FINAL REPORT

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SUMMER FLOUNDER DISCARD MORTALITY IN THE INSHORE BOTTOM TRAWL FISHERY

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ABSTRACT

In 2007, Cornell University Cooperative Extension (CCE) received an 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 inshore mixed trawl fishery. A goal of the project was to determine discard mortality relative to tow time, 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 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 time, for as 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 the 14-day monitoring period. Mortality rates were calculated by tow time, cull time and overall. Mortality rates for the 1 and 2-hour tows were less than for the 3-hour tows. Mortality at the time of the immediate cull and delayed cull were similar and increased with increasing tow time. The overall median mortality was 78.7% and was similar to the value assumed in recent summer flounder assessments. However overall mean mortality was 64.6% and is 15% less than the value used in recent assessments. Blood was extracted from sample fish and analyzed for cortisol level as an indicator of stress. ANOVAs on the cortisol level were unable to find any significant results thus indicating that blood cortisol is not a predictor of condition or survival. Those fish released after 14 days in the net-pen served as a tagging study component of the project. We continue to receive tag returns and to date have had a 10.4% return of released fish.

In 2009, CCE requested and received authorization to conduct additional fluke discard mortality research on this project with available residual funding. The remaining funds were used to conduct 4 additional modified research trips. During these trips, on deck procedures for sorting the summer flounder catch into live and dead categories for each time interval were conducted. Live summer flounder were not kept for the extended (14 day) mortality monitoring during these supplemental trips. Fieldwork conducted under this project extension was completed as of September 2009. The additional data was incorporated into the statistical analysis as a separate component.

EXECUTIVE SUMMARY

Fisheries managers, scientists and industry members share a concern over the use of the present estimation of discard mortality within the summer flounder stock assessment. The purpose of this study was to gain perspective to improve and enhance fishery information about discard mortality for summer flounder in the trawl fishery. To this end the objective was to evaluate actual trawl discard mortality within a research design for comparison to the assumed discard mortality rate currently used in the stock assessment. The study goal was to determine discard mortality relative to tow time, total catch, fish size and the amount of time that fish were on deck. Initially, ten scientific fishing trips consisting of tows of 1, 2 and 3 hours in duration were conducted. Fish were culled at consistent time intervals into live and dead on deck. Additionally, a sub-sample of live fish from the immediate cull and the delayed cull were held in an on board live system then transferred to an extended mortality monitoring net-pen system. The overall summed discard mortality as determined by this project had a mean of 64.6% and a median of 78.7%. A linear relationship of discard mortality to tow time and cull time existed. For example, the mean discard mortality in the 1-hour tows was 58%, in the 2-hour tows it was 61% and in the 3-hour tows it was 77%. Similarly related was the inverse correlation of mortality to cull time. Also, total catch was an important discard mortality factor but fish size was not. When comparing the parameter values of tow time, cull time and total catch as determined by this study it is apparent that shorter tows, faster culling and improving handling practices, while reducing per-tow total catch can definitively reduce summer flounder discard mortality. A modified Phase II component was also conducted where we only separated the fish into live/dead fraction on deck and did not save any live fish for extended mortality monitoring. The Phase II component produced similar results.

A secondary goal of the project was to provide information on summer flounder discard and bycatch within the described research design. During the overall study New York trip limits in the areas fished were low and ranged from 30 to 140 pounds per trip. Gear-induced discards ranged from .019% to 5.38% and represent those fish discarded because of size or quality (high grading). Regulatory discards are those fish caught over the trip limit excluding sublegal sized fish, and ranged from 53% to 95% for all trips. These discards are based on the very low New York trip limits in place during this project. From these findings we can see that the quantity of summer flounder discards is directly related to regulatory trip limits. In the absence of high trip limits or high landing allowances or as provided by research set-aside programs we can observe that in New York directed summer flounder fishing results in a high level of regulatory discards and as such efforts may not be economically feasible or at least have to be evaluated.

Determining a representative summer flounder discard mortality factor to be used in the stock assessment can be refined by comparing the actual quantified average tow time across the fishery as recorded on vessel trip reports (VTR) on a prorated basis to the discard mortality rate by tow time as determined by this study.

CCE is in the process of finalizing results from a separate but similar RSA-funded discard mortality project in the offshore fishery. Those results will be available soon and

can be used in conjunction with the inshore results to quantify fishery-wide trawl induced discard mortality.

Fisheries managers may want to evaluate the level of summer flounder discard as it relates to fishing effort in light of present regulations and escalating operating expenses. It is hoped that the dissemination of this information to industry members will influence voluntary adoption of practices that can reduce summer flounder discard mortality.

PURPOSE

Description of Problem Addressed

Until this study, there have not been any scientific studies conducted to assess summer flounder discard mortality in the bottom trawl fishery in the Mid-Atlantic and Southern New England areas (Terceiro, pers. com.). Despite management measures, no data has been available for the estimation of discard mortality of trawl-caught, sublegal and legal size summer flounder. In order to develop the final estimate of discard mortality for the Stock Assessment for Summer Flounder, a commercial fishery discard mortality rate of 80% was assumed as recommended by SAW 16 (NEFSC, 1993; Terceiro, 2003). However, this rate is not based on any specific studies of discard mortality in the summer flounder trawl fishery. The 80% mortality rate of commercially discarded summer flounder currently used in the stock assessment is based on the opinion of industry advisors (Terceiro, pers. com.). However, fishermen have questioned this mortality rate. Based on their knowledge and experience they believe that rate may be too high and may be resulting in unnecessary closures of the fishery. They have asked that further studies be done in order to provide a better estimate of discard mortality in the trawl fishery.

Major data and analytic needs for future stock assessments were identified in the SARC 35 review of the 2002 assessment (NEFSC, 2002) and in the Southern Demersal Working Group (SDWG) assessment updates for 2003 and 2004 (Terceiro, 2003). One of the major recommendations was to conduct further research to more accurately determine the discard mortality rate of recreational and commercial fishery summer flounder discards (Terceiro, 2003.). According to the 2003 summer flounder stock assessment (Terceiro, 2003), trawls are the largest contributor of discards and discard mortality in the summer flounder fishery. In the 41st SAW, the SDWG continued to highly recommend conducting further research to better determine the discard mortality rate of the commercial fishery summer flounder discards (NEFSC, 2005). The second highest recommendation for the SDWG for 2006 was to continue ongoing age structure exchanges between NEFSC and interested state agencies and academic institutions. This project has addressed these recommendations.

The MAFMC Research Set-Aside Program research needs and priorities for 2007 addressed a need for better estimates of discard mortality…for commercial fisheries (by gear type) for Council-managed fish. The main purpose of this project was to provide fishery managers, fishery scientists and commercial fishermen with an accurate evaluation of summer flounder discard mortality in the summer bottom trawl fishery in the Mid-Atlantic, Southern New England area. This project also addressed additional RSA research priorities including: identifying distinctions between regulatory discards

and bycatch attributed to gear…in the summer flounder fishery; conducting cooperative stock assessment surveys focusing on the summer flounder fishery; conducting tagging studies to determine seasonal movements and/or mortality estimates by age of various species; increasing sampling and conducting more representative sea sampling of the various fisheries in which summer flounder…are caught to adequately characterize the length composition of the discards; and expanding age sampling of summer flounder…from commercial catches, with special emphasis on collection of large specimens.

The commercial and recreational harvest of summer flounder coastwide is currently managed through quotas, with specific regulations designed to prevent landings from exceeding the quotas. Among the regulations imposed upon commercial fishermen are trip limits, closures when the quota is reached, minimum sizes, minimum mesh requirements for trawls, and a moratorium on entry into the fishery. The New York state quota for summer flounder is relatively low and has resulted in periods of time when the fishery is closed for management purposes.

Goals and Objectives of the Project

Goal: to provide fishery managers, fishery scientists and commercial fishermen with an accurate evaluation of summer flounder discard mortality in the inshore bottom trawl fishery in the Mid-Atlantic, Southern New England area.

Objectives: evaluate mortality of summer flounder discard in the summer fishery. Also evaluate extended mortality by tagging and releasing fish.

Goal: to provide accurate information on summer flounder discard and bycatch.

Objective: to thoroughly record all discards during normal fishing activity in the summer flounder fishery.

Goal: evaluate summer flounder discard mortality relative to tow time, fish size, and amount of time fish are on the deck of the vessel.

Objectives: analyze the stress associated with trawl capture and subsequent mortality or recovery, and suggest handling and discard procedures that will minimize mortality in this important fishery.

Evaluation of Discard Mortality

The main goal of this project was to provide fishery managers, fishery scientists and commercial fishermen with a much-needed accurate estimate of summer flounder discard mortality in the inshore summer bottom trawl fishery in the Mid-Atlantic, Southern New England area. Through this project, we have implemented a program to improve and enhance fishery information relative to discard mortality of summer flounder in the bottom trawl fishery. Actual data on summer flounder discard mortality is lacking in the current summer flounder assessment. With the cooperation of commercial bottom trawlers in NY, summer flounder discard was collected under various fishing conditions and held live. A random sample of summer flounder discards including both legal and sublegal sized fish was collected while aboard bottom trawling vessels engaged in the

summer inshore mixed trawl fishery. The vessel's standard fishing methods and gear were used for the study. Differences in discard mortality were assessed relative to tow time, fish size and the length of time the fish were on deck. Approximately 20 fish from each of 6 categories (120 fish) were measured, tagged, kept on board in flow-through seawater holding tanks and later held in a dockside net-pen for extended mortality monitoring for each trip. The 6 categories were a combination of parameters including tow times of 1 hour, 2 hours and 3 hours and 2 different deck times including immediate culling, and a normal fishing practice cull (approximately 30 minutes). Fish condition was determined based on a health index. Additional information including location, boat and gear specifics, fishing speed, total volume of the catch and discard, depth, and surface water and air temperatures were recorded. Extended mortality was monitored over a 14-day period in the net-pen and tagged fish still alive were released after 14 days. Haul-back mortality (by tow and cull), post-release mortality, control fish mortality, and total discard mortality were all calculated. The data generated by this cooperative research project will provide data on discard mortality, which is critically needed for the assessment of summer flounder. Specific work plan details are provided below.

Long Term Mortality

Information collected upon recapture of tagged and released fish has addressed the RSA research priority need for tagging studies to determine seasonal movements and/or mortality estimates by age of various species. CCE continued to collect tag returns and pay tag rewards for released fish over a four-year period. By tracking the location of recaptured fish, this study provided seasonal movement and migrational information representative of this population of fish. This information can supplement other information on distribution and migration of summer flounder. The additional discard mortality information from the tagged fish is more qualitative than quantitative. This study was set up to directly observe mortality over a two-week period in a net-pen and not as a large-scale tagging study to determine mortality from large numbers of tagged fish and subsequent tag returns. Tag returns for released fish therefore provide qualitative data on additional survival for the time the fish is at liberty.

Discards and Bycatch

The RSA research priorities identified the need for determining distinctions between regulatory discards and bycatch attributed to gear…in the summer founder fishery. This study has provided accurate information on summer flounder discard and bycatch in the inshore summer flounder bottom trawl fishery. During all scientific trips, we have thoroughly recorded all discards during normal fishing activity in the summer flounder fishery and quantified which discards would be classified as regulatory discards (based on trip limits) and which would be classified as bycatch attributed to gear (minimum size).

Analysis of Stress

An additional goal of this project was to analyze the stress associated with trawl capture and subsequent mortality or recovery. As an additional indicator of fish health and condition, we have analyzed blood cortisol levels in summer flounder caught during the

project. Blood cortisol levels have been used by researchers in previous studies as an indicator of fish condition (e.g. Barton, 2002; Barton, et. al., 2005). The stress associated with trawl capture and subsequent recovery or mortality for each of the 6 categories (3 tow times and 2 cull times) has been assessed and documented. A representative number of fish also had blood drawn for analysis just prior to their release after 14 days in captivity.

Sampling

The RSA research priority needs addressed by the sampling activities conducted in this project included: increased and more representative sea sampling of the various fisheries in which summer flounder…are caught to adequately characterize the length composition of the discards; and expansion of age sampling of summer flounder…from commercial catches, with special emphasis on collection of large specimens. This study has generated additional data on the length and age structure of summer flounder discards in the summer inshore bottom trawl fishery and has provided additional sea sampling of the bottom trawl fishery off the coast of NY. On the scientific tows, discards were sampled as if it were an observed sea sampling trip. Discard fish not saved for the live-holding portion of the study had length frequency recorded. Dead fish had scales collected. For those fish that died while in captivity, scale and otolith samples were collected. Additionally, we selected large specimens for age sampling from both the kept and discarded portions of the catch.

The research conducted has more accurately determined the discard mortality rate of commercial summer flounder discards in the inshore bottom trawl fishery. The results of this project will be useful to the commercial fishing industry, fishery managers and fishery scientists relative to the successful management of the summer flounder stock. Based on the results of this study, we have developed recommendations for handling and discard procedures that will minimize discard mortality in this important fishery. These recommendations will be distributed and promoted to the fishing industry.

APPROACH

Detailed Work Plan

The basis of the project was to improve and enhance fishery information relative to discard issues, especially discard mortality in the summer flounder commercial bottom trawl fishery. A random sample of summer flounder discards including both legal and sublegal sized fish were collected while aboard bottom trawling vessels. Summer flounder mortality was evaluated relative to tow time, fish size, and length of time fish were kept on the deck of the vessel and other factors for each trip. Approximately 20 fish from each of 6 categories (120 fish) were measured, tagged, and held in a dockside net-pen for extended mortality monitoring for each trip. The 6 categories were a combination of parameters which include tow times of 1 hour, 2 hours and 3 hours and 2 different deck times including an immediate cull, and a normal fishing practice cull (approximately 30 minutes). Our first trip occurred on May 29, 2007, the last trip was on October 9, 2007 and the final release of net-pen fish was on October 23, 2007. Four

additional trips using a modified work plan, as described under Phase II below, were conducted in September 2009.

Overall the key project components of research design, on board work plan, and net-pen design and function were effective in delivering results useful in meeting project goals. In the process we were also able to develop and perfect our field procedures for at-sea sampling and field/lab operation that were extremely beneficial in meeting the project design criteria.

On Board Procedures

The research design of this study was dictated by the specific proposal requirements, i.e. to conduct ten one-day fishing trips incorporating different trawl types, and areas fished, reflective of the inshore mixed trawl fishery. The selection of gear, fishing area, and target species was left to the participating commercial fisherman to determine in consultation with CCE. This was done to reflect a more realistic picture of the existing inshore trawl fishery for summer flounder. Through the period covered by this final report ten (10) research trips have been completed and have met the design criteria outlined in the proposal. Each trip consisted of a 1, 2 and 3-hour tow, with an immediate and delayed cull for each specific tow. Planning centered on these activities and attempted to identify possible issues such as a large quantity of fish being harvested or very few fish being harvested. In all instances a specific culling procedure was adopted, so as to maintain random sampling protocol. After haul-back the catch was dumped on deck and was then split in two and the following time line was used to sort the catch for each tow. A random sampling protocol was used for the selection of all fish for the live holding system and for sorting live/dead.

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

Processing the catch continued until all summer flounder were sorted by live or dead in 15 minute increments of time. Live/Dead sorting allowed us to quantify the relative impact of cull time for summer flounder trawl discard mortality. In addition, all other species in each tow were recorded. For each of the three tows conducted, forty live fish randomly selected (immediate cull and delayed cull as described above) for the extended mortality monitoring component were tagged, weighed, measured and rated as to condition utilizing a scale of excellent, good, poor with specific trawl damage noted. The classification of the condition of fish according to damage was as follows:

A: <u>EXCELLENT</u>: minor scratches, no visible sign of mucus damage, minor scale loss

B: <u>GOOD</u>: moderate damage, moderate scratches, visible mucus layer damage, moderate bruising, strong fish

C: POOR: significant scratching, significant scale loss and bruising, mucus layer severely affected, lethargic, fish still arches

D: DEAD: fish doesn't arch

Additional condition factors were recorded including scale loss, abrasions, fin damage, fin tearing, anal explosion, anal tearing, net marks, nose rub and scratches. The severities of these conditions were documented as significant, minor or none.

The tags used for this study were Floy-FD-94 Super Heavy Duty T-Bar Anchor Tags. The tag was injected using a Floy tagging gun into the muscle in the dorsal area of the eyed side anterior of the caudal peduncle. Tag color as well as number identified each individual fish as to tow/cull.

On Board Holding System Design and Plan

The 20 live fish, collected as described above, were held in an on board live holding system for transport to the dockside net-pen for extended mortality monitoring. The on board holding system and plan adopted is similar to that used in the commercial fishery for holding and transport of live fish. Two commercially available 1500 lb. capacity large plastic, insulated holding containers were used as the basis of the on board holding system. The insulated containers (totes) measure 48 ¾"x43 ¾"x37 ¾" and can hold 268 gallons of water each. Live fish were placed in cages made of plastic coated wire, and the cages stacked in the large containers completely filled with sea water. A third such insulated container was used for dockside transfer of the fish to the holding pen.
The cage dimensions used were:

(2) 36" x 36" x 4 ½"
(4) 31" x 18" x 4 ½"
(16) 33" x 18" x 4 ½"

Each large container held up to eight cages, with each cage typically holding up to 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 air stones were constructed to provide oxygen to the fish in the large containers. One compressor was used per trip and one was kept as back up. These holding tank aeration systems were able to provide aeration to 400 lbs of fish at 48" of water depth each. Each container utilized 2 air stones pumping approximately 1.25 cubic feet/minute. Frequent water exchanges were also made to the containers using the vessel's deck hose which pumps fresh surface water. More importantly 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 systems were continually monitored for water temperature and dissolved oxygen levels during each trip. Surface and bottom temperatures and dissolved oxygen were also monitored in the fishing areas during each tow and correlated with the temperatures and oxygen levels in the on board holding systems. In communications and discussions with the project participants Dr. Valenti and Dr. Sulikowski, it was

determined that any difference of greater then ten degrees between bottom temperature at harvest and temperature in the holding system could negatively affect the condition of held fish. On only one occasion this variation occurred. In this event we used ice to slowly reduce the on board holding temperature to within that ten degree range while still monitoring salinity and dissolved oxygen. We chose this method because it is an accepted practice among commercial fishermen and dealers in the area for holding and transporting live fish.

On Board Materials

Each trip sequence (14 days total) was initiated by loading all related project equipment and supplies on the participating fishing vessel on the day preceding the actual trip. Each trip consisted of a minimum six hours of towing time, and depending on areas fished, returned to port between 3:00 PM and 8:00 PM on the same day. The fishing vessel crew and project scientific staff (4-5 individuals) departed from Inlet Seafood's dock in Montauk at approximately 5:00 AM. The participating fishing vessel returned to Inlet Seafood's dock on that same day and the color coded tagged 120 trawl caught live summer flounder "discards" were transferred to the net-pen for the 14 day holding period.

A checklist of project trip materials was used to outfit the participating fishing vessel. The following is a list of this equipment:

1. Safety equipment including life raft, survival suits and EPIRBS
2. Live fish holding system
3. 14 fish cages
4. Two scales
5. Tag guns and colored numbered tags
6. Measuring boards
7. (2) 12 Volt battery packs, compressors, aerators and four air stones
8. Blood sampling supplies
9. Food and personal weather gear
10. YSI meter with 100 foot cable for the temperature, salinity and dissolved oxygen
11. Data sheets, totes, baskets
12. Miscellaneous supplies

Control Fish

We established a control group of summer flounder in the net-pen. This control group was comprised of legal and sublegal pound net caught fish. These fish were caught by local pound nets in close proximity to the holding net-pen. Pound nets provided a good control group of fish because the fish were captured with very little damage to the fish. There was also very little transport time associated with these fish.

A new set of control fish was procured and placed in the net-pen for each new set of experimental fish (e.g. every time we conducted a new harvest trip – every 14 days). Receipt of new control fish correlated with each new scientific trip. Twenty pound net caught control fish were delivered on the same day. Control fish were transported to the

net-pen in an aerated (and cooled if needed) enclosed sea water live holding system. Control fish were measured, weighed, color coded numerically tagged and released into the net. Control fish were also rated based on our fish condition index.

Net-Pen Construction and Installation

The ability to safely hold and monitor all study fish was necessary to fully measure summer flounder trawl discard mortality. The purpose of the net-pen system was to monitor for discard mortality over an extended period of time. It is known that not all fish that are alive immediately upon discard will survive the trauma of catch and discard. Therefore a representative holding and monitoring period was needed to assess this extended mortality. Pre-project discussions with NMFS scientists established the 14-day period as appropriate. Indeed, what we found was that high rates of mortality occurred during the first several days. After that mortality rates declined with time and approached zero before the end of the 14-day monitoring period. Thus 14 days was an appropriate time frame for the extended mortality.

Through consultation with aquaculture specialists, commercial fishermen and a 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. Additionally the net-pen system had a twine cover held in place with tamper-proof numbered seals. This cover kept all waterfowl out of the net-pen and provided a measure of security to prevent anyone from tampering with the fish in the net-pen.

Net-Pen Monitoring and Fish Release

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 shore-side 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, and 3 and then every other day during the 14-day holding period. All net-pen related data was recorded on the net-pen monitoring log. Data collected included dead fish information, fish tag numbers, surface and bottom water temperature/dissolved oxygen levels and plastic net-pen tamper proof seal numbers which were removed and installed. 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. Blood samples were drawn from all categories for plasma cortisol analysis. Information was recorded on the fish release and survival log. 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 as described in this report. 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 the 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. Local baymen were hired to lift and re-set the net-pen on each release day. Since the workings of the net-pen were constructed similar to a pound net, utilizing baymen who fish pound nets for a living guaranteed that the net-pen would be lifted and set properly each trip.

Blood Collection Procedure

For this study, fish were randomly selected at capture and release for blood sampling for plasma cortisol analysis. Depending upon availability, fish were selected from each tow and cull upon capture for blood sampling. These sampled fish were reported in the total live catch but were not tagged, caged and kept in the net-pen. Blood samples were collected from the caudal vein into chilled heparinized syringes with a 26 gauge needle. Less than 1 milliliter of blood was removed from the individual fish for the purpose of this study. Blood samples were then spun in a centrifuge to separate blood plasma, chilled and subsequently frozen. The frozen samples were shipped to the University of New England for cortisol analysis.

Data Collection

Critical to the successful completion of the project was the collection of data and information associated with this research project. Prior to embarking on our first trip a significant amount of staff time was utilized to develop the various data collection procedures and reports. The focus was the collection of information to meet the goals of the project. The following data sheets were developed and utilized throughout the project. This information was entered into a database and has undergone a statistical analysis as outlined in the project proposal by Dr. Eric Powell and Dr. Eleanor Bochenek at Rutgers University.

1. Summer flounder discard mortality 2007 control fish data sheet
2. Summer flounder discard mortality study 2007 trip log
3. Summer flounder discard mortality study 2007 tow log
4. Summer flounder discard mortality study 2007 condition and tagging data sheet
5. Summer flounder discard mortality study 2007 length frequency data sheet
6. Summer flounder discard mortality study 2007 net-pen monitoring log
7. Summer flounder discard mortality study 2007 fish release and survival log

Licenses, Permits and Administrative Requirements

Funding for this study was through the NMFS/MAFMC Research Set-Aside Program. Authorization included federal Exempted Fishing Permits (EFP), (research EFP and

harvest EFP), NYS License to Collect and Possess, NYS fluke permit, Coast Guard safety inspection sticker and certification of P&I insurance. Because of RSA requirements, call in and out for the federal participation and fax in and out for state participation for the fishing vessel was required and was the same for Cornell within the RSA program. This function was completed by program staff for both the participating vessel and for Cornell involvement. Complicated by the number of participants (10 commercial vessels and pound trap fishermen), obtaining permits and completing related necessary reporting was conducted on a fluid and timely basis. A Vessel Trip Report (VTR) for the study fishing trip day was also required and submitted to NYSDEC and NMFS by the fishing vessel operator.

Research set-aside compensation harvest was primarily coordinated through the National Fisheries Institute Scientific Monitoring Committee's RSA auction. NFI conducted the auction, allocated the RSA quota based on the auction, collected compensation funds from participating vessels and forwarded the collected funds to CCE to cover the research costs. CCE and NFI coordinated federal EFPs and state LCPs for compensation harvest vessels. Additionally, CCE utilized some of the RSA quota to allocate to participating vessels during the research cruises. The proceeds from the RSA harvest on the scientific cruises were split between the participating vessel and CCE as RSA program income.

The RSA harvest proceeds for the vessel during the research cruises helped to offset the vessel charter cost and was thus used to lower the actual vessel charter cost.

Insurance certificates including an insurance rider specifically covering the scientific staff on board were also required. For administrative purposes, all parties signed a memorandum of understanding, an independent contractor agreement, and a W-9 Internal Revenue Form detailing compensation. These various permits, licenses and contracts spell out in specific detail the responsibility of the participating parties and provided a clear understanding concerning the details of the project, goals and expected outcomes.

A separate net-pen security procedure was developed using numbered color-coded tamper proof seals. All net-pen monitoring activity involved the removal and replacement of tamper proof seals with their numbers reported to NYSDEC, to assure the net-pen was not compromised for non- project functions. A list of tag numbers for each fish placed in the net-pen for each trip was also reported to NYSDEC.

Project Coordination

Considering the complicated logistics of: scheduling commercial trawl vessels (and their availability to commit on a specific date); developing and maintaining an on board live holding system; scheduling pound net fishermen to have fresh caught control fish when needed; scheduling baymen to haul/set the net-pen; net-pen monitoring; weather complications; equipment or vessel breakdowns; handling and holding live fish with minimal impact; personnel scheduling on weekends and holidays; overall field and vessel logistics – the project went very smoothly and according to schedule. All trips and shore side net-pen components went according to plan and we were able to accomplish successful trips every 14 days. This resulted from significant project planning both

before and during field components, a dedicated staff and interested and committed commercial fisheries partners.

Tag Returns

A tag return reward program was initiated for this project. Press releases were published in local newspapers, in regional and national trade publications and on the web. Information included tag description and return policy. Tag returns were recorded and rewarded at $20.00 per tag. We continue to get tag returns.

Project Extension - Phase II

All of the funds generated by the RSA compensation harvest for this project were not fully expended during the above-described ten scientific trips. However the ten trips and the associated long term monitoring satisfied all the project tasks described in the original proposal. Therefore CCE requested and received authorization to conduct additional fluke discard mortality research with the available residual funding. Discussions were held with NMFS about the use of these residual funds from RSA compensation harvest. Discussions centered on the best use of funds relative to the goals of this project and RSA policies and priorities. It was resolved that additional work on this project would take place through an additional number of trips employing a slightly modified work plan. During this time CCE also applied for a Federal Exempted Fishing Permit and NY State License to Collect or Possess to carry out this additional research. However the time line for approval was such that we would miss the summer/fall fishing and the fish would be heading offshore. Accordingly, we requested and were awarded a one year no-cost extension so that this additional work could be accomplished during the summer of 2009. Due to delays in receiving our EFP, research trips commenced on September 14th, 2009. Due to funding constraints for this Phase II component, we were not able to conduct the extended mortality monitoring portion. Costs associated with re-installing the net-pen, daily monitoring, and other activities of the extended mortality monitoring would have put the budget well beyond the residual funds available for this Phase. Thus quantifying the on deck live-dead fraction over time was the focus of this Phase.

A total of four additional research trips were conducted during the summer/fall (2009) on vessels engaged in the inshore fishery to continue to quantify summer flounder discard mortality. CCE performed vessel outreach in order to select vessels appropriate to conduct research. Vessels selected met the standards previously developed for the first portion of the summer flounder discard study. CCE coordinated with two vessels, one from Shinnecock and one from Montauk. This allowed for the greatest coverage of the NY inshore fishery during the allotted time period. Each vessel committed to performing one day research trips that consisted of the three predetermined tow times (1 hour, 2 hour, 3 hour). The research trips performed from Shinnecock used a small mesh ($1^7/_8$") in hopes that we could catch the end of the inshore *Loligo* fishery. After performing 2 days of research out of the port of Shinnecock using small mesh and catching minimal *Loligo*, we relocated to Montauk and used large mesh (5") and focused our efforts on the inshore mixed trawl fishery.

During Phase II CCE staff conducted all components of the at-sea procedure except for holding live fish onboard and holding them in the dockside net-pen for the 14-day extended mortality monitoring. Each trip consisted of the same 1-hour, 2-hour and 3-hour tows as before. The sorting of summer flounder on deck occurred within the predetermined time intervals that were established in the earlier project (0-10 minutes, 10-25 minutes, 25-35 minutes, 35-50 minutes and 15 minute intervals after that) until the deck was cleared of fish. Fish were sorted as live or dead and legal or sublegal. Each group was weighed and classified to determine the live/dead fraction on deck. Since fish were not being held live for extended mortality monitoring, we did not separate the catch in half or delay sorting the catch until the delayed cull. Sorting of the entire catch began as soon as the catch was dumped on deck. This procedure was reflective of how fish would be handled and discarded during normal fishing practices.

Data analysis of the initial ten trips showed that the overall greatest influencing factor in calculating the total discard mortality by tow is the live/dead fraction on deck as influenced by catch and volume of other species, tow time and gear. By incorporating the average net-pen mortalities for tow time/cull time from the initial ten research trips to the live fraction on deck, valuable additional data on the inshore fishery summer flounder discard mortality can be combined with the 2007 data, without the large expense, time and logistics of the net-pen monitoring. This plan for additional work also alleviated net-pen permitting issues.

Fieldwork conducted under this project extension was completed in September 2009. The additional data was incorporated into all figures and the statistical analysis. (See Phase II component findings).

Project Management

Management and staffing for all scientific components of the project for both the at-sea sampling and shore-side holding net-pen site were conducted by the Cornell Marine Program (CCE). Collection of experimental and control fish was conducted under Federal Exempted Fishing Permit #7014, and New York State License To Collect and Possess (NYSLCP) issued to CCE.

Dr. Eric Powell, Dr. Eleanor Bochenek and Jason Morson of the Rutgers University Haskin Shellfish Research Laboratory performed data analysis. Dr. James Sulikowski, Marine Science Center, University of New England, Biddford, Maine and Professor Paul C. Tsang, Dept. of Animal and Nutritional Sciences, University of New Hampshire completed Blood cortisol plasma assay analysis. The Cornell Marine Program was responsible for the selection criteria, selection, scheduling and coordination of commercial vessel fishing support associated with this project.

The following individuals and affiliated agencies and organizations were project participants.

Cornell Marine Program (CCE):

Principal Investigator:	Emerson Hasbrouck
CCE Staff Researchers:	Tara Froehlich, Kristin Gerbino, John Scotti
Project Fishery Technicians:	Jeanette Klopchin, Eric Braun, Joe Costanzo, Corey Humphrey
CCE Aquaculture Specialist:	Gregg Rivara
CCE Secretarial Support:	Elizabeth Chopin

Rutgers University Haskin Shellfish Research Laboratory

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	Dr. Eleanor Bochenek
	Jason Morson
University of New England:	Dr. James Sulikowski
University of New Hampshire:	Dr. Paul C. Tsang

East Hampton Town Department of Natural Resources

Director:	Larry Penny
Staff:	Mark Abramson

Multi Aquaculture Systems, Inc., Amagansett, NY: Dr. Robert Valenti

Montauk Inlet Seafood, Montauk, NY:	Julia Bartlett
LI Commercial Fishing Assoc:	Bonnie Brady

Participating Commercial Fisherman:

Charles Weimar	F/V Rianda S., Montauk, NY
Chris Winkler	F/V New Age, Montauk, NY
Michael Diem	F/V Susan & Caitlyn, Montauk, NY
Sid Smith	F/V Merit, Greenport, NY
Don Ball	F/V Jen-Lissa, Montauk, NY
John Mason	F/V Vincenzo, Hampton Bays, NY
Mike Fallon	F/V Blue Sea, Montauk, NY
Dave Aripotch	F/V Caitlin & Mairead, Montauk, NY
Scott Brzescinski	F/V Patriot, Hampton Bays, NY
Brent Bennett	Pound Trap Fisherman, East Hampton, NY
Wayne Fenelon	Pound Trap Fisherman, East Hampton, NY

FINDINGS

Accomplishments and Findings

This project was successfully and fully executed and completed as per the original proposal and work plan. All goals and objectives of the project were successfully met. The project was rigorous and logistically complicated. Conducting experiments at sea on working fishing vessels can be complicated and the care and handling of live animals can pose additional challenges to a project. However our experimental design was sound and after being fine-tuned during the first two trips proved to be fully successful. The project

had full support of New York's commercial fishing industry. The project fostered and expanded the concept of cooperative research with the industry. The fact that nine different local trawlers (as well as two pound net fishermen) fully participated in the project is a testament to the cooperative research approach of this project. Research set-aside compensation harvest went very well for this project and allowed many additional fishermen to participate in this project by helping to turn the allocation of fish into dollars to pay for this successful project.

We would like to thank the Mid-Atlantic Fishery Management Council and the National Marine Fisheries Service for creating and implementing the RSA program, and for the opportunity for us to participate in the RSA program. We hope that this project was also beneficial to the overall RSA program. We further urge the MAFMC and NMFS to continue to provide opportunities for cooperative research thru the RSA program. We would also like to thank all the participants in this project as identified above. We want to offer special thanks to the owners/captains and crew of the nine trawlers that participated in the research trips. We also want to thank the National Fisheries Institute – Scientific Monitoring Committee for their assistance in coordinating RSA compensation harvest and all fishermen who participated in compensation harvest.

Our findings are presented immediately below for trips 1-10. Findings for Phase II are presented further below.

Data Reduction Techniques

Principle components analysis (PCA) was used to standardize all common bycatch species data to a mean of 0 and a standard deviation of 1. The variables included catch weight for bluefish, butterfish, all crabs, all dogfish, American lobster, sand-dab flounder, scup, all sea robins, all skates, all squid, striped bass, weakfish, whelk, and winter flounder. The PCA identified 5 axes with eigenvalues greater than 1, encompassing 75% of the variation. Factor loads indicated that axis 1 was determined by the catch weight of butterfish, all crabs, American lobster, sandab flounder, scup, and whelks. Each of these had factor loading scores exceeding 0.64. Bycatch Factor 2 was determined by the catch weight of all skates and winter flounder, with loading scores exceeding 0.90. Bycatch Factor 3 was determined by the catch weight of all squid and striped bass, with loading scores exceeding 0.73. Bycatch Factor 4 was determined by the catch weight of all sea robins, with a loading score of 0.91, and Bycatch Factor 5 by the catch weight of all dogfish, with a loading score of 0.97. Not represented in the first 5 factors were bluefish and weakfish as they were not significant factors.

We employed correspondence analysis to evaluate the relationships between categorical, discrete, and continuous variables (Clausen 1988). We converted continuous data into polytomous variables about the median. These variables included catch weight, bottom temperature, depth, and Bycatch Factors 1 through 5 from the bycatch PCA. Categorical variables included tow length and cull time, as well as several additional categorical variables, established by the following definitions: codend mesh size (large ≥ 5 inches; small < 5 inches); extension mesh size (large ≥ 4 inches; small < 4 inches); footrope length (long ≥ 90 feet; short < 90); summer flounder length (legal ≥ 14 inches; sublegal < 14 inches); summer flounder market description (small < 1 pound; 1 pound ≤ medium < 2

pounds; 2 pounds ≤ large < 4 pounds; jumbo ≥ 4 pounds). The first 4 dimensions accounted for 49% of the variation in these variables. The number of variables that loaded on Dimension 1 made it unique. (The other Dimensions dropped out.) These variables in Dimension 1 included bottom temperature, depth, codend mesh size, and footrope length. Each of these variables had loading scores exceeding |0.55|. Accordingly, key variables describing environmental conditions and gear were correlated in the data set. Tows with large codend mesh sizes and long footropes tended to be tows in shallow water with cool bottom temperatures. These variables were inherently confounding as independent variables for further statistical tests. As a consequence, one of these key variables was chosen to represent them, as a proxy for the variables loading on Dimension 1. After some investigation, the variable chosen was codend mesh size. This proxy variable was retained as a main effect representing all of the variables loading on Dimension 1 in subsequent analyses of variance (ANOVAs). No loading scores for bycatch PCA factors reached a loading value of |0.5| on Dimension 1. However, Bycatch Factor 3 scored greater than |0.45|. As a consequence, there was some degree of correlation between small catches of squid and striped bass, and cool temperatures, shallow tows, large mesh sizes, and long footropes.

Analysis of Onboard Mortality

We calculated the fraction of summer flounder alive specifically at the two cull times, immediate (0-10 minutes) and delayed (25-35 minutes). These fractions were arcsin square-root transformed prior to ANOVA analysis (Sokal and Oden 1978). In addition, we calculated the difference in fraction alive between the immediate and delayed cull times. Prior to ANOVA analyses this variable was ranked. Differences between main effects were identified using *a posteriori* least squares means tests. Trends with covariates were evaluated by *a posteriori* spearman rank correlation tests. We focused on trips 3-10 because the standard cull times were not used for trips 1 and 2. (See discussion under Problems Encountered section below.) We utilized two standard ANOVA models as shown in Table 1. The first ANOVA included as main effects, tow time and codend mesh size (which represents a series of correlated variables as previously described) total catch weight as a covariate, and all interaction terms amongst these variables. The second ANOVA utilized, as independent variables, factor scores for Bycatch Factors 1 through 5 from the bycatch PCA.

The first ANOVA (Table 1) involved the tow and gear main effects with total catch weight as a covariate. No main effects or interactions between those effects were significant for the fraction alive at the immediate cull time (0-10 minutes). Thus the fraction of fish alive when brought onboard was not significantly affected by these independent variables. Although fraction alive immediately upon capture was not affected by these variables, once the summer flounder remained on deck for 25-35 minutes, tow time and codend mesh size, and most interactions between them and with catch weight, were significant. Recall that codend mesh size represents several environmental and gear-related variables. The difference in the fraction living between immediate and delayed cull time was also significantly affected by most of the variables, including the interaction terms. The number of significant interactions suggests that survival of summer flounder on the deck is affected by a variety of factors in each tow and these factors are sufficiently variable from one tow to the next that the relationships

change, and, as a consequence, the interaction terms are routinely significant. *A posteriori* examination of the ANOVA results using least squares means tests revealed that the difference in the fraction living between the immediate and delayed cull was significantly greater for 3-hour tows than for 1-hour tows ($p = .036$). That is, the fraction living declined significantly more over time for 3-hour tows than in the 1-hour tows. However, the 1-hour tow was not significantly different from the 2-hour tow, and the 2-hour tow was not significantly different from the 3-hour tow. Similarly, larger catch weights resulted in larger differences in the fraction living between delayed and immediate culls, with higher catch weight increasing the rate of mortality. Higher catch weights are also generally associated with longer tows. The fraction living at the delayed cull was significantly greater in 1-hour tows than in 2-hour tows, and in 2-hour tows than in 3-hour tows and thus greater in 1-hour tows than in 3-hour tows. Finally, at the delayed cull a higher fraction alive was associated with smaller codend mesh size, however, codend mesh size is a surrogate for several environmental and gear-related variables, so this result should be interpreted with caution. However, it is evident that shorter tows, and the smaller total catch they usually produce, have a beneficial effect on fish survival to the delayed cull time period.

Examining the results of the second ANOVA (Table 1), that included bycatch PCA factors as independent variables, only Bycatch Factor 3 (squid and striped bass) affected the fraction alive, and then only at the 25-35 minute interval. Higher fractions of living summer flounder were associated with lower catches of striped bass and squid (Spearman's $\rho = 0.60$; $P = 0.0013$). It may not be coincidence that this particular bycatch factor loaded most heavily on Dimension 1 in the correspondence analysis, with largest catches of these fishes occurring at cool temperatures and shallow depths. Thus, the explanation for this significant result may be related to the environmental conditions under which tows were conducted, rather than a direct relationship between bycatch species and the survivorship of summer flounder on deck (Table 1).

As both ANAOVA's in Table 1 show, the fraction live at the time of the immediate cull does not appear to be significantly affected by any of the bycatch factors nor any of the gear/tow independent variables or their interaction terms. However, because of our limited sample size we cannot analyze these factor or variables on their own on a trip-by-trip basis. It could be possible that on any given trip any or multiple factors or variables could have been significant for the live fraction at the immediate cull, but not consistently so across multiple trips. We do know, as explained below, that fish condition is affected by bycatch factors and the gear/tow variables and further that condition affects survivorship. Also since the gear/tow variables and their interaction terms are significant for the live fraction at the delayed cull, but not the immediate cull, it is possible that there are a significant number of poor condition fish that are alive during the immediate cull but then start to die quicker than fish in better condition while on deck. It may also be that the live fraction at the immediate cull is affected by a parameter that was not measured. This is an unlikely scenario given the large number of parameters that were measured in this study.

Fish Health Data

The health of summer flounder was evaluated using condition categories that assigned a value of poor, good, or excellent. Condition categories were converted into discrete variables by assigning a 1 to fish in excellent condition, a 2 to fish in good condition, and a 3 to fish in poor condition. We also identified a series of injuries, including fin damage, fin tearing, anal explosion, anal tearing, net marks, scale loss, and abrasion. Each of these injuries was assigned a value of significant, minor, or none. These categories were converted into discrete variables by assigning a 3 to significant, a 2 to minor, and a 1 to none. A set of injury scales was obtained by inputting the 7 types of injuries into a PCA. PCA identified 3 factors with eigenvalues greater than 1, comprising 51% of the variation. A fourth factor brought the total variation explained to 65%. Factor loads indicated that Factor 1 was principally determined by scale loss, abrasion, and, to a lesser extent, fin tearing, all positively correlated. Factor 2 was determined by the incidence of fin damage and fin tearing, but the two variables were inversely correlated. Factor 3 was determined by the incidence of net marks, with a smaller contribution by abrasion. Factor 4 was determined by the incidence of anal tearing.

ANOVA was used to examine potential effects on fish health (See Table 2). The first ANOVA utilized the five Bycatch Factors describing the diversity of bycatch species in the tows, and because of the possibility that health was also influenced by summer flounder length, length was added as a covariate. The dependent variables included the condition index and the four injury factors obtained from the injury PCA. Trends in ANOVA results were analyzed *a posteriori* using (1) least squares means tests and (2) spearman rank correlation tests.

Injury Factor 4 (anal tearing) was not significantly influenced by any bycatch factors or summer flounder length. The condition index and the three primary injury factors were influenced by Bycatch Factors 3, 4, and 5. With the exception of Injury Factor 1 (scale loss and abrasion), summer flounder length was not a substantial contributor to condition or the occurrence of injuries. *A posteriori* examination revealed that larger fish had higher Injury Factor 1 frequencies. Increased catches of fish defining Bycatch Factors 3, 4, and 5 were associated with higher degrees of morbidity (worse condition) and increased presence of Injury Factor 1. The opposite was true for Bycatch Factor 2, where increased catches of fish were associated with lower degrees of morbidity (better condition) and a lesser occurrence of Injury Factor 1. Injury Factors 2 and 3 were positively associated with catches of Bycatch Factor 1 and negatively associated with catches of Bycatch Factors 3 and 4. Looking at condition and the occurrence of injuries as a whole, Injury Factor 1 provided relatively similar results to those obtained by the condition scale, which suggests that the condition scale was, in part, determined by Injury Factor 1 (scale loss, abrasion, and to a lesser extent fin tearing). Also Injury Factor 1 contains those injuries that are most likely to cause mucus loss contributing to a poor fish condition. In addition, clearly the occurrence of Injury Factors 2 and 3, fin damage and net marks, were inherently independent and quite divergent from the occurrence of Injury Factor 1, scale loss, abrasion, and fin tearing.

Next, using a second ANOVA (Table 2), we examined whether the condition index or injury factors were influenced by catch weight, tow time, and several environmental and

gear related variables represented by codend mesh size. To this analysis, we added, as a main effect, cull time, and as a covariate, summer flounder length. Looking holistically at the results, tow time is frequently significant, and codend mesh size is significant in four of five cases, including the condition index and three of the injury factors. Cull time is significant for the condition index and Injury Factor 4 (anal tearing). Catch weight is significant only for Injury Factor 3 (net marks and abrasion). Interaction terms are occasionally significant, but only strongly significant for Injury Factor 3. Examining these results in somewhat more detail, the condition score increased with increasing tow time, indicating a deterioration in the number of healthy fish, but a least squares means was unable to resolve a clear difference between tow times. A higher occurrence of Injury Factor 1 (scale loss and abrasion) was observed on 2 and 3-hour tows than on 1-hour tows, but a least squares means test again did not resolve a significant difference among the three tow times. Injury Factor 3 had a higher incidence in tows lasting 1 hour than it did for 3-hour tows and all three tow times were each significantly different from the other two. Larger codend mesh sizes were associated with a higher incidence of Factor 2 and 3 injuries. However, this was not true for the condition index in which small codend mesh nets were associated with a higher morbidity (poor condition). This further confirms results from the first condition and injury ANOVA that Injury Factors 2 and 3 are clearly divergent from Injury Factor 1 and the condition index in the influence of bycatch, tow time, and other variables related to the trawling process. A higher incidence of Injury Factor 3 was associated with lower catch weights. There were two notable differences in cull times. The frequency of Injury Factor 4 (anal tearing) was higher at the immediate cull than it was at the 25-35 minute time interval. In addition, higher morbidity at the 25-35 minute cull time indicated that fish were in poorer condition after spending time on deck (Table 2).

Survivorship and Condition Upon Release of Penned Fish

We examined the relationship between fish released alive from the net-pen at the end of the14-day holding duration, and the fish that died during the 14 days. After a number of preliminary investigations of the appropriate model to use involving sequential removal of those terms that were routinely non-significant, the resultant ANOVA model included three main effects, two covariates, and one interaction term (See Table 3). The three main effects were group, weight-based market category, and starting condition (poor, good, or excellent), the two covariates were average bottom water temperature and average bottom dissolved oxygen in the net-pen over the 14-day period, and the interaction term was between group and weight-based market category. Group was defined by establishing, for each trip, seven groups of fish. Six groups were defined by a 2 X 3 matrix of tow time (1 hour, 2 hours, and 3 hours) and cull time (immediate, 0-10 minutes and delayed, 25-35 minutes). A seventh group comprised the control fish obtained from the pound nets. To investigate the probability of a fish being released alive, we assigned a 0 to a fish released alive, and a 1 to a fish found dead in the pen. To examine the condition of the fish upon release, we assigned a condition index of 1 to a fish in excellent condition, a 2 to a fish in good condition, and a 3 to a fish in poor condition.

Overall results of survivorship and condition upon release were strongly influenced by group and the condition of fish when penned. Therefore the survivorship, and thus the mortality of the live fraction on deck, is controlled by the tow/cull time and the condition

of the individual fish. However, the determinants of condition upon release was strongly influenced by environmental conditions in the pen, with weight (market category) having a variable influence on survivorship depending upon the fish group. It is interesting that survivorship was influenced by group and the health status when penned and not by the environment of the pen. These results reaffirm the success of the design, placement and deployment of the net-pen system (and probably the overall live holding system as well). The net-pen system performed as planned. Survivorship in the pen was not dependent on any conditions in the pen but was dependent on trip/gear conditions. The holding system did not have any affect on the results of the experiment.

A posteriori examination using least squares means showed that survivorship was highest of all for control fish. This supports our choice of control fish for this experiment. The use of locally caught pound net fish served its purpose to provide a means of control animals in the net-pen holding system. The *A posteriori* results also show that survivorship of the fish caught during the trawl trips was highest for fish from the 0-10 minute cull, regardless of tow time, and survivorship declined for the delayed cull time. Delayed cull times were always significantly different from immediate cull times. Not only is the survivorship significantly greater in the immediate cull, the live fraction on deck is highest at the immediate cull (see Figure 1). Culling the summer flounder on deck as quickly as possible will result in lower mortality, regardless of tow time. However shorter tows usually produce smaller catches, thus facilitating faster culling of summer flounder. Survivorship was significantly better for fish going into the pen in excellent condition and significantly worse for fish in poor condition. Thus condition of the fish going into the pen was a strong determinant for the probability for survival. Recall from ANOVA2 for the fish health data that both tow time and cull time had a significant effect on condition index (shorter tows and less time on deck resulted in a healthier index). Condition upon release was highly variable between groups.

The significant result for condition on release was dominated by the immediate cull, 1-hour tow release condition being significantly better than the immediate cull, 3-hour tow release condition, a result that cannot be easily explained. For condition upon release the significant influence of group is not consistently associated with immediate culls, delayed culls, or 1, 2, or 3 hour tow times and so can not be explained by any particular tow/cull duration. Temperature and dissolved oxygen were inversely correlated relative to fish condition. High dissolved oxygen was associated with a high condition index (poor condition). Low temperature was associated with a high condition index. However neither temperature, nor dissolved oxygen, varied outside the normal range for summer flounder during the entire experiment. Temperature ranged from 15.9°C to 22.5 °C, and dissolved oxygen from 5.2 mg/L to 8.3 mg/L, so the reason for the influence of pen environment on fish condition upon release remains unexplained. Health upon release was not obviously explained by any of the main effects that one would normally assume to be determinants, namely tow time, cull time, and, to a lesser extent, the size of the fish (Table 3). Overall, the condition of summer flounder upon release is relatively inconsistently related to any pen, onboard, or tow-specific metric used in this study. However it is unlikely that condition upon release from the net-pen after 14 days is relative to discard mortality. In terms of this study, once the fish are released alive from the net-pen they are considered to have survived. That is why we chose the long 14-day

monitoring period. Also, generally fish in poor condition did not survive the 14-day monitoring period, where as those in excellent condition survive.

Cumulative Experimental Mortality

We calculated the cumulative mortality for each tow using the mortality on board (dead fraction) and estimating the number of live fish culled that would have died using the 14-day survivorship observed in the pen. First, for each trip, tow, and cull time we calculated a weight for dead fish in the net-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 net-pen, $surv_c$ is the fraction of control fish living after 14 days in the net-pen, and w_l is the weight of live fish released after 14 days.

The survivorship of live fish in the net-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 net-pen at the delayed cull time and $SP_{\tau=I}$ is the survivorship of fish in the net-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 net-pen and L_p is the weight of the live fish that were placed into the net-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:

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

Percent mortality was arcsine square-root transformed. ANOVAs were conducted using the bycatch factors described earlier and the tow time, codend mesh size, and catch weight triumvirate (See Table 4). An ANOVA using bycatch factors as independent variables produced no significant results (ANOVA1, Table 4). When this result is considered in combination with the results of the study thus far, a clear reasoning for why this may have occurred can be ascertained. First, bycatch factors have a strong influence on condition and the presence of injuries. In addition, we know condition at the start of the 14-day net-pen duration experiment strongly influenced the survivorship of fish in the net-pen. Consequently, the bycatch assemblage directly affects the condition, and thus the survivorship of summer flounder that would be released back into the water. However, bycatch factors do not influence the live/dead ratio during culling on deck. The live/dead ratio after the immediate cull is primarily influenced by catch conditions, such as catch weight, tow time, and codend mesh size as a representative for several additional environmental and gear-related variables, over the time required to cull the catch. Overwhelmingly, fish that died did so on deck during this process. Thus, any significant influence of bycatch assemblage on the cumulative mortality of the tow was rapidly minimized as time on deck increased. Thus, had fish been immediately thrown back into the water, it is likely bycatch factors would have played a significant role in determining overall mortality, but because most fish remained on deck, where they were subsequently affected by culling conditions, and not bycatch factors, the ending result is a non-significant relationship.

The second ANOVA in Table 4 was similar to our previous catch/gear models, except we removed any non-significant interaction terms. The three main effects were tow, catch weight, and codend mesh size (as a surrogate for several environmental and gear-related variables), along with two interaction terms both involving catch weight. All main effects and interaction terms were significant, except for tow time. An *a posteriori* least squares means test on tow time, despite a non-significant ANOVA result, shows that mortality was greater in 3-hour tows than 2-hour tows and greater in 2-hour tows than 1-hour tows and thus greater in 3-hour tows than in 1-hour tows. Additionally, 1-hour tows

and 3-hour tows were significantly different from each other (p = .0044). For codend mesh size, mortality rate is higher for large mesh. This result, however, needs to be interpreted with caution, as mesh size is a representative variable for a group of several environmental and gear-related variables. Finally, percent mortality increased with increasing catch weight (Table 4). Catch weight is also a function of tow time with greater catch weights occurring during longer tows.

For the first 10 trips (all 3 tow times) an ANOVA model was used that included as main effects tow time, codend mesh size, and total catch weight, and all interaction terms amongst these variables to examine the percent mortality between the extended immediate (0-10 minute and 10-25 minute) and extended delayed (25+ minute) cull times (Table 5). In this case all main effects and interaction terms are highly significant and these results too are robust to ranking and arcsine-square root transformations. Least squares means for tow time showed an expected trend: high mortality associated with 3-hour tows, lower mortality associated with 2-hour tows, and the lowest mortality associated with 1-hour tows. Least squares mean for mesh size showed higher mortality associated with larger mesh size, however this result was not statistically significant (p = 0.3965) and therefore cannot be interpreted to mean that larger mesh results in higher mortality.

For the first 10 trips, in order to look at the effect of time on deck on the fraction of live fish we added the variable "time on deck" (including 0 minutes, 10 minutes, 25 minutes, 35 minutes, 50 minutes, and 65 minutes) as a main effect to the model described above (Table 5). However, for several cull times large gaps in data (zeros) required that we combine cull times into two categories. Category 1 consisted of the following cull times: 0-10 minutes; 10-25 minutes. Category 2 consisted of the following cull times: 25-35 minutes; 35-50 minutes and all subsequent 15 minute time intervals until the deck was cleared. It was determined that time on deck was not significant (p = 0.4699) and that tow time, catch weight, and codend mesh size were all highly significant. However, an *a posteriori* least squares means test on Time On Deck (cull time), despite a non-significant ANOVA result, does show a significant difference between the Category 1 and Category 2 cull times. Once fish start to die, they seem to do so at a rate determined by tow time, catch weight and the variables represented by mesh size and to a lesser extent by time on deck. Mortality seems to be influenced mainly by what occurred while the fish were being caught. In addition, transformations do not change results and, as expected, least squares means indicates higher fraction live associated with shorter tow times and larger codend mesh.

The cumulative discard mortality for trips 3-10 for each tow length duration, as well as for all tow times combined, is shown in Table 6 and in Figure 9. Data from trips 1 and 2 was excluded because standard cull times were not used for these trips (see discussion under Problems Encountered section). These mortality rates are for the entire summer flounder catch for each tow time and reflect the total mortality for each tow from the time the fish were dumped on deck until the deck is cleared. This includes the live fraction on deck corrected for the extended net-pen mortality. 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 flounder assessment. The mean of 64.6% however is considerably less. Also the mean and median mortality rates for the 1-hour and 2-hour

tows are considerably less than the currently estimated 80% mortality. A statistical linear relationship of discard mortality to tow time exists. The mean discard mortality in the 1-hour tows was 57.8%, in the 2-hour tows it was 61.4%, and in the 3-hour tows it was 76.6%. 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 time that is most representative of the Observer/VTR data could then be used in the assessment.

The calculated mortality by the combination tow time/cull time is shown in Table 7. All of these values are considerably different, for both the mean and median, from the currently used 80% rate and exhibit a considerable range. These mortality values are only for those fish specifically culled at the time of the immediate cull and at the time of the delayed cull and do not include mortality outside of these specific time intervals. Although the mortality at the specific intervals of immediate and delayed cull are similar for each tow time, they increase with increasing tow time.

Table 8 shows the fraction of fish in the net-pen alive after 14 days. Increasing tow time resulted in an increasingly lower live fraction (more dead fish) during the 14 days. Also as Figure 1 shows, the fraction live on deck decreases significantly with increasing time on deck. Since both of these parameters significantly impact the final mortality calculation, shorter tows and shorter time periods on deck will result in lower mortality.

Cortisol Analysis

Cortisol levels were examined using similar ANOVAs, however we were unable to find any significant results. Thus it appears that blood cortisol is not a predictor of condition or survival. A total of 152 blood samples were collected and analyzed.

Phase II Component Findings

As described above, an additional 4 trips were conducted with residual funds. During these trips the standard 1-hour, 2-hour and 3-hour tows were conducted. However no live fish were retained for extended mortality monitoring. On deck procedure was to sort live-dead fraction on a continuous basis at timed intervals until the deck was cleared without regard to “immediate cull” and “delayed cull”. Although the timed intervals were consistent with the initial set of trips, the catch was not split in half to assure fish for the “delayed cull”. Therefore most fish were culled in the 0-10 minute and 10-25 minute intervals with few or no fish available after 25 minutes. Thus it was somewhat difficult to combine both data sets. In order to resolve the differences in procedure and utilize data from Phase II, a series of regression and ANOVA analyses were conducted. However, this reduced data set for trips 11-14 does not have a lot of strength in the analysis. Therefore the results from trips 2-10 provide a must stronger analysis of discard mortality. The Phase II results (trips 11-14) do however provide additional trend information on mortality and support the results of the first ten trips.

Please note that in all cases below where the variable "codend mesh size" is mentioned, it is actually a representative for several variables that loaded on the same dimension in the correspondence analysis from trips 1-10 (as explained above).

Bycatch Factors

Principle components analysis (PCA) was run again on common bycatch species data to determine if any bycatch variables loaded on different axes with the addition of data from four more trips. Bycatch Factors 1 and 2 remained the same; however, Bycatch Factor 3 is now comprised of striped bass only with a loading score of 0.91 (previously striped bass and squid); Bycatch Factor 4 is comprised of bluefish with a loading score of 0.81 (previously sea robin); and Bycatch Factor 5 is comprised of sea robin with a loading score of 0.92 (previously dogfish).

An ANOVA was used to look at the effects of bycatch species on the fraction live at the extended immediate cull (0-25 minutes) for all 14 trips by using PCA Bycatch Factors 1-5 as main effects (Table 9). Only Bycatch Factor 3 (striped bass) was significant ($p = 0.0045$), and this result was robust to ranked and arcsine-square root transformations. Other than Bycatch Factor 3 these results are consistent with the results presented in Table 1.

Multiple Regression Analyses

For the first ten trips, the best multivariate regression models were fit to data to test how well temperature on bottom, catch weight, codend mesh size, tow time, and fraction live at time (0) can predict experiment wide mortality (Table 10). The one variable model (Equation 1), made up of catch weight, was not significant at $\alpha = 0.01$ ($p = 0.0161$). The two variable model (Equation 2) was made up of codend mesh size and catch weight and the three variable model (Equation 3) was made up of codend mesh size, catch weight, and tow time. Both models were statistically significant, however the R^2 values were low at 0.39 and 0.44, respectively. A wide range of values in residuals for both the two and three variable models, in addition to the low R^2 values, suggests that while the models are statistically significant predictors of mortality fraction, they alone are not strong predictors. Furthermore, the absence of temperature on bottom and fraction live at time (0) as predictive variables in any of the three regression models indicates neither had a significant effect on experiment wide mortality. And, finally, while the three variable model was statistically significant, tow time alone had a high p-value (0.2082) which would indicate it provided less information for predicting mortality than either catch weight ($p = 0.0192$) or codend mesh size ($p = 0.0124$).

Similarly, for the first ten trips, the best multivariate regression models were fit to data to test how well temperature on bottom, catch weight, codend mesh size, tow time, and bycatch factors can predict percent mortality between the extended immediate (0-25 minute) and extended delayed (25+ minute) culls (Table 11). The one variable model (Equation 4), made up of codend mesh size, was significant ($p = 0.0014$), but had an R^2 value of only 0.36. The two variable model (Equation 5) was made up of codend mesh size and catch weight and the three variable model (Equation 6) was made up of codend

mesh size, catch weight, and tow time. Both models were statistically significant, however the R^2 values were low at 0.49 and 0.54, respectively. Again, wide range of values in residuals for both the two and three variable models, in addition to the low R^2 values, suggests that while the models are statistically significant predictors of percent mortality between the immediate and delayed culls, they alone are not strong predictors. The absence of temperature on bottom and any of the bycatch factors as predictive variables in any of the three regression models indicates neither had a significant effect on percent mortality between immediate and delayed culls. And, finally, again tow time provided less information to the three variable models with a p value of just 0.1121.

In order to be able to examine data from all 14 trips together, the best multivariate regression models were fit to the data to test how well temperature on bottom, catch weight, codend mesh size, tow time, and bycatch factors can predict the fraction live at time(0) (Table 12). The single variable model (Equation 7) included just tow time and while it was a significant regression, the R^2 value was just 0.25. The two variable model (Equation 8) contained tow time and codend mesh size. It too was significant, but also had a low R^2 of 0.43. The three variable model (Equation 9) included tow time, codend, mesh size, and catch weight with an R^2 of 0.54. The four variable model (Equation 10) included temperature on bottom as well as all three from the three variable models and had an R^2 of 0.60. Finally, the five variable model (Equation 11) included all those from the four variable model with the addition of Bycatch Factor 1. The R^2 value was highest for the five variable regression at 0.67. The presence of both temperatures on bottom and Bycatch Factor 1 in the five variable regressions indicates both are important in determining the fraction live at time (0).

The same model as the one above was then used, except that how well the variables could predict the fraction live in the entire cull for the duration 0-25 minutes (extended immediate cull) was examined. (Table 13). Results are similar for the one, two, and three variable models. The single variable model (Equation 12) included just tow time and while it was a significant regression, the R^2 value was again low at just 0.35. The two variable models (Equation 13) contained tow time and codend mesh size again. It too was significant, but also had a low R^2 of 0.50. The three variable models (Equation 14) included tow time, codend, mesh size, and catch weight and had a higher R^2 of 0.59. However, when looking at the 0-25 minute extended immediate cull as a whole, both temperature on bottom and Bycatch Factor 1 drop out as influential variables in any of the three regression models, indicating that while they may be important at time (0) they are not important beyond that point.

Finally, again using data from all 14 trips, the best multivariate regression models were fit to the data to test how well temperature on bottom, catch weight, codend mesh size, tow time, and bycatch factors could predict the percent mortality between the 0-10 minute immediate cull and the 10-25 minute culls (Table 14). The single variable model (Equation 15) included just tow time and was not significant ($p = 0.0657$). The two variable model (Equation 16) contained tow time and codend mesh size. This model was also not significant ($p = 0.0479$). The three variable model (Equation 17) included temperature on bottom, codend mesh size, and Bycatch Factor 5, however it was also not significant ($p = 0.0562$). The four variable model (Equation 18) contained the variables from the three variable along with Bycatch Factor 2 and it, too, was not significant (p =

0.0635). Finally, the five variable model (Equation 19) added Bycatch Factor 3 to the four variable model and was also not significant (p = 0.0926). The absence of a single statistically significant model indicates temperature on bottom, catch weight, codend mesh size, tow time, and bycatch factors are not predictive of percent mortality between the 0-10 minute cull and 10-25 minute cull.

ANOVA Analyses

For the following 3 ANOVA analysis, the one hour duration tows dropped out and data were used only from the 2 and 3 hour tows. This was caused because, in order to accommodate trips 11-14, we either combined the 0-10 minute cull with the 10-25 minute cull; or compared the 0-10 minute cull to the 10-25 minute cull. For many trips the one hour tow contained many zeros, especially in the 10-25 minute interval. Thus we were not able to utilize the one hour tow data in the following analysis.

For all 14 trips (2 and 3-hour tow times only) an ANOVA model was used that included as main effects tow time, codend mesh size, and total catch weight, with all interaction terms amongst these variables to examine their effect on the fraction live at the extended immediate cull (0-25 minutes) (Table 15). After performing a ranked data transformation, it was determined that only catch weight was significant (p = 0.0033). In addition, the spearman correlation coefficient indicated that as catch weight went up the fraction live went down.

For all 14 trips (2-hour and 3-hour tow time only) an ANOVA model was used that included as main effects tow time, codend mesh size, and total catch weight, and all interaction terms amongst these variables to examine the difference in the fraction live between the 0-10 minute immediate cull and the 10-25 minute cull (Table 15). Besides a very weak signal (p = 0.0336) for the catch weight – codend mesh size interaction, none of the main effects had a significant impact on this metric and using a ranked data transformation did not change this result. The results are not surprising considering this metric is confounded by the fact that the number live at the 10-25 minute cull is directly dependent upon the number live at the 0-10 minute cull.

For all 14 trips (2-hour and 3-hour tow time only) the same ANOVA model was used as described above, but this time to examine the percent mortality, a more appropriate metric, between the 0-10 minute immediate cull and the 10-25 minute cull (Table 15). In this case the codend mesh size was highly significant (p = 0.0005) as were interactions for coden mesh size - tow time (p = 0.0090), codend mesh size – catch weight (p = 0.0020), and codend mesh size – catch weight – tow time (p = 0.0079). These results were robust to transformations, including ranking and arcsine-square root. An *a posteriori* least squares means test showed small mesh sizes were associated with higher rates of mortality. In addition, while the tow time was not a significant main effect, a least squares means test showed that the 3-hour tows were associated with higher mortality than the 2-hour tows, a result that likely contributed to significant tow time interaction terms in the model.

Phase II Conclusions

The main effects of tow time, codend mesh size (as a proxy for several variables), and catch weight are routinely significant in models examining fraction live and/or percent mortality of summer flounder and these results are robust to several forms of analyses and data transformations. Bycatch species and temperature on bottom matter for the immediate mortality of summer flounder, but fall out as significant factors contributing to mortality beyond that point. As such we have developed a multivariate regression equation (see Equation 3 and Table 10) that utilizes the results of trips 1 thru 10 to predict overall discard mortality for trips 11 thru 14. Although the fit is not real strong it utilizes the 3 main effects of tow time, codend mesh size (as representative of several factors) and catch weight, which as shown above are routinely significant. The results are shown in Table 16. The extrapolated cumulative discard mortality by tow time from trips 11-14 is comparable to actual cumulative discard mortality data from trips 3-10. For trips 11-14 the estimated mean discard mortality for all trips combined was 66.0% and the median was 66.3%. For the 1-hour tows estimated mean discard mortality was 54.1%, in the 2-hour tows it was 68.3%, and in the 3-hour tows it was 75.6%.

Additional Results

In Figure 1, the fraction of live summer flounder as time on deck increases was plotted for all tows combined. As expected, the highest proportion of fish was alive on deck was during the immediate cull (0-10 minutes). The delayed cull (25-35 minute time interval) had the second highest fraction of live fish of deck. Live fish were collected for the extended mortality monitoring component during these two time periods. In order to ensure that there were enough live fish remaining for the extended mortality monitoring component in the delayed cull, the pile of fish was separated into two halves once it was dumped on deck. The first half of the pile was sorted immediately. Sorting of the second half of the pile began after 25 minutes. For some tows, all live fish were removed from the pile only during the immediate and delayed cull times. This left few or no live fish for the other time intervals. This helps to explain why the live fraction during the 10-25 minute time interval is lower than the 25-35 minute time interval. In Figure 2, the fraction of live summer flounder on deck as time increases was plotted according to tow time. The live fraction by tow time follows the same trend as mentioned above for all tows combined. Tow time was one of the three main effects which was routinely significant in models examining fraction live and/or percent mortality of summer flounder. For the immediate and delayed cull the highest live fraction of fish is observed during the 1-hour tow and lowest live fraction is observed during the 3-hour tow. A single live fish found between 65 and 80 minutes caused a spike on the graph for the 1-hour tow. It was unexpected to find any fish alive after the 50-65 minute time interval. Using the deck hose to keep the fish submerged in water increases the likelihood of fish survival.

Note: Data from trips 3-14 are used for graphing purposes in Figures 1 and 2. The time intervals used for trips 1 and 2 do not match trips 3-14. Cull time intervals from trips 1 and 2 were not spaced broadly enough to determine the effect of cull time on summer flounder mortality. The cull time procedure was modified after these two trips to allow a greater time difference between culls to more easily determine the effect. As of trip 3, the

immediate cull represents the time period between zero and 10 minutes and the delayed cull represents the time period between 25 and 35 minutes.

Figure 3a illustrates the total catch weight of all species by trip number and tow time. Figure 3b illustrates the average catch weight of all species by tow time and for all tows combined. Catch weight was one of the main effects which was routinely significant in models examining fraction live and/or percent mortality of summer flounder. Larger catches may cause increased pressure damage on summer flounder during tow and haul-back. The fish may be crushed and damaged by the weight of the catch resulting in increased mortality. Figure 4 shows the total catch weight of fluke for each trip and tow. Figures 5a-n show the catch weight of each individual bycatch species by trip number and tow time. Assemblages of bycatch species have been formed for data analysis purposes and grouped into 5 "Bycatch Factors". The effect of the catch of these species assemblages is explained in the Findings section above.

Age Structures & Sex Ratios

Age structures were collected from summer flounder in order to provide for the expansion of summer flounder age sampling from commercial catches. Upon completion of fieldwork done in the summer of 2007 we provided hard parts to the NMFS Northeast Fisheries Science Center in the form of 436 scale samples and 267 otolith samples. We also provided trip level information for all age structures, including VTR # and area fished. During the summer of 2009 an additional 378 scales and 145 otoliths were collected and forwarded to NMFS. Sex was determined for 139 fish. Out of 139 fish, 115 were female (82.7%) and 24 were male (17.3%). All length frequencies and age structures were incorporated into the NMFS commercial dockside sampling database and as such separate age information specific to this project was not reported back to CCE.

Length Frequencies

A total of 1834 length frequencies were collected for this project from "discarded" and "kept" fish caught on research trips in 2007 and 2009. A length frequency distribution chart was created from this information (Figure 6). The greatest number of individuals was at 47 centimeters. A total of 134 fish were measured at this size interval. A second peak was at 44cm. A total of 130 fish were measured at this length. The largest fish measured 74 cm and the smallest fish measured 23 cm.

Tag Returns

Over the course of the project we have had a total of 62 tag returns from our tagged and released fish. A total of 51 tagged fish were caught in 2007 and 11 tagged fish were caught in 2008 and later. Most of these returns were from the Lake Montauk/Block Island Sound/Gardiners Bay area in relatively close proximity to where they were released. Many were caught during the summer and fall 2007 and were not at liberty for very long. However, one tagged fish was recaptured in June 2010. This fish was at liberty for the longest time – just over three years. Another fish was at liberty for nearly three years. We have had tag returns from fish caught as far south as off the coasts of Virginia and southern New Jersey. There were a few tag returns from fish caught off the coasts of

Rhode Island and Connecticut and a few caught off the south shore of Long Island. We had one tag return from the R/V Albatross and one tag return from a prominent NMFS scientist caught in the recreational fishery off Rhode Island. The location of tagged fish recaptures is detailed in Figures 7 and 8. Other than the Albatross, recaptures have been from the recreational fishery and the commercial trawl fishery. We have had a 10.4% return on tagged fish. These data provide qualitative information on the extended survival of our "discarded" fish after they were released from the net-pen. The data also provides additional information on migration patterns of summer flounder caught off Long Island, New York.

Discards and Bycatch

This study has provided accurate information on summer flounder discard and bycatch in the inshore summer flounder bottom trawl fishery. During all 14 scientific trips, we have thoroughly recorded all discards during normal fishing activity in the summer flounder fishery and quantified which discards would be classified as regulatory discards and which would be classified as normal discards. Regulatory discards are discards over the trip limit (excluding sublegal sized fish). The amount of regulatory discard equals the total weight of all fluke caught per tow/trip - (trip limit + total weight of all sublegal sized fish). Regulatory discard (lbs) is then divided by total weight of all fluke caught per tow/trip to get percent regulatory discards**.** Normal discard is bycatch attributed to gear which includes sublegal fish and discards caused by high-grading (which did not occur) or other economic factors (market demand). Normal discard equals the total weight of all sublegal sized fish. Normal discard (lbs) is then divided by total weight of all fluke caught per tow/trip to get percent normal discards.

Normal (gear induced) discards by trip ranged from .019 to 5.38%. Regulatory discards ranged from 53% to 95.7% for the 14 trips. See Table 17a-b for "normal" and "regulatory" discards and bycatch by trip and tow. These discards are based on the very low New York trip limits in place during this project. During the six month study (May through October 2007) New York trip limits in the areas fished ranged from 30 to 90 pounds per trip. During the four additional trips, which took place during September of 2009, trip limits ranged from 100 pounds to 140 pounds. From these findings we can see that the quantity of summer flounder discards is directly related to regulatory trip limits. In the absence of high trip limits or high landing allowances or as provided by research set-aside programs we can observe that in New York directed summer flounder fishing results in a high level of regulatory discards and as such efforts may not be economically feasible.

Problems Encountered

Two minor problems were encountered during this project. However they did not impact the success of the project. Despite significant pre-planning for all on board procedures, it took us two trips to fine tune culling procedures to work in practical terms on deck as well as fit into a protocol for scientific analysis. The time frame intervals for sorting live/dead fraction on deck were not finalized until the end of trip 2. Therefore the live/dead fraction for trips 1 and 2 could not be utilized with the data from trips 3 through 10. Thus the cumulative experimental mortality calculations do not include these two

trips. However we were able to utilize the data for trips 1 and 2 for the extended net-pen mortality monitoring and condition data and have incorporated that data with all the other trips.

The other issue was tag loss by fish in the net-pen. This occurred primarily during warmer net-pen water temperatures and mainly for dead fish. During the warmer summer water temperatures the dead fish in the net-pen decomposed quickly contributing to the tag loss. Even with daily net-pen monitoring fish would decompose quickly. This decomposition also led to the attraction of large numbers of crabs to the net-pen area during the warm weather. The mesh of the net-pen was designed to keep crabs out of the net. We also utilized live blackfish in the net-pen to graze on small crabs that got through the mesh. However crabs would accumulate under and around the net-pen. They would stick their claws through the mesh and pick on dead fish. Soft areas are the first areas attacked by the crabs: eyes, anus, decaying belly and the small wound around the tag insertion area. Loose tags were recovered from under and around the net during regular monitoring activities. Most of the fish that lost tags (dead or alive) were matched up with the appropriate tag number based on our detailed individual fish information from when the fish was tagged. During the course of the project we also had a few live fish that also shed tags. Any fish that we could not resolve with found tags or if there was a question as to what fish the tag belonged to, a random number generator was used to assign the unknown to live/dead/tow/cull.

Additional Work

A comparable evaluation of summer flounder discard mortality in the offshore trawl fishery will complement the findings from the current project. CCE received an RSA grant in 2009 to conduct this complementary project. The composite results will define any differences in mortality between the inshore and offshore fisheries and at the same time provide a scientific basis for the discard mortality rate to be used across the inshore and offshore components of the fishery.

The significant linear relationship of tow time to discard mortality suggests that correlating average tow time as reported on vessel trip reports (VTR) involving summer flounder may help identify a quantifiable discard mortality rate to be used in the assessment model.

Since total catch also proved to be an important mortality variable, further refining the relationship between tow time and total catch may help explain/reduce discard mortality.

EVALUATION

Attainment of Goals and Objectives

The key study components of research design, on board sampling work plan and net-pen extended mortality monitoring function were highly effective in delivering research results that were successful in realizing all project goals and objectives.

Through the process of conducting this project we were able to develop and adapt procedures for on board sampling and extended mortality monitoring facilities that were compatible with project design criteria and provide scientifically based results on summer flounder discard mortality. The project was completed on schedule. Not only were we able to successfully carry out the approved project work-plan, we were also able to carry out 4 additional modified trips to provide supplemental data for the project. The following research generated information is presented as it relates to specific project goals. The primary goal of this project was to provide fishery managers, scientists and commercial fishermen with a research based evaluation of summer flounder discard mortality in the inshore trawl fishery. Our project has shown that there is an overall median discard mortality of 78.7%, which is similar to the assumed 80% value in the present summer flounder assessment. However the overall project mean discard mortality (a more useful parameter rather than median) was 64.6% and is considerably less than the value in the current assessment. A secondary goal was to provide accurate information on summer flounder discard and bycatch. Gear induced discards ranged from .019% to 5.38% and represent those fish discarded because of size, grading or other economic factors (market demand). Regulatory discards are those fish caught over the trip limit excluding sublegal sized fish, and ranged from 53% to 95% for 14 trips. Related to this goal we recorded total catch by weight and by species including summer flounder.

A third project goal was to evaluate summer flounder discard mortality relative to tow time, fish size, total catch and amount of time fish are on the deck of the vessel. As described above in the methods and findings sections of this report each of these variables were evaluated and resulted in quantitative findings.

Mortality rates for 1 and 2-hour tows were less than for the 3-hour tows. Mortality rates for all tows combined at the immediate and at the delayed cull were 51.3% versus 59.2%. However, the fraction live on deck decreases with time. Higher total catch weights related to increased rate of mortality. Longer tows usually resulted in higher total catches. Specifically larger catch weights resulted in larger differences in the fraction living between delayed and immediate culls, with higher catch weights increasing the rate of mortality. Size of fish does not seem to be a critical factor for survival. Survivorship was significantly better for fish in excellent condition and significantly worse for fish in poor condition. We continue to get tag returns for released fish and will thus be able to provide additional qualitative information on additional time at liberty (survival) and distribution.

In summary, the purpose, approach and findings sections provide factual detail related to meeting project goals and objectives. On review these quantitative findings support the conclusion that all identified project goals and objectives were attained.

Information Dissemination

In November 2007, CCE staff members gave a presentation at Inlet Seafood, Montauk, New York to report on project activities and preliminary results. Preliminary mortality rates and factors causing increased mortality were discussed in a power point presentation. A large number of project participants, fishermen and other industry members were in attendance. Attendees reported that the project and the results generated

are interesting and highly important to fishermen involved in the inshore fluke fishery in New York.

The following informative packages were developed and used to disseminate project results.

- Website
  CCE has developed a website specifically for this project. The website is a link off the CCE website and can be found at
  http://counties.cce.cornell.edu/suffolk/sfdms/fluke.html
  The website includes an overall description of the project as well as descriptions and photographs of the various components of the project including the scientific trips. A listing of tag returns is also included. Final results, once approved by NMFS, will be added to the website.

- Power Point Presentation
  A slide/power point presentation has been developed and presented to industry project participants. This presentation will be finalized when the Final Report is approved and shown at industry, management or scientific gatherings.

- Final Report (Approved)
  Will be available on our website at
  http://counties.cce.cornell.edu/suffolk/sfdms/fluke.html under "Evaluation of Summer Flounder Discard Mortality In The Inshore Bottom Trawl Fishery".

- Fact Sheet
  This fact sheet entitled Summer Flounder Discard Perspective is a brief guide to the general findings of this research and provides some common understandings and practical applications from the research findings for those individuals involved in this important commercial fishery. It also highlights project results relating to reducing discard mortality within the commercial trawl fishery. The fact sheet has been distributed at dockside meetings, press releases, etc. (See Attachment 1)

- Press Release Package
  A press release package to include Executive Project Summary, Fact Sheet, and other project report information will be developed and distributed to news and industry publications once the final report is approved. See Attachment 2 for articles featuring this project during the research phase.

- Working Paper
  A working paper based on this study was prepared and presented to the Southern Demersal Working Group in preparation for the 2008 summer flounder stock assessment. A summary of the working paper was included in the SAW report and the working paper itself is in the Appendix of the SAW report. (See Attachment 3)

- Scientific Paper

A scientific paper will be prepared and submitted to a peer-reviewed journal for publication.

- A presentation on the results and findings of this project will be presented at the 2011 Annual Meeting of the American Fisheries Society. The presentation will be part of a symposium titled "The Biology, Ecology and Management of Summer Flounder".

Miscellaneous Related Activities

Research Findings Impacts

The NYSDEC, a permitting partner to the fluke discard mortality study in the form of a New York State Marine Resources Exempted Fishing License (NYS EFL), requested and was provided trip and net-pen monitoring reports from the initial summer flounder research trips 1 thru 10. This information included fluke regulatory discard rates for the ten trips and the 1, 2, & 3-hour tows. Based partly on these regulatory discard impacts, NYSDEC developed an alternative summer flounder distribution. The alternative option provided for a weekly trip or quota limit as opposed to a daily trip limit to help mitigate the regulatory discard impact caused by the low daily trip limit. NYSDEC implemented a summer flounder weekly trip limit program on November 28, 2009 for summer flounder all gear or fixed gear permit holders. Vessels applied to participate in the program and needed to meet a stringent set of regulations. This program was closely monitored by NYSDEC and participants were required to comply with program standards. This program has been well received by the commercial fishing industry and has been a more effective management tool for NYSDEC and has been continued into 2010 and 2011.

TABLES

Table 1. Significance levels in ANOVAs evaluating the influence of Bycatch Factors 1 through 5, tow time, total catch weight, and codend mesh size on the fraction of fish alive during cull times 0-10 minutes and 25-35 minutes, and the change in the fraction live between the two cull times. *-interaction term. NS=not significant at α=0.05.

	Fraction Live Cull Time 0-10	Fraction live Cull Time 25-35	Change in Fraction Live Between Cull Times
ANOVA 1			
Tow Time	NS	0.0069	0.013
Catch weight	NS	NS	0.0091
Catch weight* tow time	NS	<0.0001	0.0017
Codend mesh	NS	0.0008	NS
Codend mesh* tow time	NS	0.0044	0.0061
Catch weight* codend mesh	NS	0.0110	0.0260
Catch weight* codend mesh* tow time	NS	0.0080	0.0130
ANOVA 2			
Bycatch Factor 1	NS	NS	NS
Bycatch Factor 2	NS	NS	NS
Bycatch Factor 3	NS	0.0170	NS
Bycatch Factor 4	NS	NS	NS
Bycatch Factor 5	NS	NS	NS

Table 2. Results of ANOVAs evaluating the influence of Bycatch Factors 1-5 and summer flounder length in one case and tow time, codend mesh size, cull time, and summer flounder length in another on the condition index (morbidity scale) and Injury Factors 1-4. NS=not significant at α=0.05. Underlined values are positive spearman rank correlations.

	Condition Index	**Injury Factor 1**	**Injury Factor 2**	**Injury Factor 3**	**Injury Factor 4**
ANOVA 1					
Bycatch Factor 1	NS	NS	0.0017	<0.0001	NS
Bycatch Factor 2	<0.0001	<0.001	NS	NS	NS
Bycatch Factor 3	0.0002	0.0210	0.0034	<0.0001	NS
Bycatch Factor 4	0.0030	0.0160	0.0013	0.009	NS
Bycatch Factor 5	<0.0001	<0.0001	0.0004	0.0150	NS
Summer Flounder Length	NS	<0.0001	NS	0.0420	NS
ANOVA 2					
Tow Time	0.0022	0.0420	NS	0.0003	NS
Codend Mesh	0.0390	NS	0.0220	<0.0001	0.0130
Codend Mesh*Tow Time	NS	NS	0.0190	0.0005	NS
Catch weight	NS	NS	NS	0.0008	NS
Catch weight*					
Tow Time	0.0140	NS	NS	0.0002	NS
Catch weight* Codend Mesh	NS	0.0350	NS	0.0006	NS
Catch weight*Tow Time*Codend Mesh	NS	NS	NS	0.0003	NS
Cull Time	0.0140	NS	NS	NS	0.0270
Summer Flounder Length	NS	0.0006	NS	0.0028	NS

Table 3. Results of ANOVAs evaluating the influence of market category (by weight), group (groups include (1) control, (2) 1-hour tow and immediate cull, (3) 2-hour tow and immediate cull, (4) 3-hour tow and immediate cull, (5) 1-hour tow and delayed cull, (6) 2-hour tow and delayed cull, and (7) 3-hour tow and delayed cull), starting condition level of summer flounder when penned, mean bottom water temperature, and mean bottom dissolved oxygen (DO) on survivorship in the net-pen and condition state of summer flounder upon release after 14 days in the net-pen.

	Survivorship	**Condition Upon Release**
Group	0.0006	0.0069
Weight	NS	NS
Initial Condition	<0.0001	0.0250
Weight*Group	0.0091	NS
Temperature	NS	<0.0001
DO	NS	<0.0001

Table 4. Results of ANOVAs evaluating the influence of Bycatch Factors 1-5 and main effects describing tow time, gear, and the covariate catch weight on the percentage of mortality of summer flounder for the entire tow.

	% Mortality
ANOVA 1	
Bycatch Factor 1	NS
Bycatch Factor 2	NS
Bycatch Factor 3	NS
Bycatch Factor 4	NS
Bycatch Factor 5	NS
ANOVA 2	
Tow Time	NS
Catch weight	0.0055
Codend Mesh	0.0035
Catch weight*Tow Time	0.0410
Catch weight* Codend Mesh	0.0026

Table 5. Significance levels in ANOVAs evaluating, for the first 10 trips only, the influence of tow time, catch weight, and codend mesh size on the percent mortality between the extended immediate (0-25) and extended delayed (25+) cull times, as well as the influence of tow time, catch weight, codend mesh size, and time on deck on the percent mortality between the extended immediate and extended delayed cull times. *-interaction term. NS=not significant at α=0.05.

	% Mortality between Extended Immediate and Extended Delayed Culls	% Mortality between Extended Immediate and Extended Delayed Culls, with Time Variable
Tow Time	0.0013	<0.0001
Catch weight	0.0454	<0.0001
Catch weight*tow time	<0.0001	N/A
Codend mesh	0.0002	<0.0001
Time on Deck	N/A	NS
Codend mesh*tow time	0.0062	N/A
Catch weight*codend mesh	0.0061	N/A
Catch weight*codend mesh*tow time	0.0075	N/A
Time on Deck*tow time	N/A	0.6525
Time on Deck*Catch weight	N/A	0.0378
Time on Deck*Codend mesh	N/A	0.8312

Table 6. 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 7. 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

Table 8. Mean, standard deviation in parentheses, median, 25th to 75th percentiles for the fraction of live fish in the pen after 14 days by tow time and overall.

Fraction Pen Fish Live	Mean	Median	25th-75th percentile
Tow 1	42.1(31.0)	45.3	13.0-68.3
Tow 2	38.7(24.7)	40.0	16.8.5
Tow 3	27.2(19.8)	33.0	7.6-41.3
All	36.2(26.1)	35.1	12.3-54.3

Table 9. Significance levels for an ANOVA evaluating the influence of Bycatch Factors 1 through 5 on the fraction live at the extended immediate cull (0-25 minutes).
*-interaction term. NS=not significant at α=0.05.

	Fraction Live Immediate Cull
Bycatch Factor 1	NS
Bycatch Factor 2	NS
Bycatch Factor 3	0.0045
Bycatch Factor 4	NS
Bycatch Factor 5	NS

Table 10. Results of a multivariate regression analysis that included temperature on bottom, catch weight, codend mesh size, tow time, and observed fraction live on deck at time(0) as input variables and experiment wide mortality as the dependent variable for the first ten trips. P values are given for each variable as well as the overall model p-value and R^2.

Model	Tow Time	Codend Mesh	Catch Weight	Model p-Value	R^2
One Variable			0.0161	0.0161	0.2182
Two Variable		0.0172	0.0113	0.0032	0.3925
Three Variable	0.2082	0.0124	0.0192	0.0050	0.4356

Table 11. Results of a multivariate regression analysis that included temperature on bottom, catch weight, codend mesh size, tow time, and bycatch factors as input variables and the percent mortality between the extended immediate (0-25) and extended delayed (25+) culls as the dependent variable for the first ten trips. P values are given for each variable as well as the overall model p-value and R^2.

Model	Tow Time	Codend Mesh	Catch Weight	Model p-Value	R^2
One Variable		0.0014		0.0014	0.3529
Two Variable		0.0009	0.0278	0.0006	0.4780
Three Variable	0.1121	0.0004	0.0463	0.0006	0.5358

Table 12. Results of a multivariate regression analysis that included temperature on bottom, catch weight, codend mesh size, tow time, and bycatch factors as input variables and the fraction live at time(0) as the dependent variable for all trips. P values are given for each variable as well as the overall model p-value and R^2.

Model	Tow Time	Codend Mesh	Catch Weight	Temp on Bottom	Bycatch Factor 1	Model p-Value	R^2
One Variable	0.0012					0.0012	0.2547
Two Variable	0.0002	0.0024				<0.0001	0.4293
Three Variable	0.0004	0.0011	0.0079			<0.0001	0.5377
Four Variable	<0.0001	0.0004	0.0005	0.0201		<0.0001	0.6086
Five Variable	<0.0001	0.0010	0.0023	0.0012	0.0157	<0.0001	0.6747

Table 13. Results of a multivariate regression analysis that included temperature on bottom, catch weight, codend mesh size, tow time, and bycatch factors as input variables and the fraction live at the 0-25 minute cull as the dependent variable for all trips. P values are given for each variable as well as the overall model p-value and R^2.

Model	Tow Time	Codend Mesh	Catch Weight	Model p-Value	R^2
One Variable	<0.0001			<0.0001	0.3476
Two Variable	<0.0001	0.0021		<0.0001	0.4927
Three Variable	<0.0001	0.0009	0.0049	<0.0001	0.5917

Table 14. Results of a multivariate regression analysis that included temperature on bottom, catch weight, codend mesh size, tow time, and bycatch factors as input variables and the percent mortality between the 0-10 minute and 10-25 minute culls as the dependent variable for all trips. P values are given for each variable as well as the overall model p-value and R^2

Model	Tow Time	Codend Mesh	Bycatch Factor 5	Temp on Bottom	Bycatch Factor 2	Bycatch Factor 3	Model p-Value	R^2
One Variable	0.0657						0.0657	0.2371
Two Variable	0.0777	0.0991					0.0479	0.3975
Three Variable		0.0155	0.0743	0.2286			0.0562	0.4829
Four Variable		0.0157	0.0502	0.1059	0.2191		0.0635	0.5588
Five Variable		0.0143	0.0386	0.0770	0.1403	0.3594	0.0926	0.6002

Table 15. Significance levels in ANOVAs evaluating, for all 14 trips, the influence of tow time, catch weight, and codend mesh size on (1) the fraction of fish alive at the immediate cull, (2) the difference in the fraction live between the 0-10 minute and 10-25 minute culls, and (3) the percent mortality between the 0-10 minute and 10-25 minute cull times. *-interaction term. NS=not significant at α=0.05.

	Fraction Live at Immediate Cull	Difference in Fraction Live between the 0-10 minute and 10-25 minute Culls	% Mortality between the 0-10 minute and 10-25 minute Culls
Tow Time	NS	NS	NS
Catch weight	0.0033	NS	NS
Catch weight*tow time	NS	NS	NS
Codend mesh	NS	NS	0.0005
Codend mesh*tow time	NS	NS	0.0090
Catch weight*codend mesh	NS	0.0336	0.0020
Catch weight*codend mesh*tow time	NS	NS	0.0079

Table 16. Mean, standard deviation in parenthesis, median, 25th to 75th percentiles for the estimated percent mortality by tow time and overall for Trips 11-14

% Mortality	**Mean**	**Standard deviation**	**Median**	**25th-75th percentile**
Tow 1	54.1	19.53	53.68	42.5-65.2
Tow 2	68.3	17.19	67.21	57.4-78.1
Tow 3	75.8	18.29	77.78	67.5-85.9
All	66.0	16.71	66.3	56.4-76.9

Table 17a. "Normal" and "Regulatory" Discards in the Summer Flounder Discard Mortality Study – Summer Flounder Discards by Trip

Trip Number	Total Weight of sublegalfish in cages	Total Weight of legal fish in cages	Total Weight of Untagged Sublegal Fish	Total Weight of Untagged Legal Fish	Trip Limit (lbs)	Total Weight of all live fish in cages	Total Weight of All Fluke Caught	"Normal" Discards (lbs)	Percent "Normal" Discards	"Regulatory" discards (lbs)	Percent "Regulatory" discards
1	2.42	315.36	5	1942	90	317.78	2264.78	7.42	0.33%	2167.36	95.70%
2	5.5	216	0	215.5	70	221.5	437	5.5	1.26%	361.5	82.72%
3	4.8	125.02	14.2	336.42	30	129.82	480.44	19	3.95%	431.44	89.80%
4	4.7	274.07	0	364	30	278.77	642.77	4.7	0.73%	608.07	94.60%
5	0	304.45	0.75	94.85	30	304.45	400.05	0.75	0.19%	369.3	92.31%
6	5.95	331.82	0	68.43	90	337.77	406.2	5.95	1.46%	310.25	76.38%
7	2.82	156.75	6	44.8	90	159.57	210.37	8.82	4.19%	111.55	53.03%
8	7.92	346.93	32.41	1494.8	70	354.85	1882.06	40.33	2.14%	1771.73	94.14%
9	0	383.6	63.48	1373.28	70	383.6	1820.36	63.48	3.49%	1686.88	92.67%
10	5.6	321.25	90.2	1363.49	50	326.85	1780.54	95.8	5.38%	1634.74	91.81%
11	0	0	12.24	1069.56	100	0	1081.8	12.24	1.13%	969.56	89.62%
12	0	0	24.35	580.4	100	0	604.75	24.35	4.03%	480.4	79.44%
13	0	0	67.21	1212.51	140	0	1279.72	67.21	5.25%	1072.51	83.81%
14	0	0	8.16	536.74	140	0	544.9	8.16	1.50%	396.74	72.81%

Table 17b. "Normal" and "Regulatory" Discards in the Summer Flounder Discard Mortality Study – Summer Flounder Discards by Tow

Trip Number	Tow Time	Total Weight of sublegal sized fish in cages	Total Weight of legal fish in cages	Total Wt of Untagged Sublegal Fish	Total Weight of Untagged Legal Fish	Trip Limit	Total Weight of all live fish in cages	Total Wt of All Fluke Caught per Tow	"Normal" Discards (lbs)	Percent "Normal" Discards	"Regulatory" discards (lbs)	Percent "Regulatory" Discards
1	1	0.6	109.73	1	489.5	90	110.33	600.83	1.6	0.27%	509.23	84.75%
1	2	1.82	95.45	2	819	90	97.27	918.27	3.82	0.42%	824.45	89.78%
1	3	0	110.18	2	633.5	90	110.18	745.68	2	0.27%	653.68	87.66%
2	1	1	59	0	4	70	60	64	1	1.56%	0	0.00%
2	2	2.5	74.5	0	84.5	70	77	161.5	2.5	1.55%	89	55.11%
2	3	2	82.5	0	127	70	84.5	211.5	2	0.95%	139.5	65.96%
3	1A	0.8	33.52	1.46	7.42	30	34.32	43.2	2.26	5.23%	10.94	25.32%
3	1B	2.8	50.5	0	9	30	53.3	62.3	2.8	4.49%	29.5	47.35%
3	2	0.2	32	7.74	123	30	32.2	162.94	7.94	4.87%	125	76.72%
3	3	1	9	5	197	30	10	212	6	2.83%	176	83.02%
4	1	3.1	70.26	0	70.6	30	73.36	143.96	3.1	2.15%	110.86	77.01%
4	2	0	105.05	0	113.9	30	105.05	218.95	0	0.00%	188.95	86.30%
4	3	1.6	98.76	0	179.5	30	100.36	279.86	1.6	0.57%	248.26	88.71%
5	1	0	59.9	0	0	30	59.9	59.9	0	0.00%	29.9	49.92%
5	2	0	168.34	0.75	76.35	30	168.34	245.44	0.75	0.31%	214.69	87.47%
5	3	0	76.21	0	18.5	30	76.21	94.71	0	0.00%	64.71	68.32%
6	1	0	105.6	0	2.2	90	105.6	107.8	0	0.00%	17.8	16.51%
6	2	2.1	126.78	0	6.58	90	128.88	135.46	2.1	1.55%	43.36	32.01%
6	3	3.85	99.44	0	59.65	90	103.29	162.94	3.85	2.36%	69.09	42.40%
7	1A	0	2.1	0	0	90	2.1	2.1	0	0.00%	0	0.00%
7	1B	0	7.92	0	0	90	7.92	7.92	0	0.00%	0	0.00%
7	2	1.4	101.39	0	9.1	90	102.79	111.89	1.4	1.25%	20.49	18.31%
7	3	1.42	45.34	6	35.7	90	46.76	88.46	7.42	8.39%	0	0.00%
8	1	1.44	115.95	0.8	183.44	70	117.39	301.63	2.24	0.74%	229.39	76.05%
8	2	3.2	120.71	3.8	252.2	70	123.91	379.91	7	1.84%	302.91	79.73%
8	3	3.28	110.27	27.81	1059.16	70	113.55	1200.52	31.09	2.59%	1099.43	91.58%
9	1	0	141.49	0	109.25	70	141.49	250.74	0	0.00%	180.74	72.08%
9	2	0	131.04	6.28	296.63	70	131.04	433.95	6.28	1.45%	357.67	82.42%
9	3	0	111.07	57.2	967.4	70	111.07	1135.67	57.2	5.04%	1008.47	88.80%
10	1	0.92	130.02	10.9	170.3	50	130.94	312.14	11.82	3.79%	250.32	80.19%
10	2	3.1	103.13	10.1	416.19	50	106.23	532.52	13.2	2.48%	469.32	88.13%
10	3	1.58	88.1	69.2	777	50	89.68	935.88	70.78	7.56%	815.1	87.09%
11	1	0	0	1.52	87.48	100	0	89	1.52	1.71%	0	0.00%
11	2	0	0	1.2	709.08	100	0	710.28	1.2	0.17%	609.08	85.75%
11	3	0	0	9.52	273	100	0	282.52	9.52	3.37%	173	61.23%
12	1	0	0	5.5	98.9	100	0	104.4	5.5	5.27%	0	0.00%
12	2	0	0	3.95	149.5	100	0	153.45	3.95	2.57%	49.5	32.26%
12	3	0	0	14.9	332	100	0	346.9	14.9	4.30%	232	66.88%
13	1	0	0	10.6	67.16	140	0	77.76	10.6	13.63%	0	0.00%
13	2	0	0	30.41	546.35	140	0	576.76	30.41	5.27%	406.35	70.45%
13	3	0	0	26.2	599	140	0	625.2	26.2	4.19%	459	73.42%
14	1	0	0	4.4	201.5	140	0	205.9	4.4	2.14%	61.5	29.87%
14	2	0	0	1.96	110.3	140	0	112.26	1.96	1.75%	0	0.00%
14	3	0	0	1.8	224.94	140	0	226.74	1.8	0.79%	84.94	37.46%

EQUATIONS

Equation 1

$$\text{mfrac} = 0.48436 + 0.00012900\ (\text{catwt})$$

Equation 2

$$\text{mfrac} = 0.80472 - 0.07641\ (\text{codmesh}) + 0.00012372\ (\text{catwt})$$

Equation 3

$$\text{mfrac} = 0.67803 - 0.08031\ (\text{codmesh}) + 0.08083\ (\text{ntow}) + 0.00011361\ (\text{catwt})$$

Equation 4

$$\text{diff2} = 0.95661 - 0.11619\ (\text{codmesh})$$

Equation 5

$$\text{diff2} = 0.81182 + 0.00010461\ (\text{catwt}) - 0.11302\ (\text{codmesh})$$

Equation 6

$$\text{diff2} = 0.65493 + 0.10011\ (\text{ntow}) + 0.00009210\ (\text{catwt}) - 0.11786\ (\text{codmesh})$$

Equation 7

$$\text{flive0} = 1.05426 - 0.13356\ (\text{ntow})$$

Equation 8

$$\text{flive0} = 0.85785 - 0.13985\ (\text{ntow}) + 0.05357\ (\text{codmesh})$$

Equation 9

$$\text{flive0} = 0.90954 - 0.12362\ (\text{ntow}) - 0.00007273\ (\text{catwt}) + 0.05329\ (\text{codmesh})$$

Equation 10

$$\text{flive0} = 2.14680 - 0.10905\ (\text{ntow}) - 0.00010532\ (\text{catwt}) - 0.06469\ (\text{Tbot}) + 0.05516\ (\text{codmesh})$$

Equation 11

$$\text{flive0} = 2.78953 - 0.09247\ (\text{ntow}) - 0.00008736\ (\text{catwt}) - 0.07188\ (\text{factor1}) - 0.09957\ (\text{Tbot}) + 0.04809\ (\text{codmesh})$$

Equation 12

$$\text{gflive0} = 1.08273 - 0.16332\ (\text{ntow})$$

Equation 13

$$\text{gflive0} = 0.89420 - 0.16933\ (\text{ntow}) + 0.04902\ (\text{codmesh})$$

Equation 14

$$gflive0 = 0.94535 - 0.15162\ (ntow) - 0.00007546\ (catwt) + 0.04901\ (codmesh)$$

Equation 15

$$diff1 = 0.08415 + 0.21001\ (ntow)$$

Equation 16

$$diff1 = 0.36322 + 0.18798\ (ntow) - 0.05875\ (codmesh)$$

Equation 17

$$diff1 = -0.05857 - 0.07156\ (factor\ 5) + 0.05761\ (Tbot) - 0.10118\ (codmesh)$$

Equation 18

$$diff1 = -0.59794 + 0.27943\ (factor2) - 0.07940\ (factor5) + 0.08812\ (Tbot) - 0.09953\ (codmesh)$$

Equation 19

$$diff1 = -0.83835 + 0.40230\ (factor\ 2) - 0.03662\ (factor\ 3) - 0.09435\ (factor\ 5) + 0.10580\ (Tbot) - 0.11518\ (codmesh)$$

Equation Key

mfrac = Experiment-wide mortality
diff2 = Percent mortality between the immediate (0-25) and delayed (25+) culls
flive0 = fraction alive at time(0)
gflive0 = fraction alive at time(0-25)
diff1 = Percent mortality between the 0-10 minutes and 10-25 minutes culls
codmesh = codens mesh
catwt = catch weight
ntow = tow time
Tbot = temperature on bottom
factor 2 = Bycatch Factor 2
factor 3 = Bycatch Factor 3
factor 5 = Bycatch Factor 5

FIGURES

Figure 1. Fraction of Live Summer Flounder as Time on Deck Increases for All Tow Times Combined (Trips 3-14)

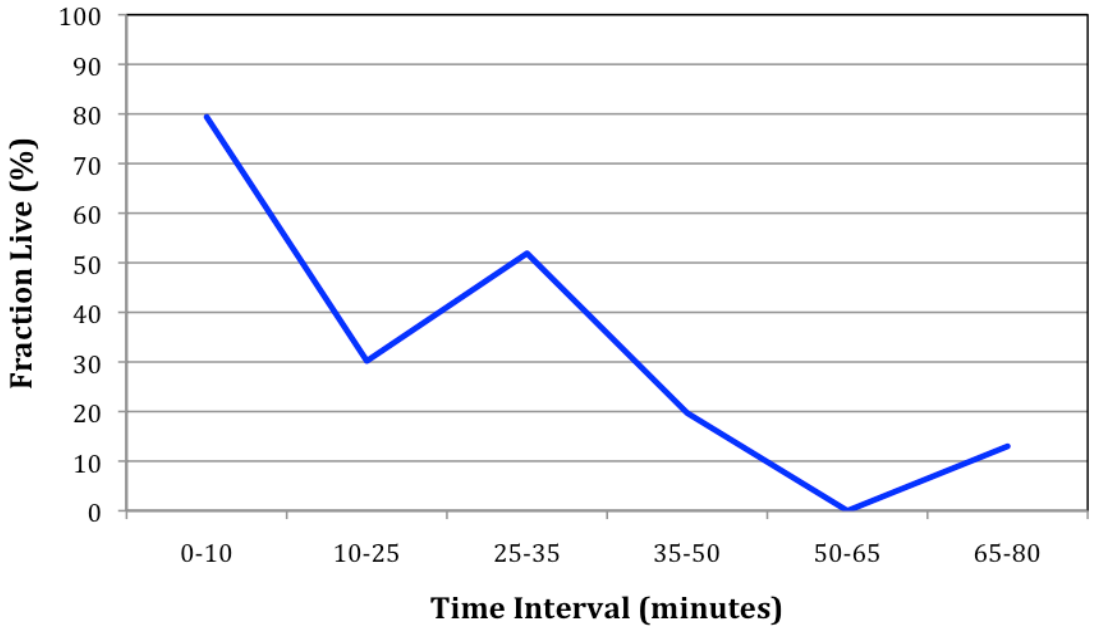


Figure 2. Fraction of Live Summer Flounder as Time on Deck Increases by Tow Time (Trips 3-14)

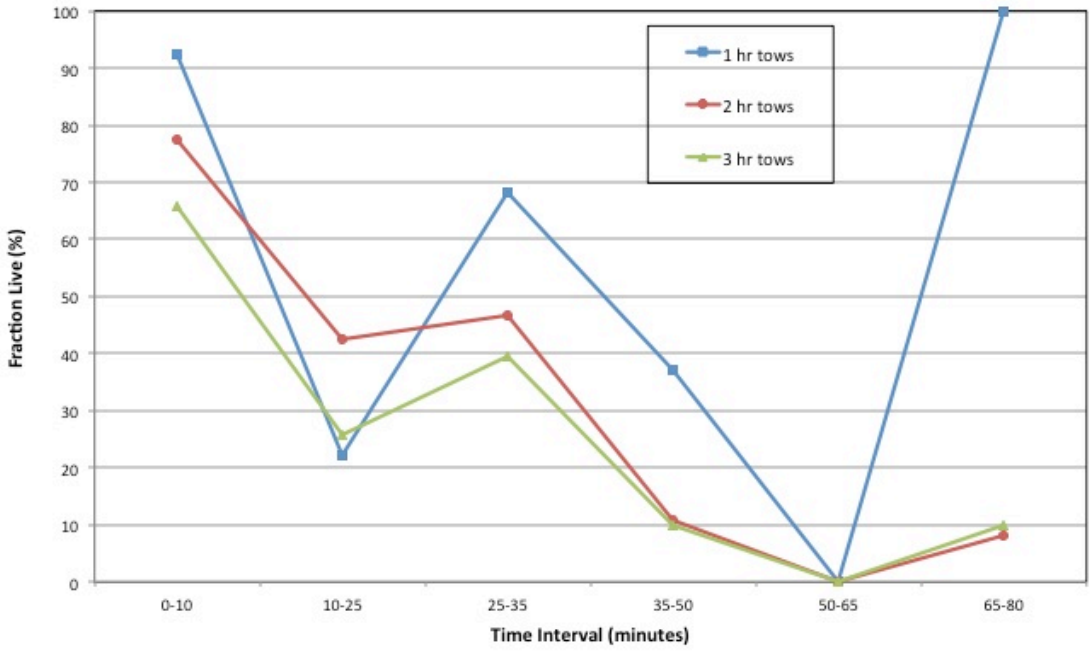


Figure 3a. Total Catch Weight of All Species by Trip Number and Tow Time

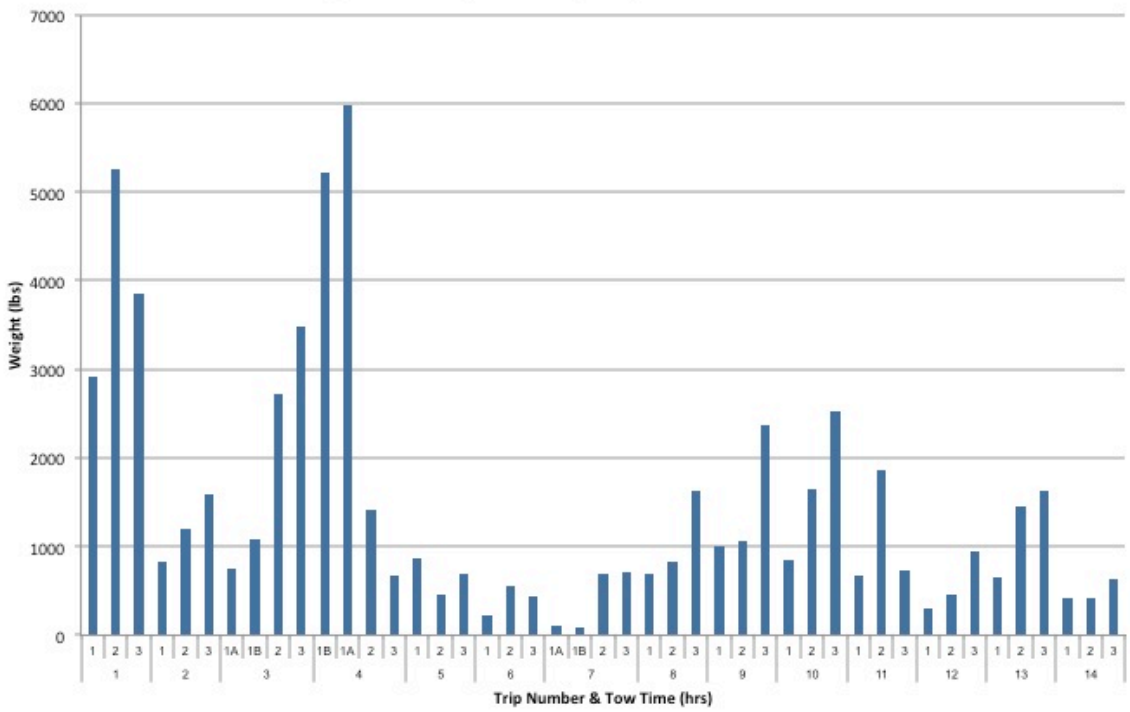


Figure 3b. Average Catch Weight of All Species By Tow Time and Overall

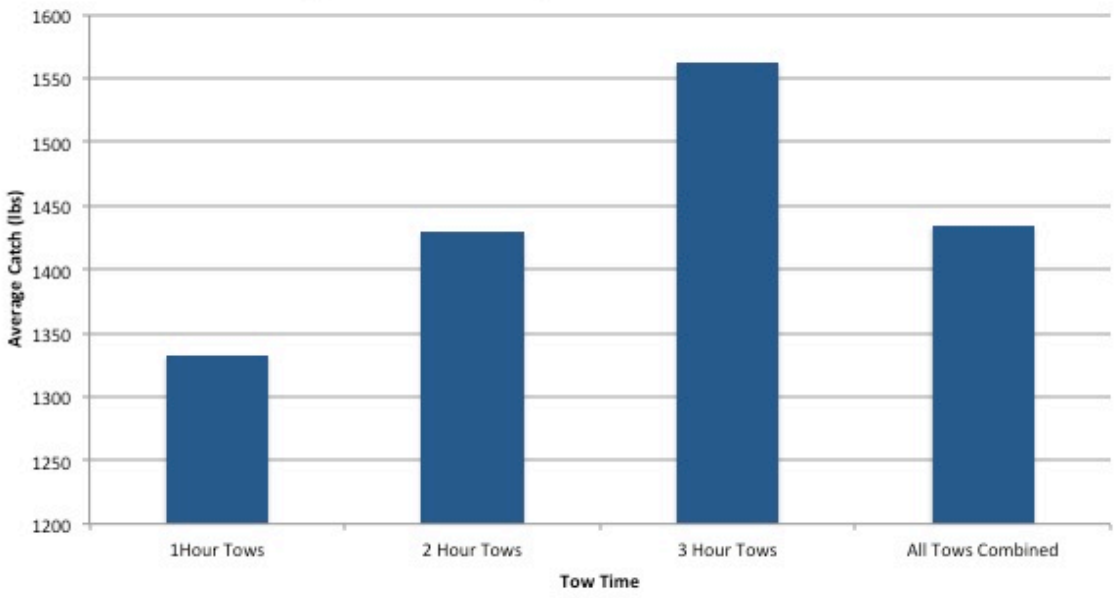
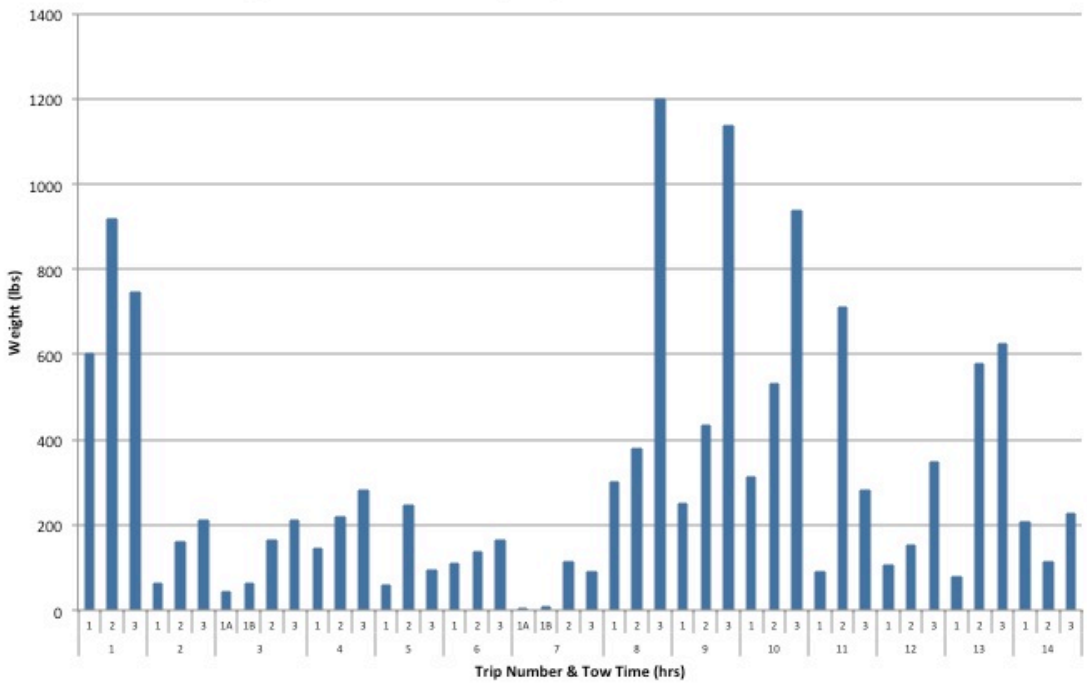


Figure 4.Weight of Fluke Catch by Trip Number and Tow Time



Figures 5a-n. Weight of Each Species Catch by Trip Number and Tow Time

Figure 5a. Skate Catch

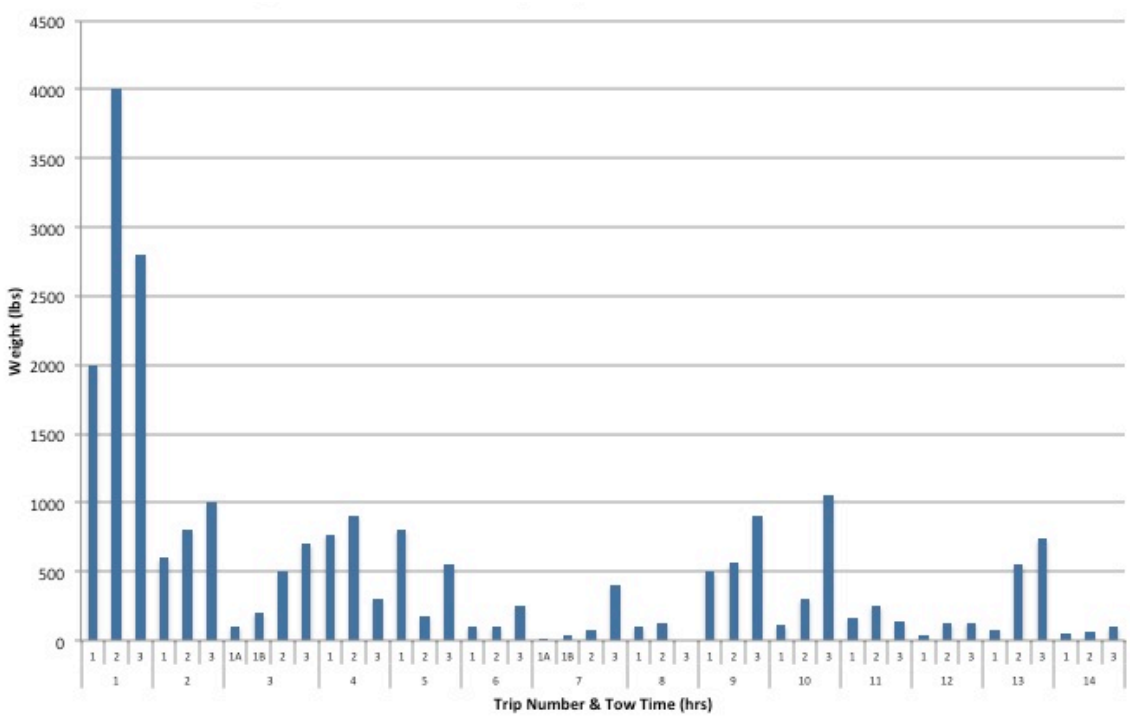


Figure 5b. Squid Catch

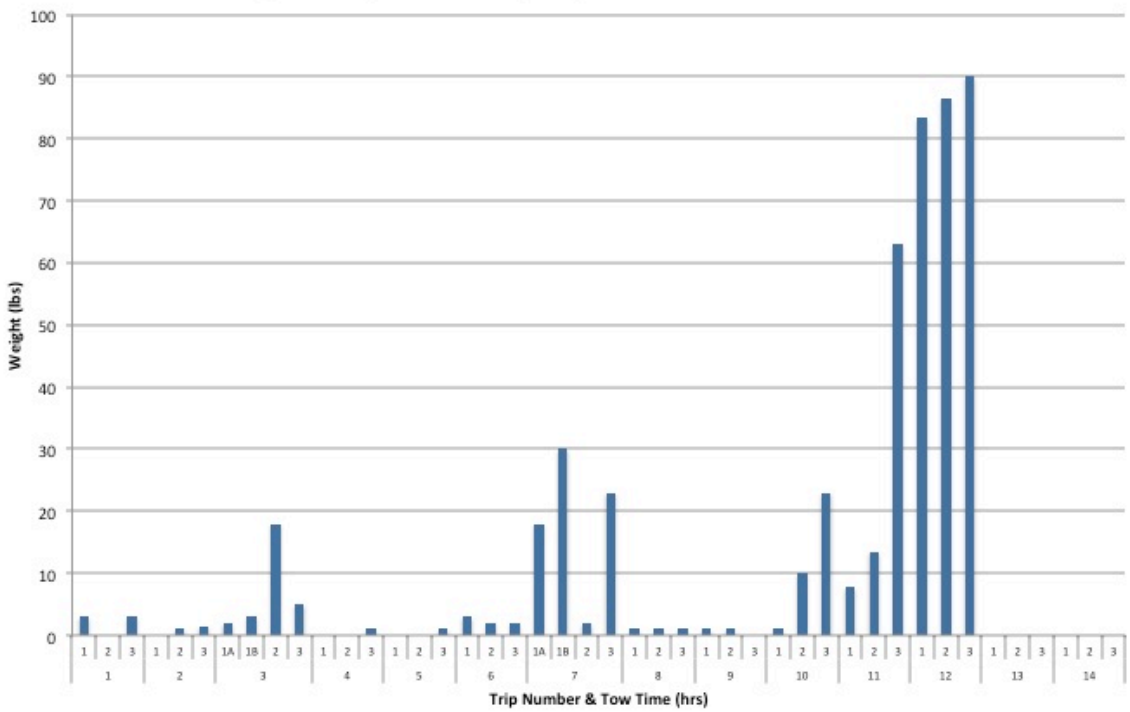


Figure 5c. Bluefish Catch

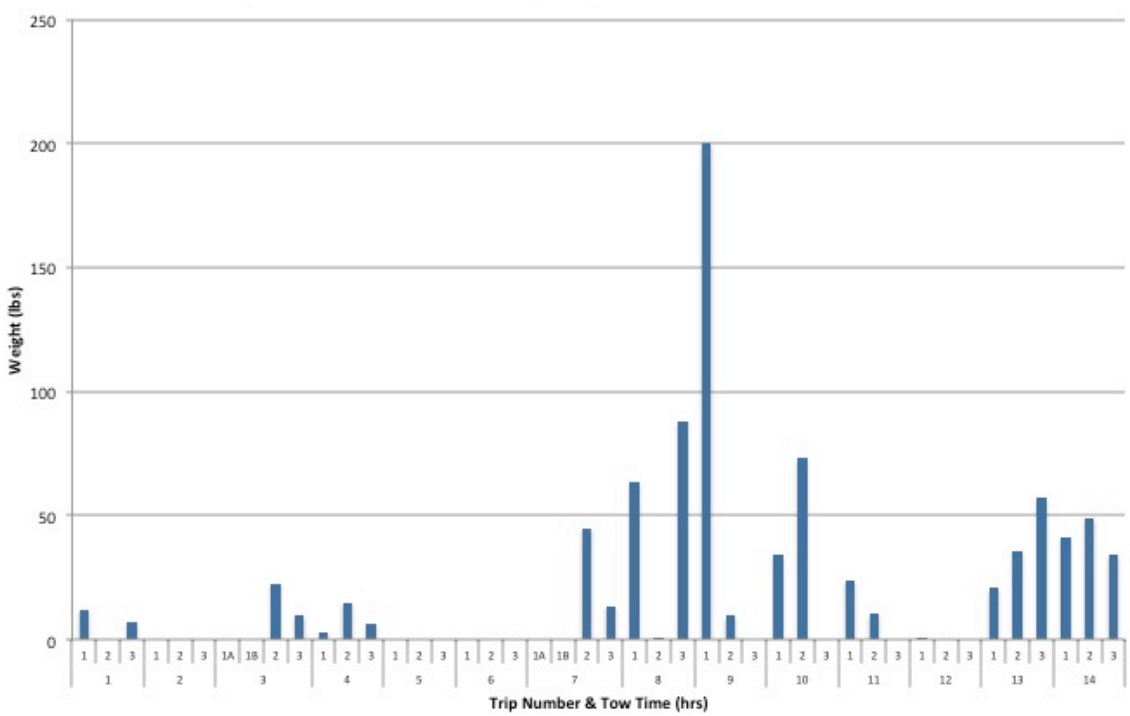


Figure 5d. Butterfish Catch

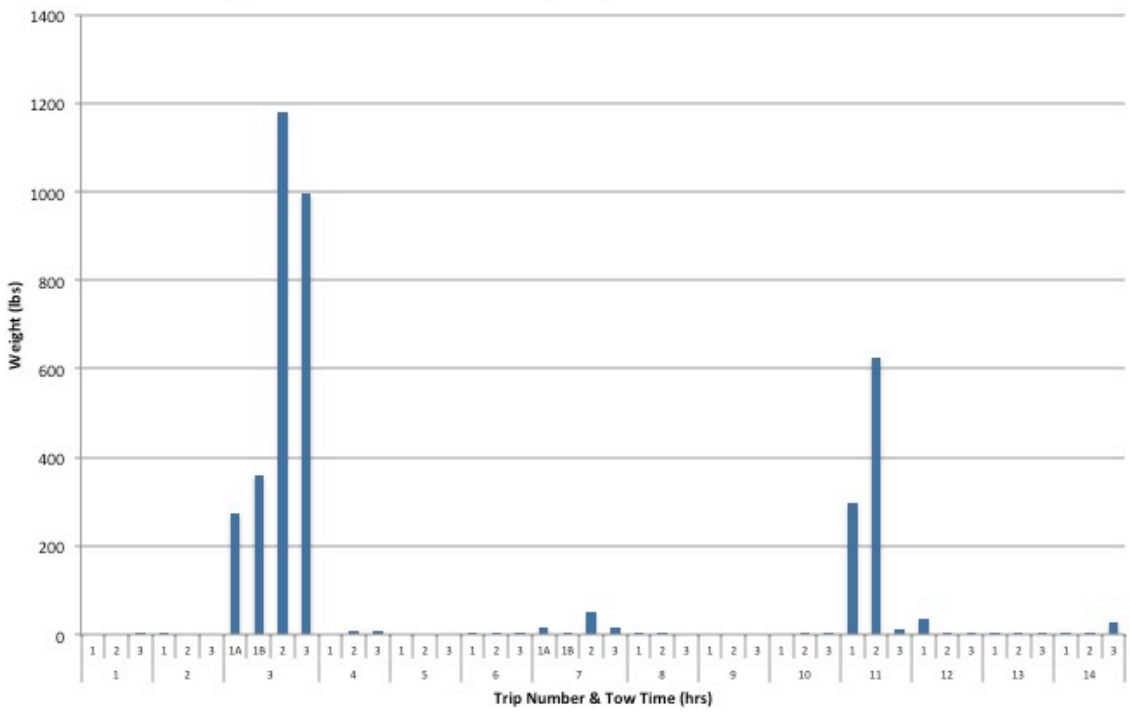


Figure 5e. Crab Catch

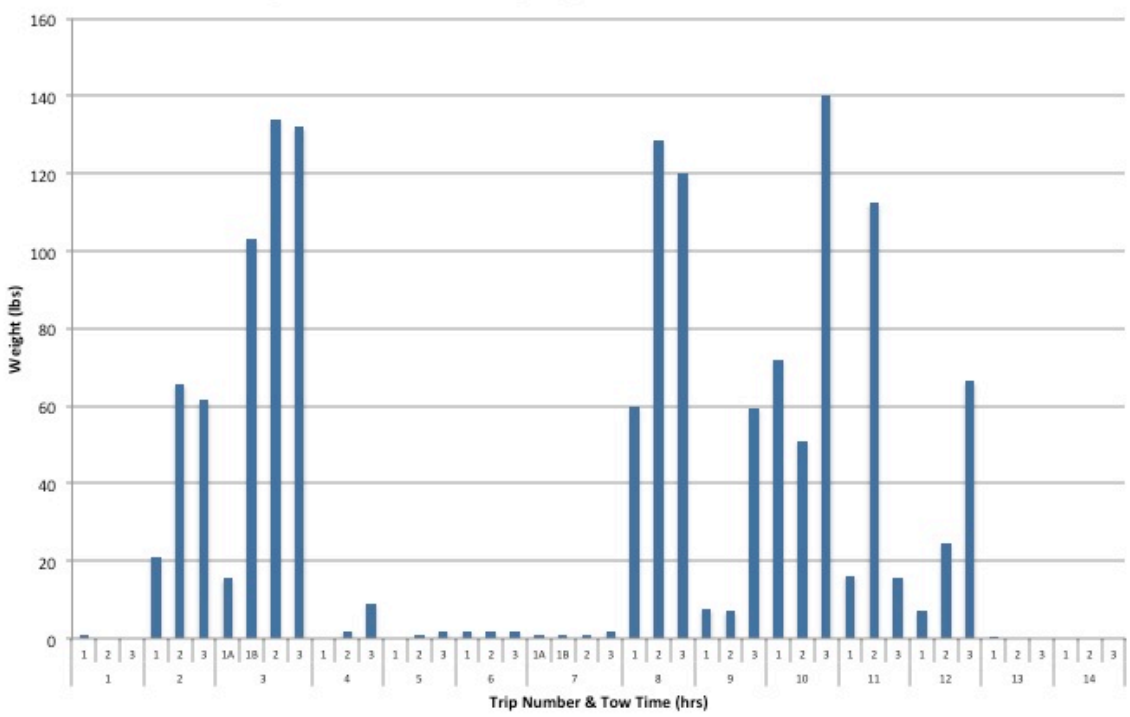


Figure 5f. Dogfish Catch

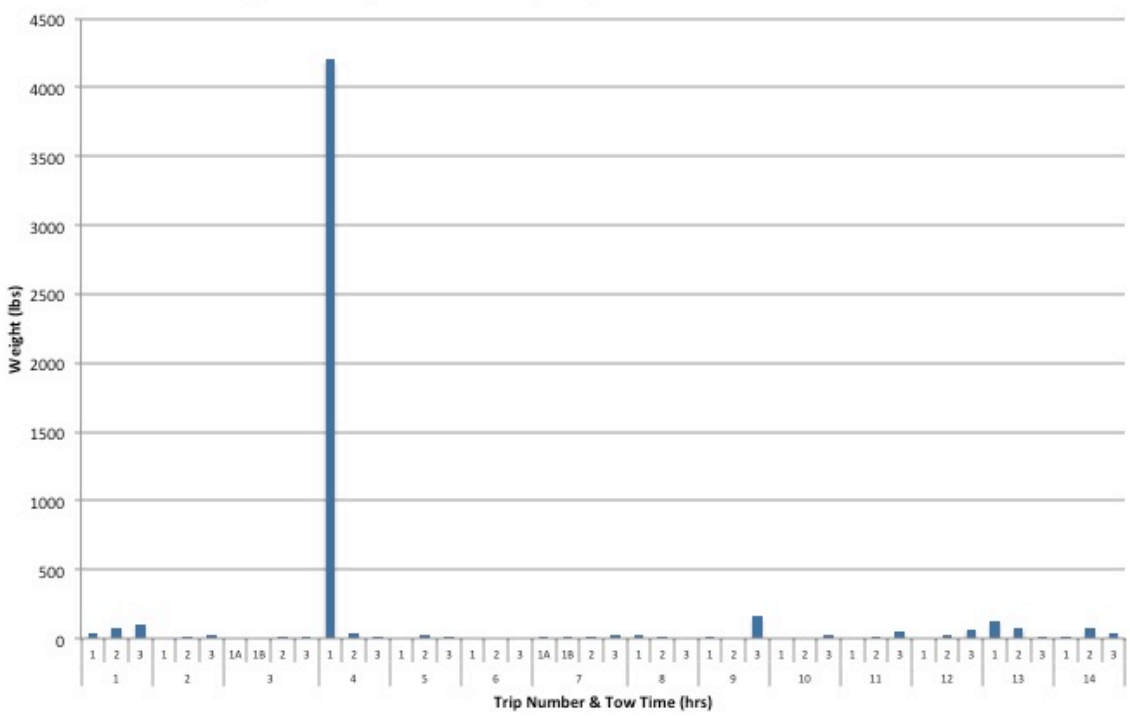


Figure 5g. Lobster Catch

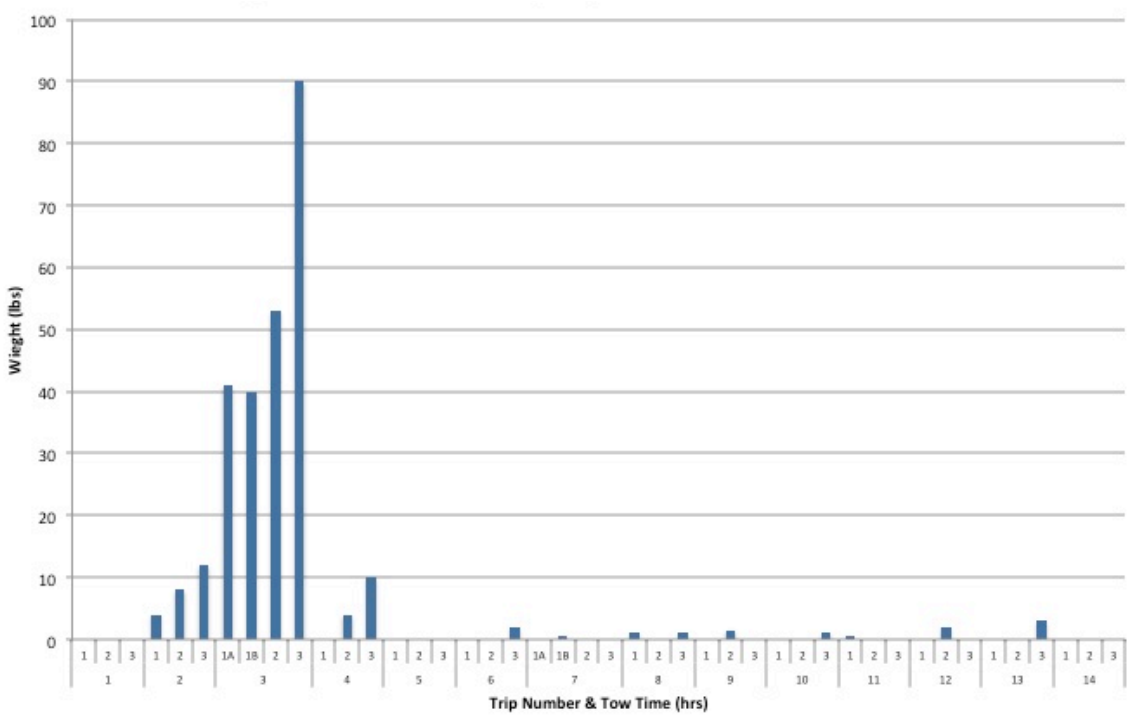


Figure 5h. Sand Dab Catch

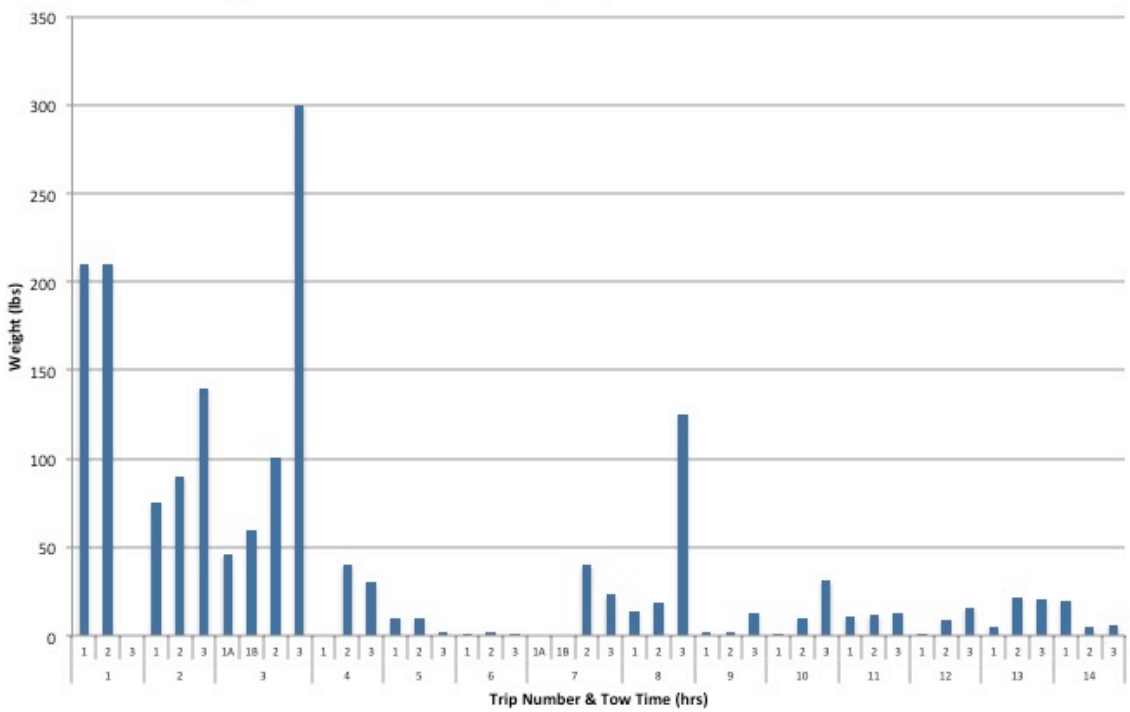


Figure 5i. Scup Catch

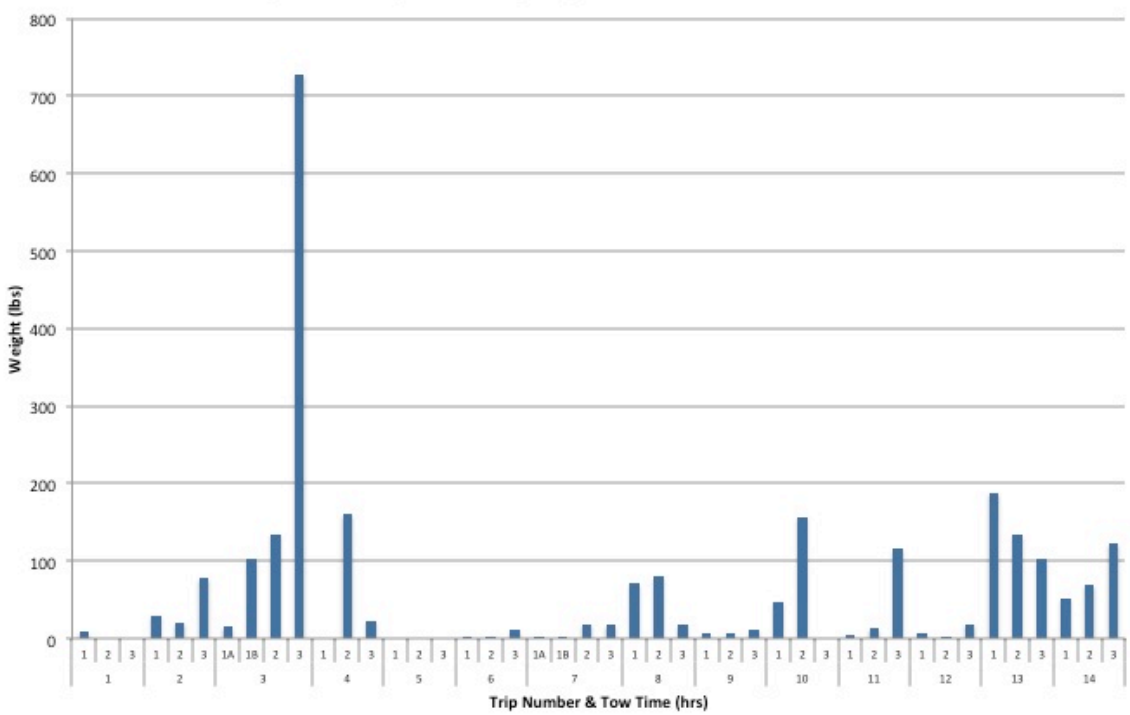


Figure 5j. Sea Robin Catch

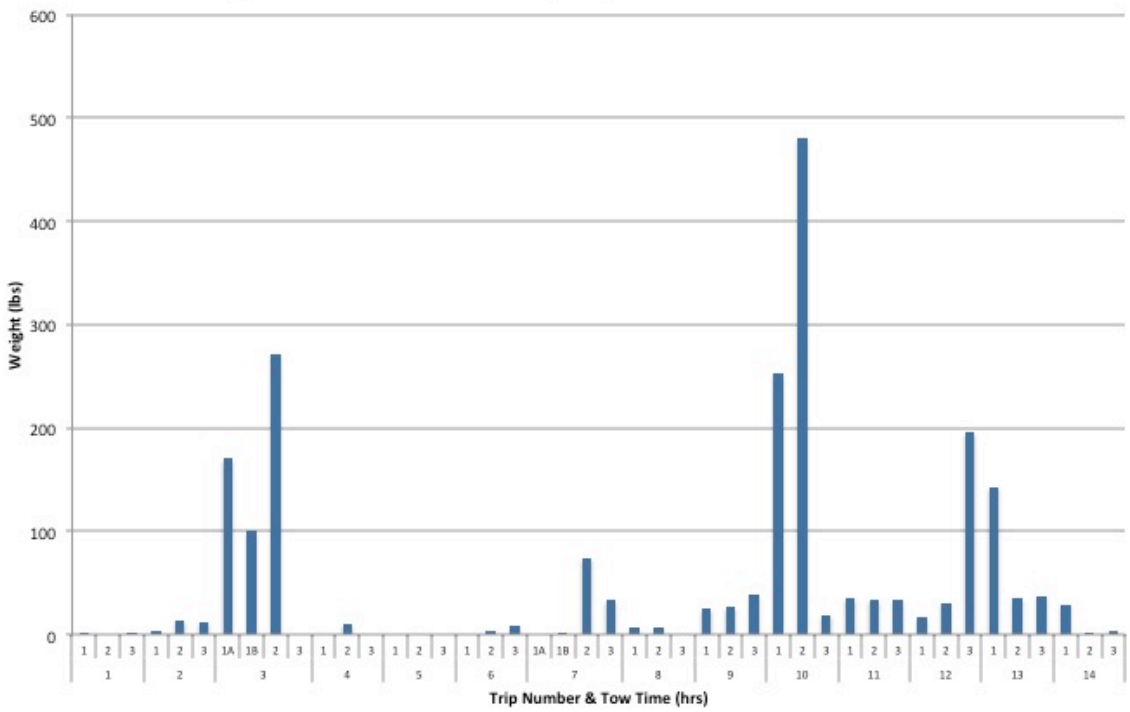


Figure 5k. Striped Bass Catch

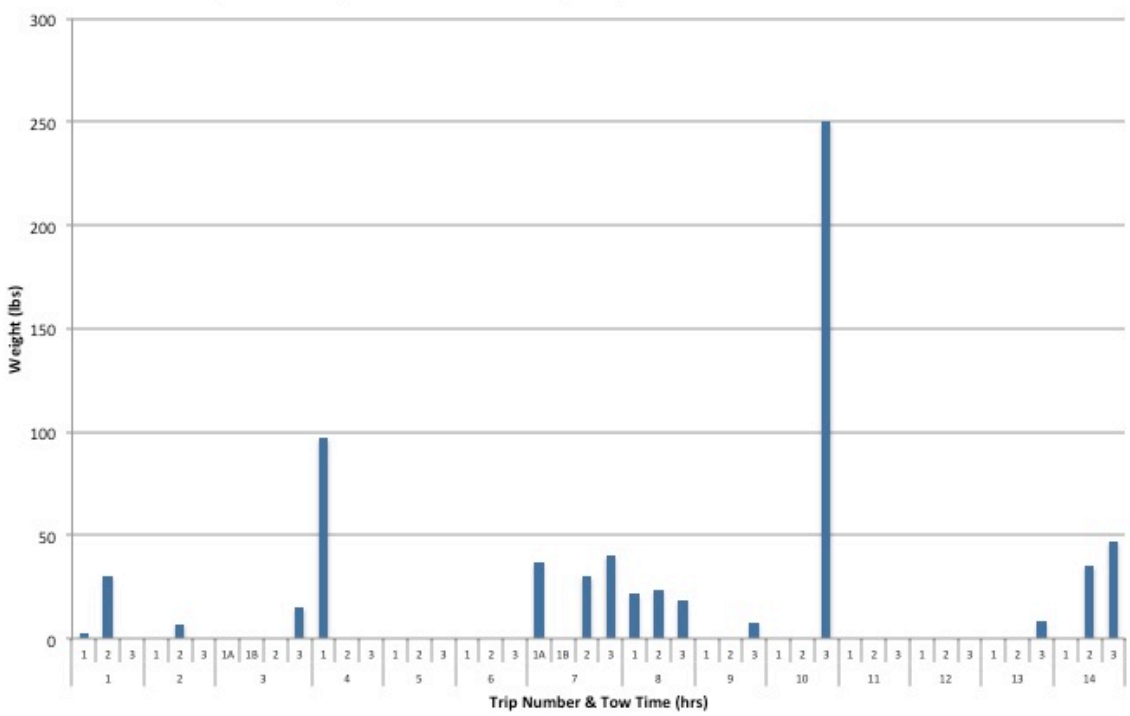


Figure 5l. Weakfish Catch

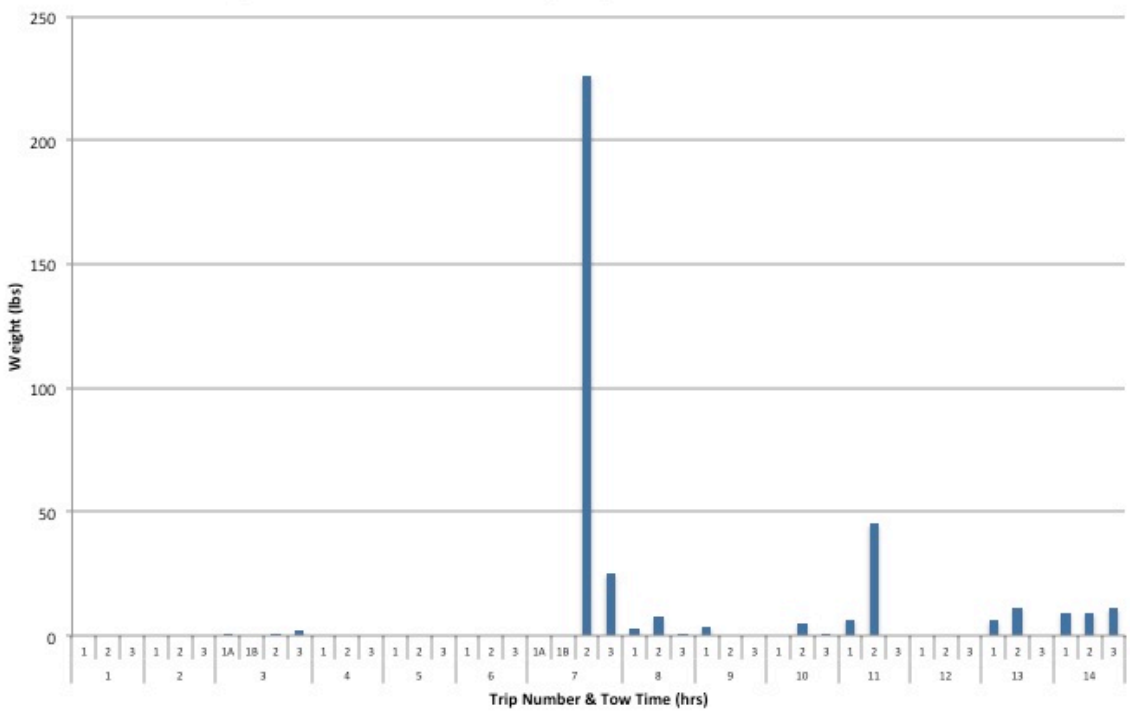


Figure 5m. Whelk Catch

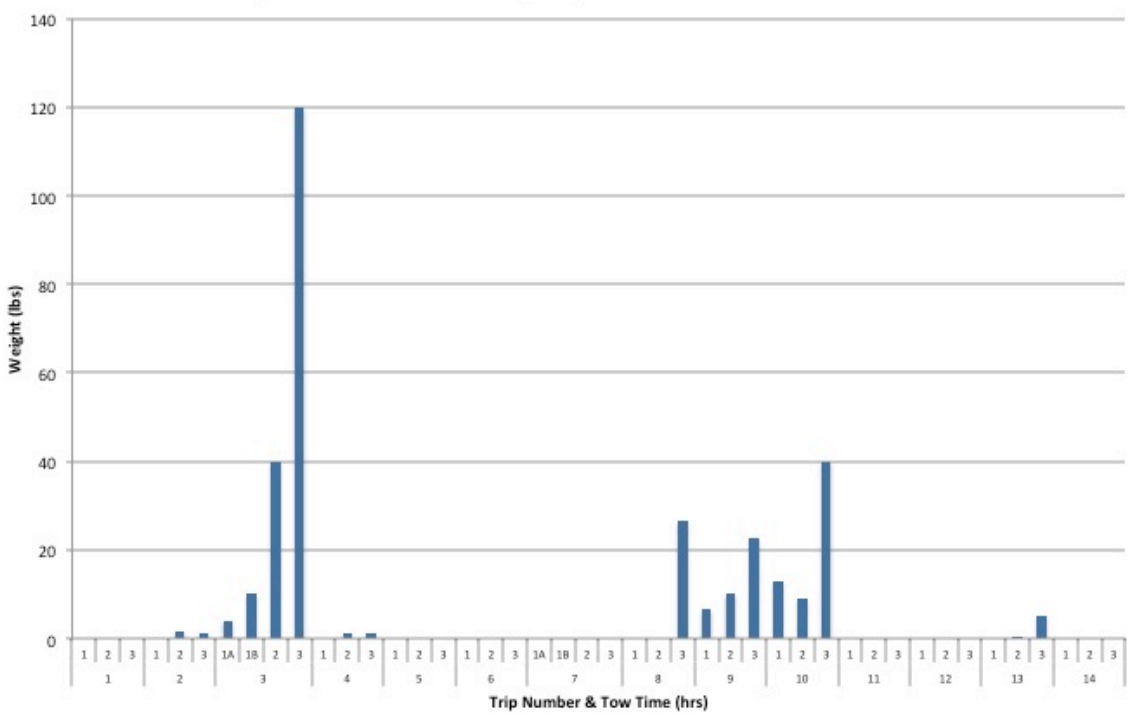


Figure 5n. Winter Flounder Catch

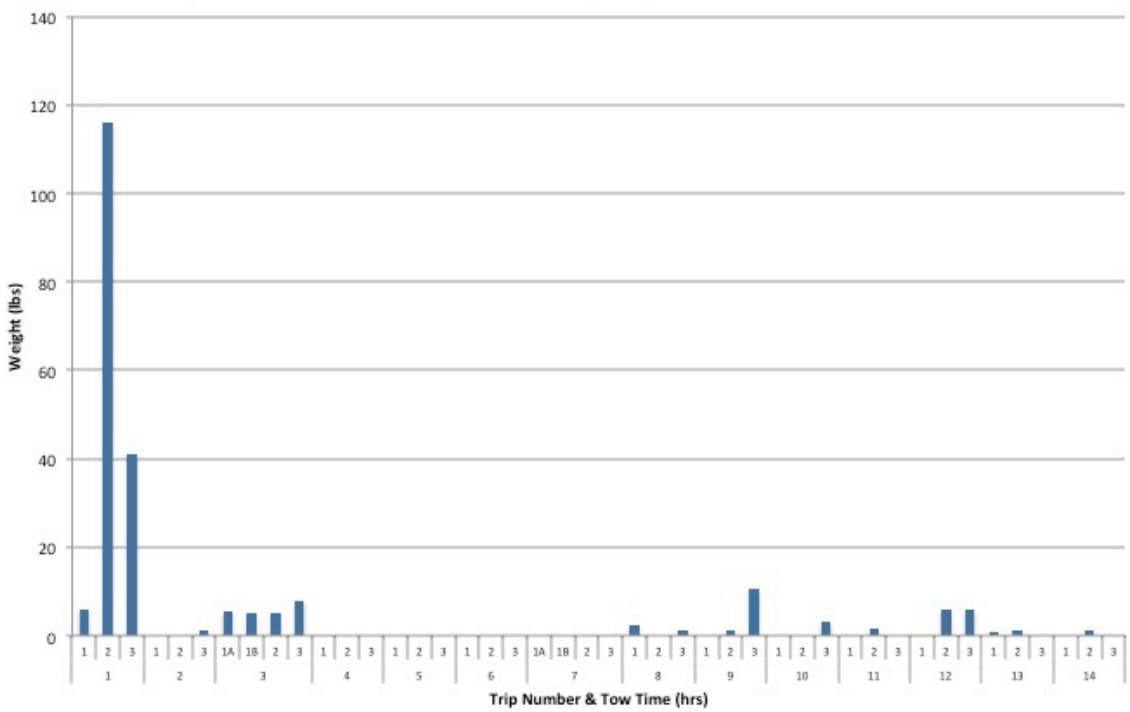


Figure 6. Summer Flounder Length Frequency Distribution

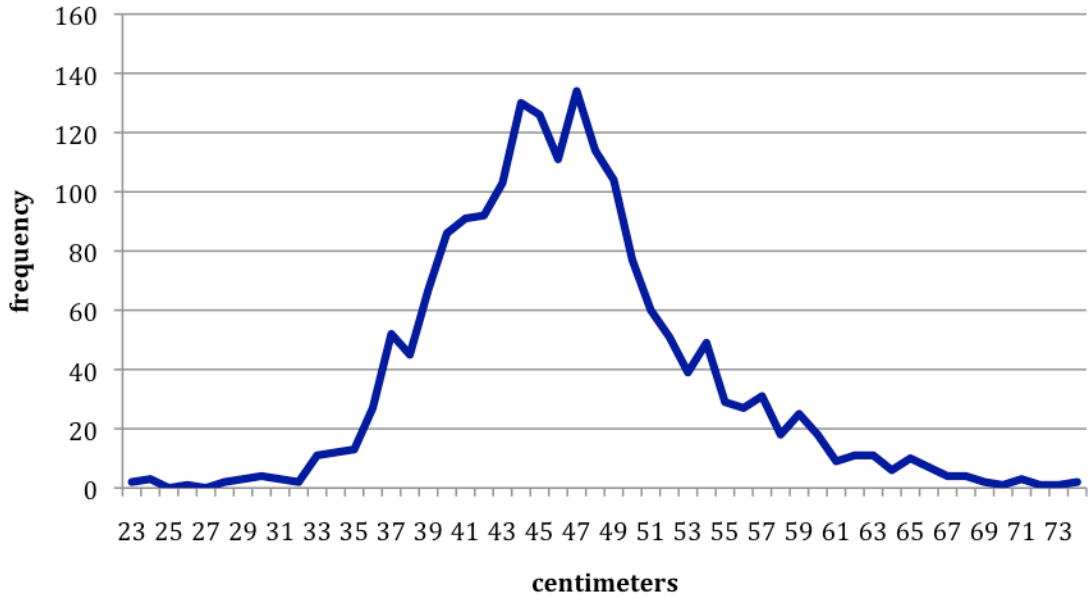


Figure 7. Location of Tagged Fish Recaptures
(62 tagged fish have been recaptured as of December 2010)

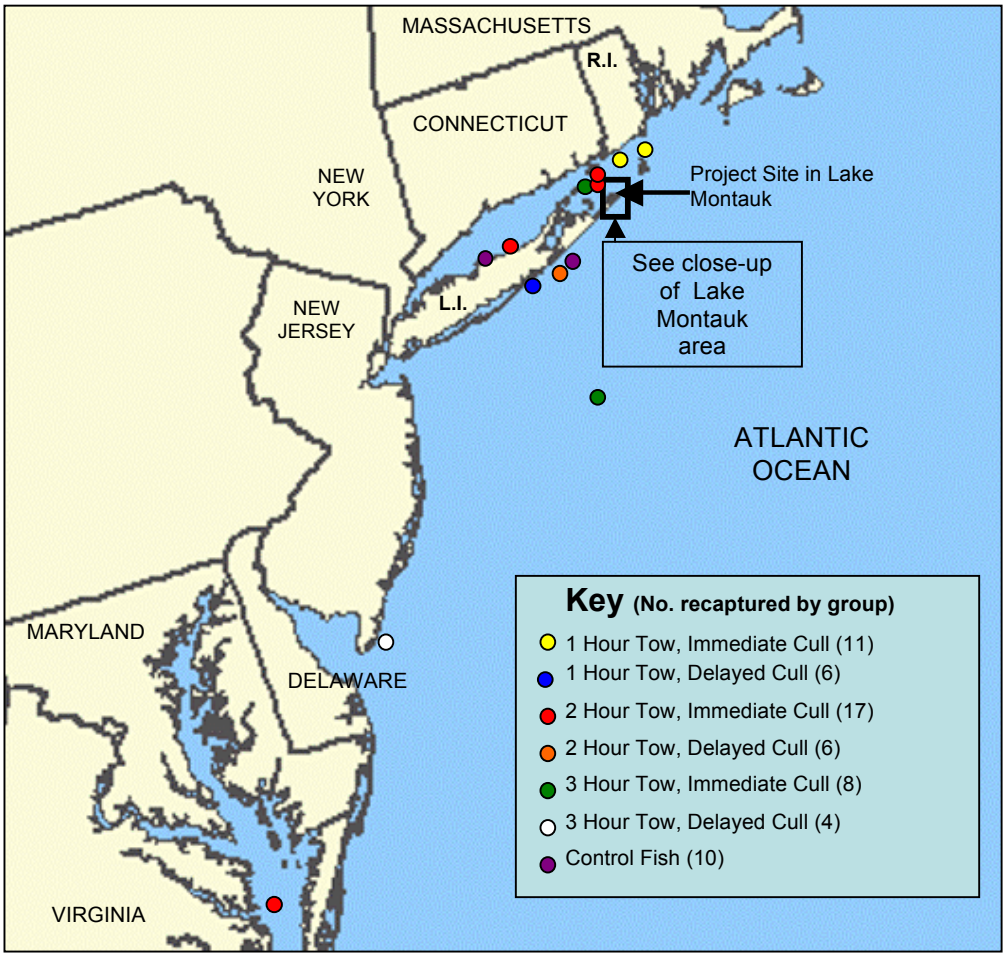


Figure 8. Location of Tagged Fish Recaptures Near Lake Montauk

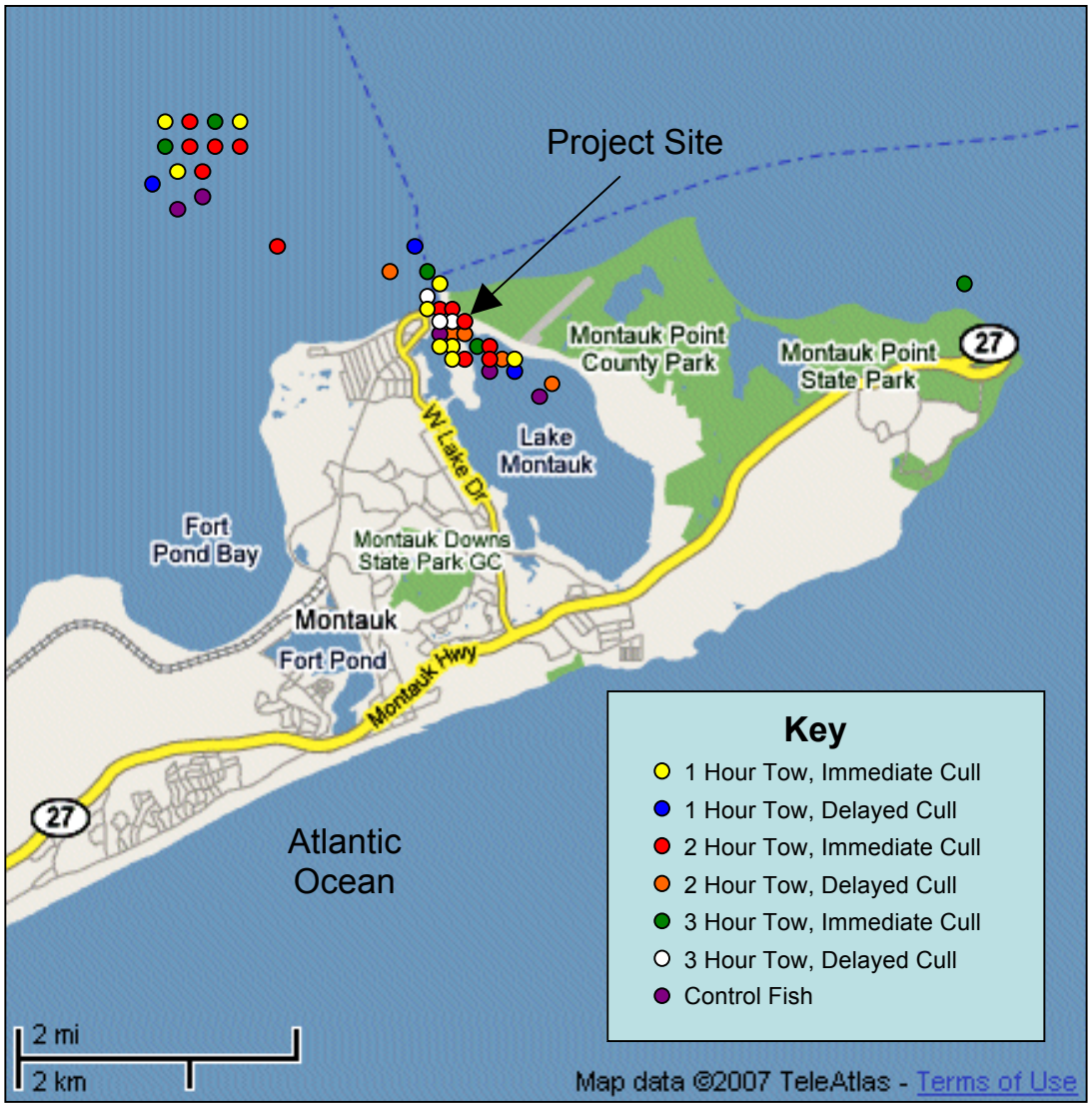
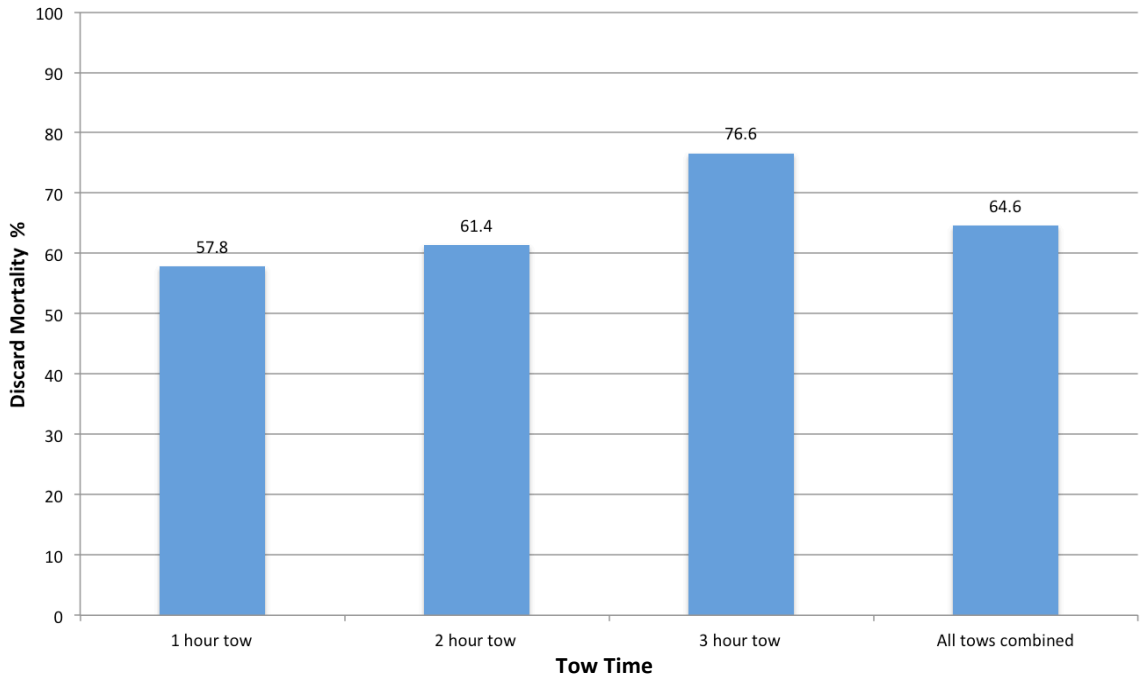


Figure 9. Mean Cumulative Summer Flounder Discard Mortality by Tow Time and for All Tows Combined for Trips 3-10



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ATTACHMENT 1

FACT SHEET

SUMMER FLOUNDER DISCARD MORTALITY
PERSPECTIVE

Summer flounder or fluke (*Paralichthys dentatus*) is found from Nova Scotia to Florida in shallow estuarine waters and along the outer continental shelf. Summer flounder migrate seasonally inshore and offshore. Spawning occurs between the fall and late winter.

Summer flounder support important commercial and recreational fisheries. They are managed cooperatively by the Atlantic States Marine Fisheries Commission (ASMFC) and the Mid-Atlantic Fishery Management Council (MAFMC). Management goals are achieved through the use of commercial quotas (allocated by state and season), recreational harvest limits, minimum mesh requirements, minimum fish size, possession limits and other gear restrictions.

Fishery managers, scientists and commercial fishermen share a common concern over the present use of 80% for discard mortality within the summer flounder management plan. In 2007 the Cornell Marine Program received a Research Set-Aside grant to determine the actual Summer Flounder trawl discard mortality. The fieldwork has been successfully completed and the full final report is available on our website. At www.counties.cce.cornell.edu/suffolkprograms/marhome.htm (under research) "Evaluation of Summer Flounder Discard Mortality In The Inshore Bottom Trawl Fishery."

This fact sheet is a brief guide to the general findings of this research. The information attempts to provide insight and common understanding related to the practical application of the research findings for those involved in this important fishery.

Our approach will be to answer some important obvious and common questions concerning summer flounder discard mortality.

Q: *Why is summer flounder discard mortality important?*

A: To begin, the unintended consequence of the summer flounder management plan is the creation of discards and the resulting mortality. A summer flounder discard mortality factor is used in the stock assessment calculation and impacts the annual available quota. An important challenge of management measures is to minimize bycatch to the extent possible. Since all bycatch can not be avoided management measures need to minimize the mortality of such bycatch. From a practical view discard mortality affects the available quota, and from a broader perspective the composite stock population.

Q: *What do the terms bycatch, economic discards and regulatory discards mean?*

A: 1 Bycatch – the term bycatch means fish which are harvested in a fishery which was not sold or kept and include economic discards and regulatory discards.

2 Economic discards – The term economic discards means fish which are a targeted species, but which are not retained because of size, quality or other economic factor.

3 Regulatory discards – The term regulatory discard means fish harvested in a fishery which are required by regulation to discard when caught. An example would be fish caught over the daily trip limit.

Q: What was the purpose of the summer flounder discard mortality study?

A: The purpose of this study was to gain perspective to improve and enhance fishery information about discard mortality for summer flounder in the trawl fishery. Presently the summer flounder fishery management plan uses an estimation or assumed discard mortality factor.

Q: How was the study conducted and what were the study goals?

A: The study goal was to determine discard mortality relative to tow time, total catch, fish size and the amount of time that fish were on deck. To respond to this goal actual trawl discard mortality was monitored and compared to the present assumed estimation. Ten scientific fishing trips consisting of tows of 1, 2 and 3 hours were conducted.

Q: What were the study results and how do they compare to 80% estimated discard mortality rate?

A: The summed discard mortality had a median of 78.7%. However, the overall project mean, a more useful parameter rather than median was 64.6% and is considerably less than the value in the current assessment. Mortality rates for 1 and 2-hour tows were less than for the 3-hour tows, with both the mean and median mortality rates for the 1- hour and 2-hour tows considerably less than the current estimated 80% mortality.

Q: Do trip limits effect discard mortality?

A: There is a direct and significant relationship between trip limits and discard mortality. For example, during the six month (May- Oct) study period New York State summer flounder trip limits ranged between 30-90 lbs. Due to these relatively low trip limits regulatory discards (those fish caught over the daily trip limit excluding sublegal sized fish) ranged from 53% to 95% for the ten trips. Higher discards equal higher overall mortality. State management quota distribution plans should consider methods of avoiding particularly low daily trip limits when possible. Alternatives include optional weekly trip limits or sectoring harvesting capabilities.

Q: What are the critical discard mortality factors?

A: Tow time is far and away the greatest contributor to discard mortality. To a lesser degree, cull time and total catch impact discard mortality but are arguably inter-related to tow time. Fish size, gear type, co-harvested species, water temperature, etc. were not statistically important discard mortality factors.

Q: What can I do to effectively reduce discard mortality?

A: First, reduce tow times to the shortest (and most fuel efficient) levels possible relative to existing trip limits. Deck pen and hydrate fish during culling using deck hoses when possible. Cull regulatory and economic discard as efficiently as is feasible. The take-home message from the project is to make short tows and quickly cull the catch in order to maximize fluke discard survival.

Exclude use of any culling equipment; (i.e. shovels, fish picks/forks etc.) Use special designed super grip rubber gloves. Raise crew awareness to the importance of adopting handling practices that don't further compromise discarded fish condition. Today's discard maybe tomorrow's keeper!

Q: What and how do various discard factors effect survival?

A: Let's begin by describing our research approach. Summer Flounder mortality was evaluated relative to tow time, fish size, and length of time fish were kept on the deck of the vessel for each of the ten trips. A random sample of summer flounder discards including both legal and sublegal sized fish were collected while aboard bottom trawling vessels.

Approximately 20 fish from each of 6 categories (120 fish) were measured, tagged and held in a dockside net-pen for mortality monitoring for 14 days. The 6 categories were a combination of parameters which include tow times of 1 hour, 2 hour and 3 hours and 2 different deck times involving an immediate cull (0-10 minutes) and a normal fishing practice cull (approximately 30 minutes).

As noted tow time and to a lesser extent total catch and cull time were the key mortality variables. Conversely fish condition as recorded across all measured variables resulted in higher survival for fish held that were rated in excellent condition.

Q*: Does the species composition of the fish caught with Summer Flounder effect discard mortality?*

A: Interestingly, there does not appear to be a significant effect or impact on summer flounder mortality related directly to individual co-harvested species. However larger catches did correlate to increased mortality and these larger catches included large quantities of skates.

Q: How does the type of gear effect fluke discard mortality?

A: While there is some evidence that gear (larger mesh vs. small mesh) can in combination with other factors impact discard mortality it was not clearly evident in our study findings. Mainly, because not enough trips involving small mesh were conducted, since this gear is not typically used in the inshore fishery. Further efforts isolating large and small mesh gear as a specific study focus could help determine their relative discard mortality impacts.

Q: What additional work needs to be completed to determine a valuable discard mortality factor for fluke?

A: A comparable evaluation of summer flounder discard mortality in the offshore trawl fishery would compliment these findings. The composite results will define differences and at the same time provide a scientific base for the discard mortality rate used across the inshore and offshore components of the fishery. The significant relationship of tow time to discard mortality reported suggests that correlating average tow time as reported in vessel trip reports (VTR) involving summer flounder may help identify a quantifiable discard mortality rate. Also since total catch proved to be an important mortality variable, determining the difference between tow time and total catch may help explain/reduce discard mortality.

Q: *How was discard mortality calculated?*

A: Discard mortality was calculated for all tow times and deck times. ANOVA analysis and a *posteriori* analysis (commonly used statistical analysis) were performed on all data elements to determine which

factors were significant to fish condition and survival. These included total catch weight, catch composition, net size and dimensions, mesh size, water temperature, fish condition, fish size and cull time among others.

Q: *Was extended discard mortality evaluated?*

A: As an adjunct to the project objective to evaluate mortality of summer flounder in the inshore fishery a tagging program was employed for all released study fish. Information collected upon recapture of tagged and released fish therefore will provide qualitative data on additional survival for the time the fish is at liberty.

Q: *How will the study results be used?*

A: The final project report will be viewed by Southern Demersal Working Group (SDWG). The SDWG has recommended additional work be conducted to understand the factors affecting discard mortality rates and the difference between the inshore and offshore components of the multispecies trawl fishery to facilitate future application of this information into the stock assessment.

The questions raised and answered in this fact sheet were offered to provide better understanding on how we can use this valuable resource for all those involved in this important fishery. As mentioned for more information please visit our website at
www.counties.cce.cornell.edu/suffolkprograms/marhome.htm

ATTACHMENT 2

Press Release Package

Dan's Paper – July 6, 2007 – Page 111 – "Go Fish"

The News Review – July 26, 2007 – Page 30A – "Cornell Seeks Return of Fish Tags"

Commercial Fisheries News – Compass Publications
May 2007 – Page 22A – "Fluke Study"

December 2006 – Page 21A – "NFI-SMC Announces RSA Quota Auction to Raise Research Funds"

Tag Return advertisement – August, September, October, November 2007

The Fisherman Magazine – tag return advertisements
8/02/07 Issue #31
8/16/07 Issue #33
8/30/07 Issue #35
10/04/07 Issue #40
10/18/07 Issue #42

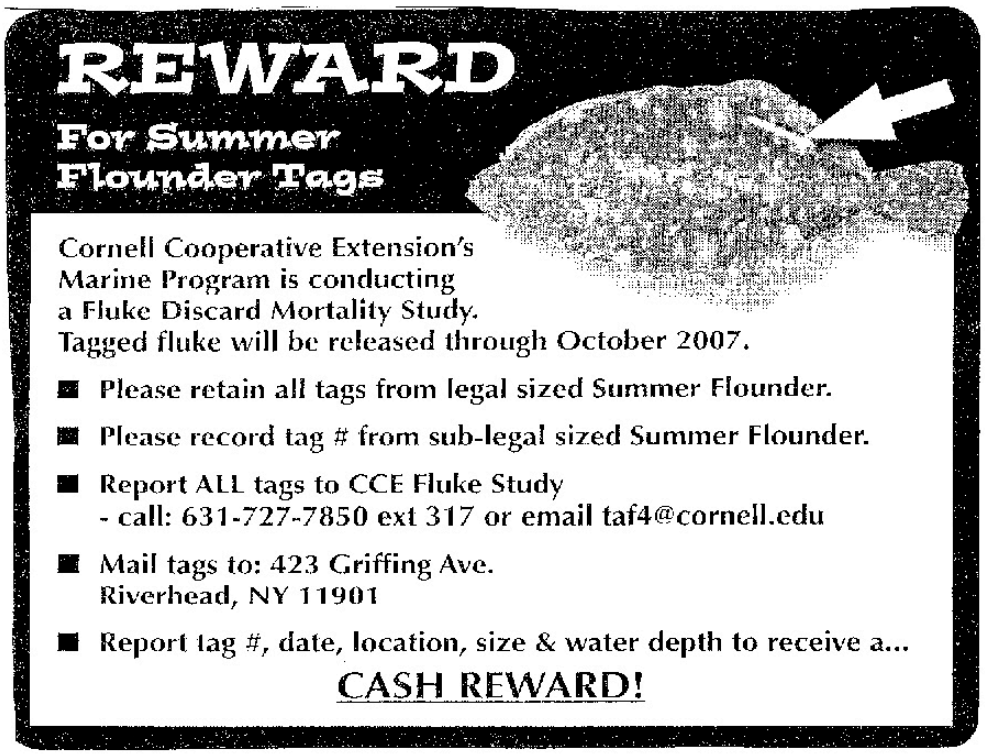
National Fisherman – Diversified Publications – tag return advertisements
Issue September 2007
Issue October 2007
Issue November 2007

Websites:
Northeast.com
Thefishingline.org
Fishtheisland.com

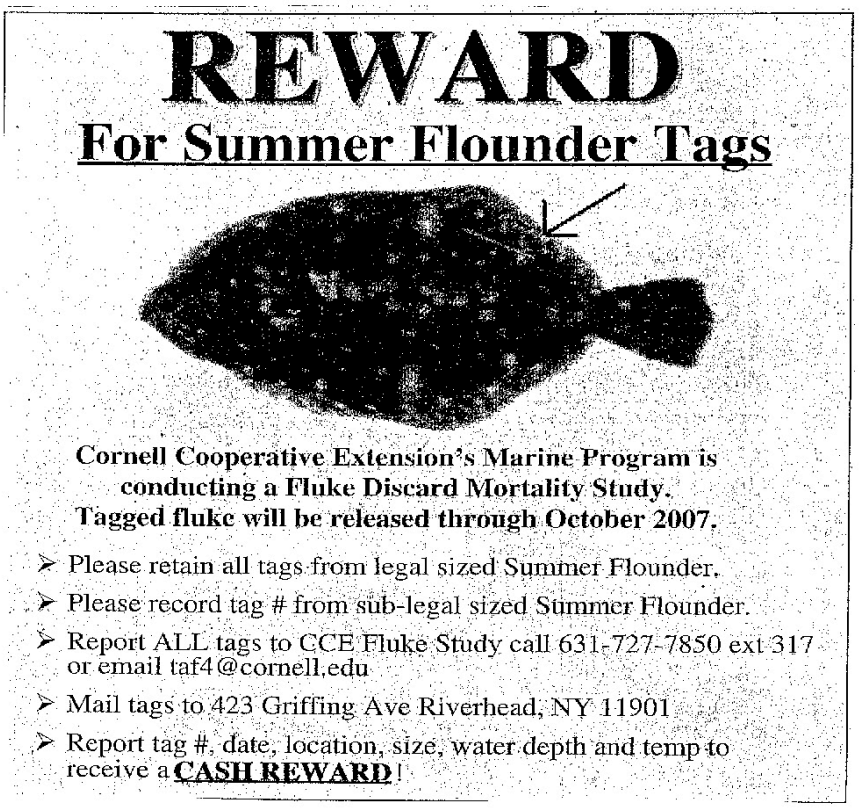
The East Hampton Star – June 14, 2007 – "Putting Fluke to the Test" by Rusty Drumm

Dockside flyers all summer 2007

Newsday – June 15, 2009 – Page A2 – "Their Catch of the Day is for Research"



Tag Return Advertisement in National Fisherman magazine



Tag Return Advertisement in Commercial Fisheries News

NFI-SMC announces RSA quota auction to raise research funds

CAPE MAY, NJ – This year's auction of research set-aside (RSA) quota by the National Fisheries Institute-Scientific Monitoring Committee (NFI-SMC) will be held on Dec. 18.

Starting at 10 am that day, NFI-SMC Chairman Dan Cohen will auction off the harvest rights to approximately 2.21 million pounds of RSA quota to members of the organization. That's nearly twice as much as was available in 2005 due in large part to a significant increase in the *Loligo* squid RSA poundage available.

Specifically, the RSA species and amounts that will be auctioned are:

- Summer flounder – 309,711 pounds;
- Black sea bass – 119,358 pounds;
- Scup – 221,581 pounds;
- *Loligo* squid – 1,193,099 pounds; and
- Bluefish – 363,677 pounds.

These RSA quotas were "set aside" by the Mid-Atlantic Fishery Management Council and subsequently awarded to NFI-SMC for cooperative research projects by the National Marine Fisheries Service (NMFS).

This is the fifth year NFI-SMC has conducted the auction via conference call. Anyone who wants to participate must join the organization and pay their 2007 dues by Dec. 11, 2006.

RSA quota can be harvested and landed outside of regular trip limits and seasons.

"Those boats that won the scup quota in the 2003 to 2006 auctions were able to wait until the seasons were closed or the trip limits restricted, and their fish was worth substantially more in the market," Cohen said.

When we pay for observers and fuel to conduct cooperative supplemental finfish surveys or test gear, every recreational and commercial fisherman in the Atlantic benefits.
—Dan Cohen

Cooperative research

NFI-SMC will use the money raised through dues, contributions, and this year's auction to fund its ongoing Mid-Atlantic Supplemental Finfish Survey, a *Loligo* squid net testing study, and a discard mortality study of summer flounder in the bottom trawl fishery.

The supplemental finfish study, which is now in its fourth year, enables industry, in cooperation with NMFS, to conduct trawl surveys in times, depths, and areas that augment NMFS's annual spring and fall surveys. Data from the supplemental survey are now being used in some stock assessments conducted by scientists at the NMFS Northeast Fisheries Science Center.

The *Loligo* net testing project will compare the current legal codend and a codend comprised of meshes less than 2.5" to gauge the effectiveness of the smaller mesh at reducing the capture of small, unmarketable squid.

Cornell Cooperative Extension developed the summer flounder discard mortality study and received the RSA award from NMFS.

"NFI-SMC is helping them turn the set-aside quota awarded them into dollars to support their research project," the committee explained.

$1.5 million so far

NFI-SMC formed in 1997 in response to a lack of congressional funding for Mid-Atlantic cooperative research.

Since then, fishermen, docks, processors, and support companies have contributed more than $1.5 million to fund the organization's cooperative research and scientific monitoring projects.

Cohen explained that the RSA auction generates funds that NFI-SMC then uses to help "make the 'best available science' better."

In addition to money raised during the auction, the organization relies on contributions and dues from member boats, docks, processors, and even individual captains who contribute whenever they can afford to.

Contributions per year have ranged from $250 for a small gillnetter up to $10,000 for the larger docks and processors.

"When we pay for observers and fuel to conduct cooperative supplemental finfish surveys or test gear, every recreational and commercial fisherman in the Atlantic benefits," Cohen said.

More info

NFI-SMC membership dues are one-half of one percent of a boat's gross stock of Mid-Atlantic species up to $2,000 per year. Captains who contribute more than $1,000 to the NFI-SMC will be eligible to bid on the full lot of each species.

After all full lots are auctioned, a separate auction will follow for vessels that have contributed $499-$999.99 to NFI-SMC. These vessels will be eligible to bid on smaller lots. The auction rules will be finalized just prior to the auction date.

Checks for dues should be made payable to NFI-SMC and mailed to: NFI-SMC, 1636 Delaware Ave., Cape May, NJ 08204, attention Greg DiDomenico.

For more information, call DiDomenico at (609) 898-1100. **/cfn/**

REWARD

For Summer Flounder Tags

Cornell Cooperative Extension's Marine Program is conducting a Fluke Discard Mortality Study. Tagged fluke will be released through November 2007.

- Please retain all tags from legal sized Summer Flounder.
- Please record tag # from sub-legal sized Summer Flounder.
- Report ALL tags to CCE Fluke Study call 631-727-7850 ext 317 or email taf4@cornell.edu
- Mail tags to 423 Griffing Ave Riverhead, NY 11901
- Report tag #, date, location, size, water depth and temp to receive a **CASH REWARD**!

Their catch of the day is for research

BY JENNIFER SMITH
jennifer.smith@newsday.com

Seagulls shrieked overhead as crew members emptied a net plump with skates, bluefish and flounder onto the deck of the fishing vessel Darana R.

The gleaming fish weren't destined for Fulton Fish Market. Instead, researchers with the Virginia Institute of Marine Science counted, weighed and measured them before tossing them back into the blue waters of Block Island Sound.

The survey is part of an effort to sample fish and invertebrates such as lobster in coastal waters from Montauk to Cape Hatteras, N.C. The data will help fisheries managers develop harvest limits.

With an estimated annual cost of more than $800,000, the project is the biggest yet for the Mid-Atlantic Research Set-Aside program, which uses fish to pay for research.

The program finances so-called "cooperative research," where scientists work on commercial boats whose skippers historically have been skeptical of the data that underlies the catch limits they must obey.

"It's a great way for scientists and fishermen to cooperate," said Emerson Hasbrouck of Cornell Cooperative Extension, who has used RSA grants to study summer flounder.

Some scientists make arrangements with individual captains, who use the research quota to sell the fish they land as compensation for their time and effort.

Others, such as Hasbrouck and Chris Bonzek of the Virginia Institute, pay for research by selling that quota to fishermen at an auction set up by a seafood industry group.

Bonzek said his team could never catch enough fish themselves to pay for the work.

"We're lucky to benefit from the auction," he said.

TimesReview *Newsgroup*

What's Happening Today

7/26/07 Cornell Cooperative Extension of Suffolk County is reaching out to those who fish our waters to help with a major survey involving the mortality of discarded fluke and flounder. What's in it for those who cooperate with the effort is a $20 payment for each tag removed from fish caught. What Cornell will want to know is the date, location, size of the fish and water depth of the catch. Through September, Cornell scientists will cull sample fish, weigh and measure them and tag the fish, which will be kept in holding tanks for 14 days before being released back into the local waterways. They're asking for all tags from legal-size summer flounder to sub-legal size summer flounder. Call (631) 727-7850, ext. 317, or e-mail taf4@cornell.edu for more information

THE EAST HAMPTON STAR
SHINES FOR ALL

Putting Fluke to the Test

By Russell Drumm

(06/14/2007) Tara Froehlich and Jeanette Klopchin bubbled to the surface, yellow air hoses snaking around them, diving masks in place. They swam to a small floating dock and put a few more dead fluke in a basket to be counted. Emerson Hasbrouck, senior extension educator with the Cornell Cooperative Extension, kept a tally.

The diving agents were working inside an underwater cage made of net similar to the bailing section of a pound trap. The fluke they were bringing up had been caught two days earlier, on May 30, by the dragger Rianda S. The divers were culling the dead fish from among the 120 that had been placed in a holding pen attached to Montauk's Inlet Seafood dock.

Mr. Hasbrouck and the fishing partners of the Inlet Seafood company are working together on an experiment they hope will shed light on the number of "regulatory discards," that is, fish that must be thrown back when a boat's daily limit has already been reached — how many of them survive being forced into the net, lifted on board, culled, and returned to the sea.

The Rianda's May 30 trip was the first of many fluke collection trips that will take place through October aboard different craft and under a number of different conditions. All participating boats are equipped with seawater holding tanks.

Mr. Hasbrouck said that getting a handle on the actual survival rate will help those who manage the species fine tune their approach.

"The goal is to show what the actual mortality rate is instead of a best guesstimate. There are no studies that show it. Oftentimes fishermen can't help but catch summer flounders, so why throw back dead fish," Mr. Hasbrouck said.

The fluke collected on the trip were monitored over a two-week period to see how many would die. They were checked every other day. Those caught by the Rianda S on May 30 that survived the two-week test will be released today.

Collection trips are expected to go out every 14 days. The Montauk dragger

New Age will be fishing for the next group of test fluke. There is a $20 reward for those who recapture the released fish in the days, weeks, and months to come.

Before they were put into the holding pen, each of the Rianda's fluke was tagged. The tags identify which tow (dragging of the net) caught the fish. The tows were either one, two, or three hours long.

In addition, each tag tells Mr. Hasbrouck if the individual fish were taken from the deck and placed in the deck tank immediately, or after a 20-minute delay. The experiment includes a control group comprised of fish caught in pound traps. Trap-caught fluke are subjected to very little stress.

On May 30, the Rianda caught 1,600 pounds of fluke. By federal law, she was only permitted to keep 90 pounds. Except for "research set-aside" fish, the rest had to be thrown back by law.

For years now, fishermen have complained that managing the fluke resource via daily trip limits resulted in unacceptable mortality — fish that die as a result of their ordeal despite being returned to the sea. Instead, they favor a quota covering a greater length of time, a monthly quota, for instance. The preferred approach — the ability to keep all the fluke they catch each trip — would allow them to fill their boat's quota faster, and then stop targeting that species.

Mr. Hasbrouck's team also keeps a record of the conditions under which the fluke were caught. For instance, if they were caught in a net loaded down with dogfish, more damage would be expected because of the crush of fish.

As of Friday, 84 of the 120 fluke from the Rianda's trip had died. "The estimated rate that the government uses is 80-percent mortality. We are at 70 percent, and this trip the fluke were caught with a significant amount of skates, which probably reduced survival. We're seeing that hardly any of the fish that we determined were in excellent condition died. The ones that did die were in poor or moderate condition."

He said he didn't know what fishery managers would do with the results of the study, "but we will document it, and we may have recommendations. I don't know what they are yet, and some could be common-sense things: mortality reduced by shorter tows, and faster sorting times, for instance."

Government managers use the discard mortality rate to come up with a fluke "stock assessment," the size of the population. Mr. Hasbrouck said that if the experiment's mortality rate was significantly lower than 80 percent — "if fewer are dying, it could mean there are more fluke out there."

Dan's Papers

Go Fish

(July 6, 2007) This past week's full moon attracted large stripers to East End waters. Ken Morse, of Tight Lines Tackle in Sag Harbor, said he weighed in a 40-pounder. Then Harvey Bennett at Amagansett's Tackle Shop said a client came in with a 47-pounder, but the high hook report is from Paulie Apostolides of Paulie's Tackle in Montauk - a 57-pound striped bass.

Fluking action also turned red-hot after the winds died down. Steve at Wego Fishing Bait &` Tackle in Southold weighed in a 7.5-pound fluke. He also reports good porgy fishing in the Peconic bays and the sand eels have recently been showing up, which make excellent bait for all local catches. Harvey Bennett had a client weigh in an 8.5 pound fluke caught off the beach in Napeague and Ken Morse reports a 12-pounder weighed in at Tight Lines.

For surf fisherman, bluefish were caught in Heady Creek at the eastern end of Shinnecock Bay. The cut to the ocean at Mecox Bay, on the Water Mill/Bridgehampton border, was opened by the Town of Southampton at the end of last week. Baitfish usually pour out of Mecox to the ocean, attracting bluefish and striped bass, but the cut may have closed itself naturally by now.

Two of the winning sharks caught by Montauk Marine Basin's tournament winners last weekend were a 264-lb. blue shark and a 519-lb. thresher. The next big shark tournament is the Montauk Boatmen and Captains Association charity competition on July 14 and 15 at Star Island, with more than $100,000 in prizes offered.

Noreast.com has its Flukemania Smackdown tournament the same weekend. The entry fee is only $25 and $20,000 in cash prizes will be given out. Winning fish will be the heaviest fluke caught in excess of 20 inches (awards range from $100 for winners #6 to 15 and $10,000 for the first prize winner). Register online at **www.noreast.com** or call 1-866-610-2246.

Offshore fluking from the one-mile buoy outside the Shinnecock inlet east to the Castle off the Meadow Lane ocean beach has been bringing in large fish. Inside Shinnecock Bay, fluking has been good at the Basket.

The Cornell Marine Program out of Riverhead is conducting a fluke survey on the mortality rate of undersized fluke (less than 19.5 inches). Every two weeks, a number of these tagged fluke are released back into local waters. If you catch one, return it to the water but report the tag number, color, location caught, water depth, length of fish and weight to the program at (631) 727-7850 ext. 317 (or Taf4@cornell.edu) and receive a $20-per-tag payment.

The Cornell Marine Program will also be conducting a Bluefin tuna survey. They are looking for commercial and party boat captains to participate. The email contact and telephone numbers are the same as for the fluke program. Commercial and sports fisherman must work together to conserve and sustain the fishery.

-Rich Firstenberg (**YeOldeSalt@aol.com**)

ATTACHMENT 3

Draft Working Paper for Pre-Dissemination Peer Review Only

Appendix Working Paper 2
June 2, 2008

Appendix 1

Working Paper 2 (TOR 1) – Commercial Discard Mortality

Discard Mortality of Summer Flounder in the Inshore Trawl Fishery

A Working Paper in Support of Term of Reference 1

Stock Assessment Review Committee (SARC) 47 Meeting
Woods Hole, MA

June 16- June 20, 2008

Emerson Hasbrouck
Tara Froehlich
Kristin Gerbino
John Scotti

Marine Program
Cornell University Cooperative Extension

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This information is distributed solely for the purpose of pre-dissemination peer review. It has not been formally disseminated by NOAA. It does not represent any final agency determination or policy.

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 time, 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 time, cull time and overall. Mortality rates for the 1 and 2-hour tows were less than for the 3-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 1, 2 and 3-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, 40 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 time. A total of 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 a 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/ dissolved oxygen 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 net-pen and L_p is the weight of the live fish that were placed into the net-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 times combined, is shown in Table 1. These mortality rates are for the entire summer flounder catch for each tow time 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 1-hour and 2-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 time 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 time 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