WORKING PAPER:

DISCARD MORTALITY OF SUMMER FLOUNDER IN THE INSHORE TRAWL FISHERY

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SUMMARY

In 2007, Cornell University Cooperative Extension received a RSA grant to determine the discard mortality in the inshore summer flounder trawl fishery. Fieldwork was carried out successfully from May through October 2007 off Long Island, New York. Ten scientific trips were made on commercial draggers working the traditional mixed trawl fishery. A goal of the project was to determine discard mortality relative to tow duration, fish size, and the amount of time fish were on the deck of the vessel. Tows of 1, 2 and 3 hours in duration were conducted. Fish were culled both immediately (from 0-10 minutes on deck) and after being held on deck for a delayed period of time (25-35 minutes on deck). Approximately 20 live fish were removed from the immediate and delayed culls upon haul-back of each tow. These live fish were weighed, tagged, and graded by condition before being transferred to a flow through seawater holding system where they were held on deck for the duration of the trip. The total catch of fluke was weighed and sorted between live and dead at consistent intervals of time to determine the effect of culling for a long as it took to clear the deck. Other variables were examined including total catch weight, species composition of total catch, fish condition factors, gear size, water temperature and air temperature. Upon arrival at the dock, live fish were transferred to a dockside net pen holding system and monitored for mortality over a 14-day period. Discard mortality rates were calculated based on the live/dead fraction of fish sorted on deck as well as the mortality rate of the live fish held in the monitoring net pen system over a 14 day period. Mortality rates were calculated by tow duration, cull time and overall. Mortality rates for the one and two hour tows were less than for the three hour tow. Mortality rates for the immediate cull

and delayed cull were similar. Overall median mortality was similar to the value assumed in recent summer flounder assessments.

METHODS

The research design of this study was dictated by the specific proposal requirements, i.e. to conduct ten one-day fishing trips incorporating different gear types, and areas fished, reflective of the inshore mixed trawl fishery. The selection of gear, fishing area, target species was left to the participating commercial fisherman to determine in consultation with CCE. This was done with the hope of not skewing the results in any one given direction, by letting the natural conditions dictate the project activity to reflect a more realistic picture of the existing inshore trawl fishery including summer flounder. Ten research trips were completed and have met the design criteria outlined in the proposal. Each trip consisted of a one, two and three hour tow, with an immediate and delayed cull for each specific tow. A specific culling procedure was adopted, so as to maintain random sampling protocol. The following time line was used after haul back:

- 0-10 minutes (immediate cull) – collection of 20 live fish for cages plus sorting of live and dead fish from one half of the pile.
- 10-25 minutes – sorting of live and dead fish only.
- 25-35 minutes (delayed cull) – collection of 20 live fish for cages plus sorting of live and dead fish from second half of the pile.
- 35-50 minutes – sorting of live and dead fish only.

Processing the catch continued until all summer flounder were sorted by live or dead in 15 minute increments of time until all fish were sorted. In addition, all other species in each tow were recorded. For each of the three tows conducted, forty live fish randomly selected were tagged, weighed, measured and rated as to condition utilizing a scale of excellent, good, poor with specific trawl damage noted.

The live fish selected for the mortality monitoring component of the project were held during the trip in an on board holding system. Twenty live fish were selected from each cull time for each tow duration. 120 total live fish were held for each trip. The on board holding system and plan adopted was similar to that used in the commercial fishery for holding and transport of live fish. Two 35 cubic foot, 268 gallon capacity Bonar insulated holding containers were used in addition to 22 holding cages constructed of plastic coated wire. The live fish were placed in the cages, and the cages were stacked in the Bonar containers filled with seawater. Each Bonar container held up to eight cages, with each cage typically holding ten fish. This system allowed for optimum holding and transport of the fish. The cages kept the fish from sloshing in the containers, kept the weight of fish off of each other and allowed for maximum water flow around each individual fish.

Two (2) twelve volt battery operated aerator compressor systems utilizing four large capacity air stones per container were used to aerate the holding system. This method has proven to be very effective in terms of maintaining fish condition and was very practical for fish handling purposes. The on board holding system was continually monitored for water temperature and dissolved oxygen levels during each trip. Surface and bottom temperatures and dissolved oxygen were also monitored in the targeted fishing areas and correlated with the temperatures and oxygen levels in the on board holding system.

The ability to safely hold and monitor all study fish was necessary to fully measure summer flounder trawl discard mortality. Through consultation with aquaculture specialists, commercial fishermen and gear specialist we were able to design, construct and install a 15' diameter by 15' deep pentagon shaped net pen attached to a stake system incorporating a pulley rope system which allowed the raising and lowering of the net pen similar to a pound net installation. This design allowed easy access to stock and the ability to monitor and finally release study fish with minimum impact. The net pen was installed next to the Inlet Seafood Dock at Montauk. The location was adjacent to the Montauk Harbor Inlet and provided excellent water quality and good flushing and exchange with Block Island Sound.

At the end of each of the scheduled discard mortality harvest trips all fish held live in the on-board live holding system from each tow and cull, were transferred to the dockside net pen holding system. They were held in the net pen system for 14 days to monitor mortality. Scuba certified staff conducted net pen monitoring on days 1, 2, 3 and then every other day during the 14 day holding period. Information collected included dead fish vitals, fish tag numbers, surface and bottom water temperature/ DO levels. Scales and otoliths were also collected from dead fish.

On day 14 the net pen was lifted and all remaining fish including live fish, dead fish and control fish, were removed from the net pen. Tag information and fish condition index were recorded for all fish. All live control and experimental fish were released in adjacent waters. The net pen was then re-set and prepared to receive a new set of control fish as well as the new set of experimental fish being harvested on board the mortality harvest trip. We utilized two CCE crews on each day that we had a scheduled harvest trip (every 14 days). One crew went out on the trawler and performed all scientific components associated with the collection and harvest of fish. The other crew was the net pen shore side crew and took care of all scientific components related to: collecting and releasing fish from the net pen after their 14 day study; accepting and processing new control fish; transferring the new set of experimental fish into the net pen when the harvest vessel and crew returned to the dock at the end of the day. This two crew procedure provided for efficiency of the overall process and allowed us to stick to a schedule of a new harvest trip every 14 days in order to accomplish the number of trips needed before the end of October. Also, local baymen were hired to lift and re-set the net pen on each release day.

RESULTS

We calculated the cumulative mortality for each tow on trips 3-10 using the mortality on board and estimating the number of live fish culled that would have died using the 14-day survivorship observed in the dockside holding/monitoring pen. First, for each trip, tow, and cull time we calculated a weight for dead fish in the pen that was corrected for the mortality rate of control fish in the pen, $\hat{w}t_d$:

$$\hat{w}t_d = w_d - [(1 - surv_c)(w_d + w_l)] \qquad (1)$$

where w_d is the weight of dead fish in the pen, $surv_c$ is the fraction of control fish living after 14 days in the pen, and w_l is the weight of live fish released from the pen after 14 days.

The survivorship of live fish in the pen, SP, was determined as:

$$SP = wt_l / (wt_l + \hat{w}\, t_d) \qquad (2)$$

The survivorships from equation (2) were used to calculate the ratio of survivorship between the immediate and delayed cull times, ΔS:

$$\Delta S = SP_{\tau=D} / SP_{\tau=I} \qquad (3)$$

where $SP_{\tau=D}$ is the survivorship of fish in the pen at the delayed cull time and $SP_{\tau=I}$ is the survivorship of fish in the pen at immediate cull time.

We calculated the elapsed time between the immediate and delayed cull times, t as:

$$t = [(t_e - t_s)/2 + t_s]_{\tau=D} - [(t_e - t_s)/2 + t_s]_{\tau=I} \qquad (4)$$

where t_e is the end of the time interval in question, from the time the net was brought onboard, and t_s is the start of the time interval in question, both in cumulative minutes.

The change in the survival fraction, ΔS, between the two cull times is converted to a rate, fm, that can be used to estimate the change from any other cull time, under the assumption that the rate is linear with time:

$$fm = (-\ln(\Delta S))/t \qquad (5)$$

Thus, to calculate the amount of surviving summer flounder, we apply this rate to each 10-15 minute cull period, using equation (4) to determine the elapsed time. Then, the estimated fish surviving, EL, is:

$$EL = \sum_{i=1}^{n} (L_{up} + L_p) e^{-fm \times t} \qquad (6)$$

where L_{up} is the weight of live fish that were not placed into the pen and L_p is the weight of the live fish that were placed into the pen.

The estimated weight of dead fish for each tow, ED, is then:

$$ED = wt_c - EL \qquad (7)$$

where wt_c is the total catch weight for all summer flounder.

Finally, the % mortality for the tow can be calculated as:

$$\%Mortality = ED/(ED + EL) \qquad (8)$$

The discard mortality for each tow length duration, as well as for all tow durations combined, is shown in Table 1. These mortality rates are for the entire summer flounder catch for each tow duration and reflect the total mortality for each tow from the time the fish were dumped on deck until the deck is cleared. The median mortality for all tows combined at 78.7% is very close to the estimated overall discard mortality of 80% currently used in the summer founder assessment. The mean of 64.6% however is considerably less. Also the mean and median mortality rates for the one hour and two hour tows are considerably less than the currently estimated 80% mortality. In order to use a mortality rate representative of the overall inshore fishery for summer flounder, tow length parameters of the fishery should be evaluated. Observer data and VTR data should be analyzed for average tow time across the fishery. Our calculated mortality rate for the tow duration that is most representative of the Observer/VTR data could then be used in the assessment.

An *a posteriori* least squares means test on tow time shows that mortality was greater in 3-hour tows than 2-hour tows and greater in 2-hour tows than 1-hour tows. Additionally, 1-hour tows and 3-hour tows were significantly different from each other ($p = .0044$).

The calculated mortality by tow duration and cull time is shown in Table 2. All of these values are considerably different, for both the mean and median, from the currently used 80% rate and exhibit a considerable range. Interestingly there is not much difference between the overall mortality rate for all tows combined at the immediate cull and at the delayed cull.

Table 1. Mean, standard deviation in parentheses, median, 25th to 75th percentiles for the percent mortality by tow time and overall.

% MORTALITY	MEAN	MEDIAN	25TH-75TH PERCENTILE
TOW 1	**57.8(35.5)**	**63.9**	**27.7-96.0**
TOW 2	**61.4(31.4)**	**63.3**	**32.7-89.1**
TOW 3	**76.6(29.5)**	**86.9**	**60.0-98.0**
ALL	**64.6(32.2)**	**78.7**	**31.0-96.0**

Table 2. Mean, standard deviation in parentheses, median, 25th to 75th percentiles for the percent mortality by tow time, cull time, and overall. I=initial cull. D=delayed cull.

% MORTALITY	MEAN	MEDIAN	25TH-75TH PERCENTILE
TOW 1 I	**44.9(39.2)**	**34.6**	**9.0-96.0**
TOW 1 D	**44.3(41.7)**	**31.8**	**1.6-87.3**
TOW 2 I	**47.8(36.1)**	**48.5**	**11.2-78.4**
TOW 2 D	**68.4(28.9)**	**68.5**	**43.2-97.8**
TOW 3 I	**62.7(36.7)**	**68.8**	**32.1-97.0**
TOW 3 D	**68.5(27.7)**	**63.8**	**45.6-97.4**
ALL I	**51.3(36.8)**	**50.1**	**12.5-96.0**
ALL D	**59.2(34.9)**	**59.4**	**32.6-95.6**