

Title page: The design, development, and field testing of an innovative circular net pen to be used to assess bycatch mortality of Atlantic cod at sea.

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Project objectives and scientific hypotheses: The mortality rate of fish discarded after capture is one of the most significant factors affecting marine fisheries management today and is listed by the National Marine Fisheries Service as a priority research area. However, the discard mortality of Atlantic cod (*Gadus morhua*), one of the most commercially important fish in New England waters, has received little investigation following otter trawl capture. This presents a problem because bycatch mortality rates are obviously needed to assess total fishing mortality, to understand population dynamics, and to arrive at correct management strategies. Thus, the determination of discard mortality rates is essential in order for stock assessments and ultimately the successful management of cod in the Gulf of Maine. In contrast to previous studies that have employed cages and on-deck holding tanks to measure bycatch mortality in cod and other species, this study will develop and test expansive net pens with an innovative design that extends from the surface to just above the seafloor. More conducive to normal discard conditions, the spacious open-net system will enable the monitoring of cod in a manner significantly closer to what would be experienced under actual commercial fishing conditions. Such a development will reduce interferences from holding tanks/cages (e.g. forced barotraumas), account for factors such as avian predation at the surface, and strengthen the accuracy of discard mortality estimates for cod and additional species in future studies. The development of a successful net pen will also have broad applications for the future assessment of discard survivorship in others species of need.

Methods and work plan: The PI's were funded through a project development award by the Northeast Consortium to design and test an innovative open net system to study discard mortality at sea. The net was custom built by *Reidar's Manufacturing Inc.* (Fairhaven, MA). The fundamental design of the net pen consists of a collapsible spherical column that floats at the surface and is weighted down but suspended above the seafloor (Figure 1; Appendix 1). The net pen measures 3.3 m in diameter with a maximum net sock height of 20 fathoms. Five, half inch marine grade aluminum rings, enhanced with rod stiffeners provide structural support, maintain the maximum breadth of the top and bottom of the pens, and stop lateral displacement (Appendix 1). Thirty two high impact floats line the top ring and provide buoyancy as well as a lip to keep cod from escaping through the top of the net. There is also a removable inner net that can serve as a shield to eliminate avian predation and/or increase the "lip" size of the ring when in place. The body of the net pen is constructed of 4" square spectra netting. The bottom of the pen is designed as a pot with an opening akin to the codend of a trawl net. This over all design has made for easier storage, transport, deployment, haul-back, and

reduction in depth when in use. This free floating net is then tended by a fishing vessel which is anchored to and floats with the net.

Work completed to date: The net pen was tested for a 24 hour period in September 2007. During this time period, the net was deployed and retrieved 15 minutes later and then re-deployed for 24 hours before final retrieval (Figure 2). The pen was re-deployed for 30 hours on April 16th and 17th, 2008. During this experiment, 40 trawl caught cod were placed in the net (Figure 3). A video camera was inserted into the pen and cod were actively seen swimming within the net. Moreover, it appeared that individual cod were using the net at different depths to recover from the trawling process (Video 1)

Results to date: During the deployment times, the structural integrity of the net was maintained, even when the sea wave-height increased to 2-4 foot for an extended period of time and with the tethering vessel anchored to the sea floor. Based on the success of the net design and the ability for cod to use the net to recover from the trawling process, we believe the net can be deployed for any length of time under the same sea conditions to study discard mortality in a variety of fish species.

Impacts and applications: Now that the net pen has been shown to work through field testing, the logical next test is to use it for the purpose it was created for. Thus, this net would be the first of its kind to address discard mortality of trawled cod under natural conditions, generating data that can be directly considered by the Stock Assessment Review Committee (SARC) within the next NOAA Northeast Regional Stock Assessment Workshop (SAW) for the cod. In providing a scientific basis for management, the SARC considers studies of this nature for the SAW. In addition, this net can be used as an innovative protocol for accurately assessing the short-term discard mortality of additional gadoids and finfish. The spacious open-net system to be utilized will enable the monitoring of fish in a manner significantly closer to what would be experienced under actual commercial fishing conditions while still allowing the assessment of robust sample-sizes. Such a development will reduce interferences from holding tanks/cages (e.g. forced barotraumas) and strengthen the accuracy of short-term discard mortality estimates for cod and additional species in future studies.

As previously mentioned we envision this system, or a modification of it, to be used to estimate short-term discard mortality of various other commercial species in the northwest Atlantic. Moreover, while not monetarily feasible in the proposed study, the use of these net pens to study other causes of mortality such as time on deck, sampling during the summer and winter seasons, or the physiological parameters (i.e changes in cortisol levels) behind the observed mortalities, will only increase our understanding of the fate of discards in the multispecies trawl fishery. Future work left on the duration of the grant period will be consultations with other fisherman, scientists and industrial partners in how we can best facilitate new funding for new studies with this net design.

Related projects: N/A

Partnerships: Captain Joe Jurek and Captain Charles Felch.

Presentations: The seventh annual Northeast Consortium Participants Meeting; title-Skate's, Dogs, and a big net; a cooperative research love story; date-12/11/07; location-Portsmouth NH.

Student participation: Undergraduate: Univeristy of New England: Nathan Furey, Angela Cicia. Graduate: Travis Ford, University of New Hampshire.

Published reports and papers: N/A

Images: See attached files.