usually only 2 to 3 crew members are on deck to process the catch, which can take several hours. In the summer months these scallops are exposed to surface water and air temperatures above their lethal limit. (Photo by A. Cass)

crabs $m^{-2}$ in 2004). This suggests that crabs were not aggregating in the areas with high scallop recruitment. This may be due to the size-refuge bivalves experience from decapod predation (Juanes 1992). Crabs actively select smaller scallops, preferring 20 to 30 mm and 30 to 50 mm shell height when offered 20 to 70 mm and 30 to 110 mm shell height scallops, respectively (Elner & Jamieson 1979, Jamieson et al. 1982). The scallops observed in 2003 were larger than the preferred size range of crabs. The consumption rates cited by Hart & Shank (2011) were for scallops with mean shell heights of 34.1 ± 4.2 mm and 36.5 ± 4.9 mm (Wong & Barbeau 2005) and 25 to 35 mm (Nadeau et al. 2009), which are smaller than the mean shell height of scallops we observed in 2003. Hart (2006) concluded that crabs *Cancer* spp. had no significant effect on scallop recruitment in the Mid-Atlantic from 2000 to 2002, when scallops from the exceptional 2001 year class would have been at optimal prey size. We maintain that crab predation was a less likely cause of the high mortality of small scallops between 2003 and 2004 than discard mortality.

## Conclusions

As noted by Hart & Shank (2011), the cause of the high mortality of juvenile scallops during 2003–2004 may never be known for certain. It is likely that both natural and fishing-related mortality played a role in the loss of 10.4 billion scallops. However, accepting one or the other of these hypotheses as the primary cause has profound implications for fisheries management. If the crab predation hypothesis is correct, then it was a natural occurrence and the timeframe of 13 mo required by NMFS to implement a protective closed area (the Elephant Trunk area) had no effect on the health of the stock. However, we maintain that discard mortality played a major role in the decrease of juvenile scallop abundance in the Mid-Atlantic between 2003 and 2004, and to avoid similar losses in the future requires real-time, spatially specific information and rapid responses by management.

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