POTYEAR: Determining the Seasonality of Cod Pots

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Names in **bold** played a key role in project design and implementation.

Project Objectives

Our goal is to continue to develop cod pots. To accomplish this goal, we have identified the following objectives:

1. To compare catch rates and sizes of Atlantic cod captured in Norwegian and Newfoundland cod pots;
2. To compare catch rates and sizes of Atlantic cod over eight months;
3. To observe Atlantic cod behavior to bait and to cod pots.

A worldwide interest in investigating and improving fish potting exists. Currently, active research occurs in Canada, the Faroe Islands, Iceland, Norway, Sweden, France, the United Kingdom, and the United States. Interest in potting extends to the Southern Hemisphere, and to Asia. Potting is becoming increasing popular based on trends toward lower energy, lighter impact fishing gear and gear that causes less harm to target and non-target species and habitats. Pots offer a source of apparently undamaged, healthy fish for tagging and other scientific studies. Releases of undersized and unmarketable fish from pots appear to have low or zero release mortalities in our previous research (Pol and Walsh 2005). Pots also provide an alternative

survey and harvest method for areas inaccessible to trawling, such as coral reefs and other complex benthic habitats. On the negative side, use of pots may increase buoy lines in the water and risk injury to marine mammals. However, this risk could be controlled via spatial/temporal measures (e.g. DAM closures) or gear modifications.

Interest in Massachusetts in pots arose from occurrence of “overharvest” (this term includes regulatory discards – otherwise landable fish that are discarded due to regulations) – catches that exceed daily allowable landing limits. Where overharvest occurs, damage or wasteful mortality (which harms rebuilding) may result if a particular gear catches too many fish. Or, fish may be left in the water for harvest the next day, with loss of quality. In these cases, a gear that can catch and hold fish harmlessly, or that allows discard with low or no mortality, will improve stock rebuilding and economic return. Pots appear to be a gear with these characteristics.

The Northeast Consortium supported the first successful study where Atlantic cod were caught in fish pots in our region. Pol and Walsh, working with Marcella and using a pot designed by the Centre for Sustainable Aquatic Resources in Newfoundland, Canada, were successful at catching Atlantic cod, up to 13 in one pot haul, in the Massachusetts Cod Conservation Zone (CCZ) off Boston in May and June 2005. However, the captured cod tended to be below minimum landing size and average catch rates were not economical. Further investigation in the same area by DMF working with Marcella in December 2005 - February 2006 with comparisons to nearby multimesh gillnets had similar low catch rates, and suggested that cod in pots were smaller and hungrier than cod caught in nearby gillnets. However, the sampling area was restricted and the number of samples and the number of pots used were very low in this small study. Underwater filming showed cod attracted to, but not often entering, the pot.

We hosted (and the NEC supported) an international workshop on gadoid harvest with pots (GACAPOT) in Gloucester in 2006 that examined progress on catching haddock, cod and related fish in pots. One conclusion drawn from that meeting was the necessity of lining up the entrance of the pot with the bait plume caused by the movement of water over the bait. Norwegian scientists have designed their pots to float and rotate in response to current. Underwater observation of their pots show >95% of fish approach the pot from the downcurrent direction, where the bait scent is pushed by the current and detected by fish. Cod may not be able to find an entrance if it is not directly oriented with the bait plume.

A second important conclusion from GACAPOT was that fish in general and Atlantic cod specifically are only vulnerable to pots during certain times of year. This vulnerability is seen in all fishing gears, and may be due to hunger levels, presence of prey or predators, migration, spawning status, or temperature, or a combination of these and other factors. Therefore, in development of pots, it is of primary importance to establish when cod are maximally vulnerable to pots. This knowledge can then be used to define when and if further experiments on the details of pot design and deployment are necessary to improve catch rates, and to establish where and when experiments should be carried out for maximum exposure to cod.

Cod pots need further investigation and development to be successful. We envision this project as the most useful next step: to conduct overnight sets for four days per month in Massachusetts state waters of both Newfoundland and Norwegian designed cod pots, across eight months of a year (November-June). We also propose to conduct filming of fish reaction to bait using underwater cameras. The results of this work will quantify catch rates in pots across 8 months, compare effectiveness of two pot designs, and determine the best time to catch cod with pots. This project will strengthen a scientific-fishing partnership, a team that shares scientific and fishing expertise with one another, to develop an innovative gear on a commercial vessel.

Methods and Work Plan

The Newfoundland cod pot designs (NF) (Figure 1) are all pyramidical when fishing and are constructed in three ways: two are 6.5 ft x 6.5 ft x 41 in and consist of a steel frame with netting panels; one of these designs is collapsible, saving deck space. The third type is 6 ft x 6 ft x 41 in and made from polyvinyl-coated wire mesh. All three have netting attached at the top: 30 meshes of 4-in diamond mesh with a float that creates the pyramid of netting on top. Each pot has two entrances on opposite sides with 16-in diameter circular rings. Previous research showed these three designs did not fish differently from one another. They need some repair work to be made as similar to one another as possible.

We will contract with a netmaker to construct 10 pots following the Norwegian design (NO) (Figure 2). These pots are collapsible two-chamber rectangular pots made of netting, designed to float and move with the current. They have one entrance, are made of netting and are approx. 44 in x 20 in x 53 in.

Figure 1: Setting a Newfoundland-style cod pot

We plan to operate from the northern edge of the Cod Conservation Zone to off Scituate, Massachusetts. We will remain in Massachusetts waters and use a non-Federally permitted vessel to avoid the complexity of obtaining an Experimental Fishing Permit. Use of pots and access to closed areas can be obtained through a permit from the Division of Marine Fisheries, which has been obtainable in the past.

We have identified the months of November through June as times when cod can be caught using longline bait in the study area. We will deploy pots in pairs (but fished as singles) of one NO design and one NF design with 0.25 nm of each other. Bait will be standardized to clams which are known to be effective (Pol et al. 2007). Set locations will be determined using fishing experience, an echosounder and jigging.

Figure 2: Norwegian floating pot

Pots will be set and hauled on four consecutive days in each month. Catch will be identified, weighed, and measured. In cooperation with the Cod Tagging Program of the School of Marine and Atmospheric Science and Technology of the University of Massachusetts-Dartmouth, cod will be uniquely tagged and released. Fin clips will be collected from fish that are extruding eggs or milt to assist microsatellite genetic studies of cod by Dr. David Berlinsky of the University of New Hampshire. We do not intend to kill or land any fish and we expect fishing mortality to be low or zero. Pots will be hauled and remain on land between months.

Operational and biological data will be collected by DMF biologists, including catch composition and weights for all species, lengths for Atlantic cod (and other species as practical), set and haul times and locations, pot type, weather conditions, depth, temperature (surface and bottom) and tag data. Data will be entered into a customized Access database which will be provided to the NEC at the conclusion of the study.

The field work will continue for eight months; our goal is 32 sea days with 10 pairs of pot catches per day. Catches will be analyzed using pot type and month as factors; after exploratory analysis of the data, appropriate parametric or non-parametric analysis will be conducted.

Additionally, we will conduct at least one filming session each month. An underwater camera will be attached to a pot and a live-feed will be observed and recorded on the F/V *Ann Marie*, using a filming rig previously developed for this vessel. We will initially investigate the effect of removing the sides from an NF pot, and observe fish behavior in reaction to hanging bait. Behavior will be analyzed quantitatively later in the laboratory. We intend to progress to observation of reaction to entrances and other pot factors. Temperature probes will be attached to each pot to identify temperature effects on catch.

Table 1: Timeline for conduct of the POTYEAR project

2008					
Jul	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Acquire permit; Database development				Set/haul pots	Set/haul pots
Repair NO pots; have NF pots built; move pots to Hull; order bait				Film behavior	Film behavior
					Data audit and entry

2009								
Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul - Aug**	**Sep -Nov**	**Dec**
Set/haul pots	Set/haul pots	Set/haul pots	Set/haul pots	Set/haul pots	Set/haul pots	Data and video analysis	Final report writing	Submit final report
Film behavior	Film behavior	Film behavior	Film behavior	Film behavior	Film behavior			
Data audit and entry	Data audit and entry	Data audit and entry	Data audit and entry	Data audit and entry	Data audit and entry			

Work Completed to Date

A Categorical Exclusion for conduct of this project was received from NMFS in August 2008. SMAST Institutional Animal Care and Use Committee (IACUC) approval was granted in October 2008. The sub-award from UNH was completed in November 2008.

Newfoundland-style pots previously constructed were transported to Hull, MA to Bob Marcella's house in September 2008. Kelo Pinkham was contracted to design and to construct Norwegian style pots based on a diagram published in Fisheries Research, and input from one of the creators of the diagram, Svein Lokkeborg of the Institute of Marine Research in Bergen, Norway. Ten pots were constructed and delivered in December 2008. A bait supply was secured and repair to a common design for the eleven Newfoundland-designed pots was completed, including minor alteration of one pot for filming purposes.

Fieldwork began in December 2008. Between December 2008 and April 2009, 20 trips were completed, with 254 pot-hauls in 127 pairs. Four additional trips were completed in May 2009, with four more scheduled to occur prior to the report date. Database development was completed by January 2009, and data entry was initiated. Currently, all trips between December and April have been entered and preliminarily audited.

SMAST and DMF personnel have tagged more than 215 cod with t-bar tags. Nine DST (depth, salinity, and temperature-recording) tags have been applied, and 9 fin clips for genetic testing by David Berlinsky have been collected as of April 2009.

Several unexpected difficulties arose during the last 12 months.

1) Fieldwork began in December 2008 due to unavoidable delays in project start-up; additionally, dangerously bad weather eliminated one sampling day in December. Pol and

Marcella discussed an appropriate reaction that best serves the project objectives, and have chosen to reserve four days for November 2009, and one other day for an undetermined time.

2) A combination of dangerously bad weather and poor underwater visibility has prevented any serious underwater filming. It is hoped that improved weather and water clarity in June will allow filming.
3) Three pots were lost at sea with their temperature probes. A NO pot apparently drifted away or was removed by someone else. To combat future occurrences, NO pots were anchored more heavily and marked with Marcella's lobster buoys. One NF pot was set too close to a bottom obstruction and could not be lifted off bottom and was beyond diver range. A second NF pot was simply lost with no trace. Secondary buoy lines were added to pots to assist recovery if hung up or one buoy is lost.
4) The Norwegian floating pots initially obtained their buoyancy from rings of PVC pipe that were sealed. These rings also provided the structural frame for the pot. Fractures in the PVC allow flooding of the rings and loss of buoyancy. A pot was tested in an SMAST tank in April 2009. It was observed to be in partial bottom contact. The rings were intentionally breached, and flotation added until the pot floated to design specifications. Based on these observations and field experimentation, all Norwegian pots were breached and additional buoyancy in the form of deepwater gillnet floats were purchased and added in time for April testing.

Results to Date

It is too soon to place too much weight on the results of the project to date. With that thought in mind, a few musings can be made. They are organized by the three project objectives.

1. Compare catch rates and sizes in the two pot designs.

Pots were set with one Norwegian style pot and one Newfoundland style pot in pairs, with the idea that both pots would sample the same fish, and catches would demonstrate which pot was more attractive or better at holding captured fish. Pairs where at least one Atlantic cod was caught in one of the pots do not suggest any simple patterns of effectiveness between the two types of pot (Figure 3).

For example, pairs in December and March suggest that the Norwegian pots caught more fish – the data points are mostly above the equal catch line. However, in April, the month with the largest catches so far, the data points are more spread, and on 27 April, all points are below the line, indicating that the Norwegian pots caught more fish every time.

The clustering of points nearer the equal catch line in April is also a change. Many of the pairs in earlier months included zero catches in one of the two pots in a pair. This trend seemed to change in April.

The smaller size meshes in the Norwegian pots would appear to retain smaller Atlantic cod (Figure 4). While this result may seem logical, it does hint that the mesh size of the sides of the pot have an influence on the size of fish retained. The larger count of smaller fish may also explain differences in catch rates between pots. Counts of legal fish between pots were approximately equal.

More species were captured in the Norwegian pots (Table 2). This observation is consistent with the retention of smaller cod due to smaller meshes; most of these species are smaller fish that may have escaped from the larger meshes of the Newfoundland-style pots.

One surprising finding was the catch of lobsters in the floating Norwegian pots. These catches may have been a result of a lack of flotation. This problem has been corrected, and we will examine future catches for the presence of lobsters.

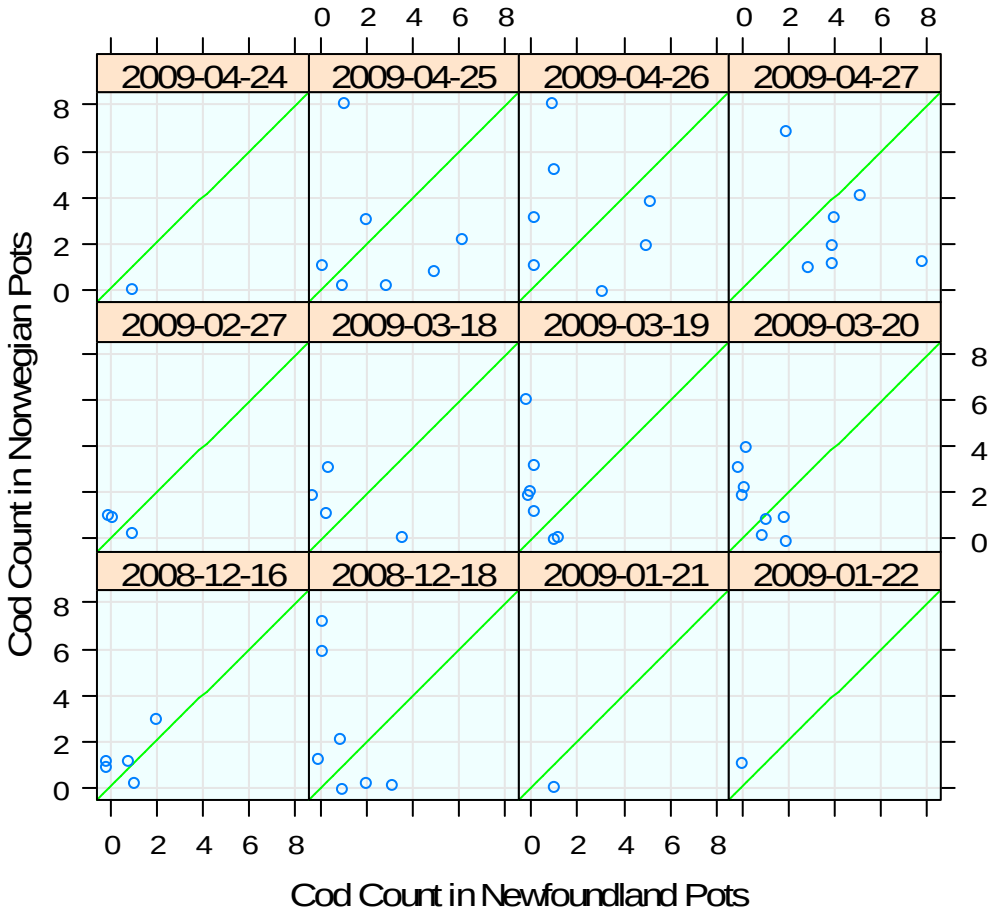

Figure 3: Catches in pairs of Newfoundland and Norwegian pots by sampling day. Rows include December 2008 and January 2009 (bottom row), February-March 2009 (middle row) and April 2009 (top row). The green dashed line is the equal catch line.

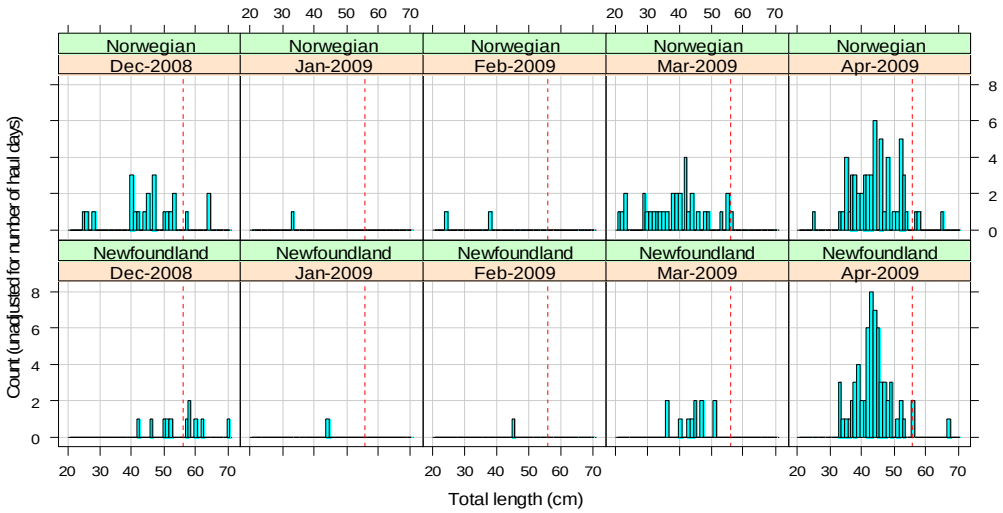

Figure 4: Length frequencies for Atlantic cod caught in Norwegian (top row) and Newfoundland (bottom row) style pots by month (columns). Counts are raw, and have not been adjusted for unequal effort in December. The red line marks the minimum legal size.

Table 2: Catches in pots by type, in counts, from December 2008-April 2009.

Species		Norwegian	Newfoundland
Cod, Atlantic	*Gadus morhua*	115	103
Lobster, American	*Homarus americanus*	42	5
Cunner (Yellow Perch)	*Tautogolabrus adspersus*	36	1
Crab, Jonah	*Cancer borealis*	11	3
Pollock	*Pollachius virens*	6	
Hake, Red (Ling)	*Urophycis chuss*	5	
Crab, Rock	*Cancer irroratus*	3	
Raven, Sea	*Hemitripterus americanus*	2	2
Herring, Atlantic	*Clupea harengus*	2	
Ocean Pout	*Macrozoarces americanus*	1	2
Redfish, Nk (Ocean Perch)	*Sebastes sp*	1	1
Cusk	*Brosme brosme*	1	
Lumpfish	*Cyclopterus lumpus*	1	
Crab, Northern Stone	*Lithodes maja*		5
Flounder, Winter (Blackback)	*Pseudopleuronectes americanus*		1

2. Comparison of catch rates and sizes of Atlantic cod over eight months.

Catches were dramatically different between months (Figure 4), with April (and preliminarily, May) showing the largest catches. January and February had near-zero catches. We do not believe these catches are due to an inability to find fish. We used multiple methods to find cod, including use of an echosounder, jigging, reports from lobstermen of cod in lobster pots, and catches by longline fishermen. It appears that these catches reflect a lack of availability or presence of cod in the area.

3. Observation of cod behavior to bait and cod pots.

As reported above, dangerous weather and poor visibility have limited observations. We have

established the ability to film, but have not been able to.

4. Other observations

The Norwegian pots are much easier to handle: they are lightweight, and collapsible. However, they may not be as durable as necessary, and in future versions, the flotation should be separate from the pot structure to ensure positive buoyancy.

Multiple catches of eight fish in a haul, and the presence of many just sublegal fish suggest that potting is potentially a fishery with a future.

Future Work

Work is planned to continue as scheduled for June. Some additional pot maintenance will be completed. Work will then be paused until October 2009 in preparation for final fieldwork in November 2009. Data audit and entry will continue as trips are completed. The original work plan allowed for analysis and final report writing to be conducted for six months following the conclusion of fieldwork. Following that timeline, we would anticipate a final report in June 2010, coinciding with the due date for an annual report.

Impacts and Applications

We are quite pleased with the size of the catches and the ease of handling the Norwegian pots. We feel we have begun defining times when future research or a fishery could occur. We expect that these results will be of value to the network of cod pot researchers that has been established through ICES as we work together to improve pot catches, by determining differences between these two pot designs. We also intend to continue to develop pots locally, and therefore this information is valuable to local fishermen who may be interested in pots as an alternative gear. Scientists who need a supply of cod that are in excellent health (for tagging, stress studies, survey techniques, etc) should consider use of this harvest method. Further, managers may find this gear type to be a useful alternative to harvest practices in specific areas. However, at this time, pots are not yet ready for widespread commercial use.

Related Projects

This project provides tagging opportunities for SMAST personnel, overseen by David Martins and Steven Cadrin, and through them, fin clips for genetic research by Dr. David Berlinsky of the University of New Hampshire.

Partnerships

The project is a strong collaboration between DMF and Robert Marcella, with each participant bringing independent and overlapping expertise, with mutual respect of that expertise as well as healthy discussion of decisions. Pol and Marcella worked together to define the project objectives and direction, the study area and times of year when the project should be conducted. They jointly considered logistics of deck handling of pots and number of pots that could be handled in a day. They worked together to find and acquire an adequate bait supply, storage, and delivery method for the project. Marcella provides lead on determining timing of monthly fishing

activity, maintenance and storage of pots, and set location, and has primary responsibility for determining safe working conditions due to weather and deck activity. Pol provides lead on database development, data analysis, and report writing. Szymanski leads the sea sampling and coordination with SMAST personnel.

Marcella and three crewmen (one or two at a time) have been involved directly with the project, with a network of other fishermen advising us on possible locations of Atlantic cod. Kelo Pinkham constructed the pots. At this point, more than eight scientists from DMF and SMAST have participated in sampling and tagging.

Presentations

Pol, M. 2009. [poster]. Fishing Inside the Box? Northeast Consortium 8th Annual Project Participants Meeting, 25 March 2009, Portsmouth, NH.

Pol, M. 2009. [presentation]. Seasonality and comparison of Canadian and Norwegian fish pots for Atlantic cod. ICES Study Group on the Development of Fish Pots for Commercial Fisheries and Survey Purposes (SGPOT), 16-17 May 2009, Ancona, Italy.

Published Reports and Papers

None

Data

All electronic data from this project are being entered into a customized Access relational database, and will be provided to the Northeast Consortium Fisheries & Ocean Database at the same time as final report submittal.