Technical Report

Massachusetts Division of Marine Fisheries
Technical Report TR-40

Proceedings of the International Technical Workshop on Gadoid Capture by Pots (GACAPOT)

M. Pol, P. He, and P. Winger

Commonwealth of Massachusetts
Executive Office of Energy and Environmental Affairs
Department of Fish and Game
Massachusetts Division of Marine Fisheries

January 2010

Massachusetts Division of Marine Fisheries Technical Report Series

Managing Editor: Michael P. Armstrong
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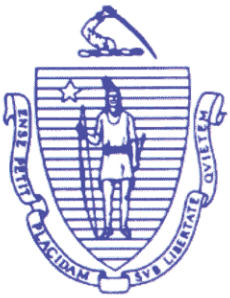

Proceedings of the International Technical Workshop on Gadoid Capture by Pots (GACAPOT)

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March 2010

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Abstract: An international technical workshop to discuss the capture of gadoids (cods, haddock, and saithe/pollock) in baited traps, or pots, was held in Gloucester, Massachusetts, USA on 4 November 2006. Attendance at the workshop included 50 scientists and fishermen actively studying pot capture of gadoids, technical staff and others interested in pots in general from 16 nations and five continents. The workshop determined basic principles for potting gadoid species by examining the current state of research on gadoid capture in pots and assessing the direction of future research for improving catch rates. Conclusions suggested that research into pots was still at an early stage, and that much vital work needed to be done; however, pot volume and orientation of the bait plume and entrances were identified as important factors. Future studies using a combination of laboratory and field techniques to identify critical design details and behavioral factors such as reaction and behavioral thresholds for a variety of stimuli were described.

Introduction

An international technical workshop to discuss the capture of gadoids (cods, haddock *Melanogrammus aeglefinus*, and saithe/pollock *Pollachius virens*) in baited traps, or pots, was held in Gloucester, Massachusetts, USA on 4 November 2006. The workshop, known as GACAPOT, was convened by Dr. Paul Winger of the Centre for Sustainable Aquatic Resources of the Marine Institute, Memorial University of Newfoundland and Labrador, Dr. Pingguo He of the Institute for the Study of Earth, Oceans, and Space at the University of New Hampshire, and Mr. Michael Pol of the Massachusetts Division of Marine Fisheries.

Fish pots, baited structures for capturing fish, are an alternative gear with ideal or near-ideal qualities, including low impact on habitat, narrow species selection and low capture and discard mortalities. Pots have also demonstrated a remarkable degree of species selectivity. Furthermore, although post-pot-capture mortality of gadoids is unquantified, qualitative assessment of discarded fish indicates high survival rates. A commercial pot fishery for Pacific cod *Gadus macrocephalus* has been established; however, for other gadoids, improved catch rates are needed to reach commercial viability.

This workshop attempted to focus on determining basic principles for potting gadoid species by examining the current state of research on gadoid capture in pots and assessing the direction of future research for improving catch rates. The workshop was primarily intended for researchers actively studying the pot capture of gadoids, including technical staff and fishermen, and secondarily for those interested in pots in general.

Attendance at the workshop included 50 scientists and fishermen, technical staff and others from 16 nations and five continents (Table 1). The morning session of the workshop consisted of 9 invited talks. The afternoon session included a focused, lively discussion on defining essential pot characteristics and directing future research and ended with a listing of conclusions.

At the time of the workshop, research on pots targeting Atlantic cod *Gadus morhua* had recently been conducted in Canada, Faeroe Islands, Norway, and the United States. Research on pots targeting haddock *Melanogrammus aeglefinus* and saithe/ pollock *Pollachius virens* had also been conducted in Norway and the United States. In addition, an ICES Study Group on the Development of Fish Pots for Commercial Fisheries and Survey Purposes (SGPOT) had been proposed. Since the GACAPOT workshop, work on gadoid capture has continued and expanded to other Northern Hemisphere nations, including Iceland, Sweden, France, Germany, Scotland, Ireland and other nations. SGPOT has now met and corresponded for three years and is currently developing a formal report on their work.

This document includes summaries of each presentation and of the questions that each generated. The **Discussion** section describes the content of the workshop's afternoon session. A list of conclusions was made at the end of the meeting by M. Pol. Slide images from each presentation are included in the Appendix.

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Presentations

Pingguo He, "Fishing with Baited Pots: An Introduction". Pingguo He gave an overview of fish potting. He discussed pot definitions and qualities, comparing and contrasting pots to traps, and proposed a new definition. He showed examples of pots and traps through photographs (Appendix, pp A4-A15), and highlighted the limitation of the FAO definition where a pot is classified as a type of trap. The difference between pots and traps was summarized by pointing out that traps guide and then trap fish, while pots attract and then retain fish. He then reviewed capture principles, showing commonalities with other stationary gears, and the distinctive aspect of pots, a non-return device that allows entry, but discourages exit. He described possible environmental factors affecting pot fishing, differences in fishing effects, and mammal interactions, emphasizing previous work on attraction to baited gears. Specifically, the impact of temperature on swimming speed and the effective area of a pot was illustrated. A list of references on pot topics such as: searching, attraction and reaction; soak duration; baited pot fishing trials; pot size selectivity; conservation issues (ghostfishing and mammal entanglement); pots as research tools; study methods for pots; and literature reviews was provided. He asked attendees to consider several points as we worked through the day: fishing season, feeding and spawning; availability of prey items; bait type and presentation; pot size and entrance; and how to balance entry and exit.

Pingguo He, "Some Fish Pot Experiments in Newfoundland and in Gulf of Maine". He presented his own experiences in Newfoundland with flounder pots, spherical pots, collapsible pots and trapots (traps along a leader line) (Appendix, pp A16-A19.)

Bjarti Thomsen, "Pot research and pot fishery in the Faeroe Islands and other European countries". Thomsen continued the discussion of pot definitions including the FAO definitions and offered to share his list of references on pot work (Appendix, pp. A20-A32). Thomsen highlighted the low observed efficiencies of pots and gave an overview of pot use in Europe. He gave his impression of pot functionality and behavioral effects and mentioned some new work that has been completed by others. In Thomsen's own experiments, he looked at long lasting baits, alternative stimuli, and varying pot designs and showed video demonstrating cod attraction. His methodology of video observation was detailed. However, no strongly positive results were obtained. He presented various design evolutions that dealt with bait container locations, frozen bait, and visual lure tests using movement and light. Cod were observed to defend bait for lengthy periods, preventing other fish from accessing the pot entrance. Pot entrances on top were tried. Fish did not react to a leading light. Thomsen felt that the observational methodology was successful, and that an effective long-lasting bait had been developed, that pot entrances should face downstream or be accessible on all sides, and suggested future research on pot designs and visual stimuli and their impact on fish's optimotor responses, including moving objects, light, sound, and electricity. He also presented a diagram of an idealized pot system.

Attendees requested more details on his underwater observation system, types of fingers used, and the success of light emitting diodes. The territoriality of individual cod was observed, but no solution for deterring these fish was suggested.

Svein Løkkeborg (presenter) and Odd-Børre Humborstad, "The Norwegian Pot Story". The history and development of the original Norwegian pot 30 years ago were described, including difficulty with low catch efficiency and large pot size. Løkkeborg showed how development of torsk *Brosme brosme* pots and collapsible pots continued (Appendix, p. A33-A42). He discussed cod behaviors with respect to entrances and retention in the pot and Humborstad's and his work with double and wider entrances. Cod were found to dislike narrow entrances, but to readily escape from large entrances. He mentioned potential problems like size and bait location. He showed design modifications for reducing king crab bycatch and increasing cod catch with two-chambered, floating

pots. Løkkeborg demonstrated the importance of the odor plume orientation with the pot opening. Finally, Løkkeborg showed torsk reaction to bait with a streamer and deployment of a trapot or "underwear" (the meaning of "trapot" in Norwegian). He described continued development of long-lasting bait and added stimuli to increase the rate of entry into pots. A summary of an ideal cod pot's characteristics based on their research was presented: floating, with the odor plume oriented out of the funnel, a wide or double funnel, with two chambers separated by a narrow entrance. Long-lasting bait with visual and other stimuli was also included.

Discussions and questions focused on long-lasting bait possibilities, further modifications in the pot designs, methodologies that they had used, the importance of funnel sizes on fish size-dependent captures, and possible usage of visual stimuli.

Philip Walsh, "Development of baited pots for harvesting cod in Newfoundland and Labrador". Walsh showed the advantages of cod pots from both environmental and industry perspectives: environmental friendliness; high discard survival; high quality; good size and species selectivity; minimal ghost fishing; and research uses (live fish for tagging, etc.) (Appendix, pp. A44-A53). These aspects were summarized by saying that "pots catch fish, they do not kill fish." He discussed the history and methodologies of research at the Marine Institute, testing various cod pot designs beginning in 2000. During that time they have compared the effectiveness of funnels, floating roofs, funnel shape, and entrance characteristics among other factors. Pot size and shape, opening shapes, triggers, depths and soak times were all examined. Comparisons to gillnets showed that pots could double gillnet catches. Walsh identified the importance of the fish's seasonal condition and hunger status to the capture process. He then showed video of a pot retrieval and cod behavior around a pot.

Questions for Walsh concerned his pot designs with respect to bait types and locations and funnel shapes, the importance of color, escape vents for bycatch, and sampling design with respect to soak times.

Craig Rose, "Pot Fishing and research in western USA". Rose presented research for sablefish pot development based on Alaskan crab pots (Appendix, pp. A54-A65). Rose reviewed a baited fishing gear behavioral model and illustrated the effectiveness of DIDSON sonar and an ICCD camera to determine fish movement tracks around pots. While thousands of entries into the sonar field were recorded, only 19 pot entries were recorded. His observations showed that the abundance estimates were dependent on the relation of the observed side to the current direction: more fish were observed on the downcurrent side. Rose continued by proposing possible improvements of pot designs by optimizing pot volume, improving tunnels and other aspects, and future work with bait. He also suggested setting entangling gear (gillnets or trammel nets) near the pot to improve catches.

Questions pertained to catch rates, bait types, and the results of his study, including bait placement.

Michael Pol, "It isn't the pot - it's the cod". Pol described US East Coast pot fisheries with various species (American lobster *Homarus americanus*, scup *Stenotomus chrysops*, black sea bass *Centropristis striata*, channeled whelk *Busycon canaliculatum*, and red crabs *Chaceon quinquedens* and attempts to modify those gears for cod potting (Appendix, pp. A66-A70). He presented his own work with Walsh's pot designs using various baits showing successful but low cod catches in Massachusetts Bay. Comparisons to fish in nearby gillnets showed emptier stomachs in pot-caught fish. Pot frame type seemed unimportant, and modifications to entrance details did not improve catches. Tag recaptures and no observed mortalities suggested good survival. Video of cod behavior showed cod biting a loose string (likely displacement behavior) and a strong rush to the bait once it was vigorously attacked. Pol concluded that future work should look at hunger and spawning conditions, other comparative designs, contrast effects such as flashing, and density dependency.

Questions raised included topics of cod learning behaviors and sampling design.

Ken La Valley, "Feasibility of a directed Atlantic haddock trap fishery in the Gulf of Maine". La Valley identified high abundances of haddock and low abundances of cod as his motivation for a haddock pot fishery. He then reviewed his experiment in Maine with trap designs based on Pacific cod pots, Alaskan crab pots, and a two-chamber pot (Appendix, pp. A71-A76). He also hoped to compare three baits (Norbait, surf clam, herring). No haddock were caught, but for other species the two-chamber pot and clam bait caught the most fish, all species combined. Each design caught fish, but haddock abundance in the area was low. LaValley concluded that seasonal components and the pot design were important and that future modifications will use floated pots with modified one-way devices or entrances (triggers).

Questions focused on haddock availability.

Takafumi Arimoto, Anukorn Boutson, and John Haluan, "Fish pots in Asia and some recent works in Japan". Under the framework of this title, a review of potting in eastern Asia was presented (Appendix, pp. A76-A95). Arimoto began by referring to a pot meeting that occured 20 years prior. He described the use of pots from the Phillippines, Malaysia, United Arab Emirates, Taiwan, and Okinawa, Japan. Boutson presented, "Bycatch and its reduction from blue swimming crab pot fishery in Thailand" where he reviewed Thailand's pot fishery and his own experiment modifying the pot design. Haluan continued this presentation with "Fish pots in Indonesia" where he discussed Indonesia's pot designs and methods. Arimoto finished the presentation with an overview of fish potting in other areas of Asia. He also identified published research on reactions of puffer fish to pots in the laboratory, the hydrodynamics of various pot designs and behavioral responses of greenling to small changes in entrance architecture. Arimoto concluded that further research should address pot entry and escape, inter- and intra-specific behaviors inside the pot, soak times, and density relationships. Work should continue on improving the efficiency of the pot designs, particularly increasing the pot volume, setting pots in longlines, entrance characteristics, and optimal bait.

Questions addressed the environmental benefits of pots on corals over other harvest methods.

Discussion

Paul Winger introduced and moderated the final discussion session of the workshop starting with two questions: What are the essential successful characteristics of pots? What are their weaknesses? Referring to a behavioral model of reactions to baited fishing gear, he described how a fish's condition is filtered through mediating mechanisms and output responses based on behavioral patterns. Drawing on understanding those mechanisms can offer a pathway to maximize catchability.

Discussion continued around the importance of familiarity of the gear to fish, and on a fish's ability to learn. Examples were cited of rapid learning by wild fish held captive in underwater cages. The model of lobster gear, where sublegal lobsters may experience captures and escapes from pots before retention, was considered for relevance to new gadoid pot fisheries. Do gadoids need to have prior entry and escape experience with pots prior to entry and capture? The role of social facilitation of cod was discussed, and the possibility of leaving a cod in a pot as an attractant was considered - this practice is not used in the Alaskan fishery.

Strategies and ideas for luring fish to pots were discussed, including the development of long-lasting baits as a means of reducing costs to the fisherman by allowing gear to remain attractive longer. The importance of a model which includes consideration of both the environmental conditions and a fish's individual condition (hunger state, etc) was described as a way of understanding capture likelihood. Additional possible attractants were discussed, including lights and metal.

Seasonality of capture was discussed, including the possible effect of the spawning status of the target fish. The effect of spawning on hunger status was considered.

Winger listed the consensus for "things that haven't worked so far" which included setting pots in the absence of fish, setting at the wrong time of year, narrow entrances, poor bait placement, unbaited trapots, summer fishing in Newfoundland, unstable (moving) pots, and light emitting diodes (as currently placed).

The possibility of using leaders (as in a trapot) was considered and discussed. The role of prey availability and hunger status was theorized to affect both capture and seasonality of capture.

Multiple participants mentioned the role of pot volume and shape, especially whether round or square pots were better. The possibility that pot movement might be an attractant was considered. Volume impacts not only attraction, but also retention by changing the saturation level of the pot. Smaller pots allow the use of a smaller boat, which decreases fixed costs. The benefit of multiple chambers, and the choice they offer to fish, was considered. Winger continued with two ideas to improve trap designs: multiple entrances on all sides or correctly orienting the entrance. Details of pot entrance configuration were discussed. For floating pots, especially in a current, the importance of balancing the flotation was mentioned. Also, the complexities of bait led to consideration that strongly stimulating baits might confuse fish; the viability and value of different baits were discussed. Bait intensity limits were briefly mentioned.

The potential for interspecies interactions, including bycatch and conflicts with marine mammals, were the final items discussed.

Summary and Conclusions

Michael Pol abstracted the main points of the GACAPOT workshop, based on the presentations and the discussions.

1. We are still in the early stages of understanding pots, and a lot of basic testing of pot characteristics needs to be done.
2. Catches might be simply related to abundance; we rarely know the local densities.
3. Increasing pot volume appears to increase catch.
4. Behavioral reasons for the effect of larger volume are unclear, although the effect could be density-dependent.
5. An optimization exercise could help define the catch rates necessary for practical use.
6. Bait plume orientation with entrance is vital, and can be achieved through floating pots, orientation while setting, or multiple entrances.
7. Pot design (volume and floating, adding a leader) could be a tank/engineering exercise.
8. Cod learning is possible and laboratory experiments could illuminate whether familiarity or novelty is a factor.
9. Use of non-olfactory or multiple stimuli appears to have some promise for increasing catches. We need to understand the feeding behavior of the target species, including detection and reaction thresholds.
10. Observation of cod is extremely valuable; inexpensive and expensive technologies are available to help us observe and record fish behavior; laboratory experiments are also useful.

The meeting concluded with positive remarks and a desire to continue the networking and dialogue initiated by the meeting.

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