MINOUW

Case study results

3.7 – Transition to pots for gadoid fish, Norway

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RESEARCH & INNOVATION

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SUMMARY

Along the coast of Norway, experiments were conducted to test how artificial lights can increase the effectiveness of pots to catch Atlantic cod, as a low-impact alternative to current fishing practices (such as trawl, longline, gillnet, bottom set seine. Laboratory investigations determined behavior responses of krill and cod to light of different wavelengths, intensities and flicker frequencies. Field experiments tested the most promising light sources in fish pots to increase catch rates. Krill were most effectively attracted to artificial light sources emitting wavelength of 530 nm and broadband white light, and increased light intensity gave increased swimming activity. Pots with a strong white light source gave pronounced increase in catch rates of cod compared to pots with bait only. Using artificial light in pots gives increased catch rates of Atlantic Cod because the light attracts dense swarms of krill, their prey. This may make pots a viable alternative to traditional fishing gears that are less environmental friendly, with higher rates of discards.

CASE STUDY RESULTS

Type of intervention

The intervention tested artificial light to increase the effectiveness of pots to catch gadoid species (specifically Atlantic cod, Gadus morhua) as a low-impact alternative to current fishing practices (trawl, longline, gillnet, bottom set seine) along the coast of Norway.

Aim of the experiment

The experiments in this case study included both laboratory investigations and field trials testing the use of artifical light to affect the behaviour of cod and krill (Meganyctiphanes norvegica, a principal prey species) in order to increase catches in pots. Previous work has indicated that while cod are attracted to bait at distances up to 700 m and congregate outside baited pots, only a small percentage (11 %) enter the pots (Anders et al. 2016). The laboratory experiments aimed to determine which light characteristics (intensity, wavelength composition, flickering frequency) are most attractive to krill. The most promising light stimuli for krill were tested to determine whether they would have repulsive or attractive effect on cod. The field experiments put this knowledge into practical use by incorporating the light with the most promising characteristics into fish pots and comparing their effectiveness against pots with bait alone.

Anders, N., Fernö, A., Humborstad, O-B., Løkkeborg, S. and Utne-Palm, AC. 2016. Species specific behaviour and catchability of gadoid fish to floated and bottom set pots. ICES Journal of Marine Science, doi:10.1093/icesjms/fsw200

Main activities carried out

Krill experiment: Krill were caught by a large plankton net (MIC-net) at depths of 150 to 180 m. The experiment used the distribution of krill in a 80 l tank with a light source (the magic lantern, developed in Task 2.7: Promoting selectivity using artificial light) at one end, to assess the degree of attraction to light of different wavelength (410, 425, 448, 470, 505, 530, 560, 590, 625 nm and white light), intensity (0.25, 0.5 and 1.0 µE m-2 s-1) and flicker frequency (constant light, 2 Hz, 8 Hz). The experiments were conducted in a dark room. Eight replicate groups were tested by turning on the experimental light unit at a pre-set wavelength, flickering rate and intensity. The treatments were presented in random order. The number of krill positioned in the three different sections of the tank were recorded every 30 seconds for 5 minutes.
Cod experiment: Cod were caught by fyke-nets. The experiments were conducted in two large indoor tanks (400 cm long, 150 cm wide and 100 cm deep). Two fish were taken from the holding tank the evening before the experiment and placed in each of two experimental tanks. The only source of lighting in the experimental room was the tested light stimulus (the magic lantern) and two infra-red LED spotlights (IN-905 V2, wavelength 940 nm) to enable video recordings. A wide-angle camera was mounted centrally above the tanks. The light stimuli source was placed at one end of the tank. Each fish experienced the same twelve light-stimuli treatments, which were a combination of four wavelengths (448 nm, 505 nm, 530 mm and white light as defined by the krill experiment) and three flickering rates (constant light, 2 Hz, 8 Hz), all at an intensity of 0.25 µE m-2 s-1. The treatment order was randomized between the eight replicate fish. Fish behaviour was recorded for 10 minutes before (control) and 10 min after the light-stimuli was placed in the tank. The video was analysed by noting which side of the tank the cod were at every 30 s for 10 minutes in each period (i.e. treatment and control).
Field experiment: The experiments were carried out in a fjord in northern Norway. The bottom set two-chamber cod pot (100 cm wide, 150 cm long and 120 cm high) baited with squid was used. Pots with artificial light and pots with bait only were attached alternately to a common ground rope at intervals of about 50 m. The pots were set in the evening at depths of 60-137 m and hauled the next morning. Three different light sources were tested: white light of high intensity (17.700 µE m-2 s-1) and white and green light of low intensity (3 µE m-2 s-1). A Go-Pro camera was mounted in some of the pots with a light source to observe krill attraction and cod behaviour. During hauling, the number of cod caught was noted and the stomach content was determined.

Main results

Krill responded to the artificial light sources, and the most attractive wavelength was 530 nm, while broadband (425 - 750 nm) white light was equally attractive.
Light intensity did not affect attraction of krill, but it affected swimming activity.
These light stimuli appeared to be slightly repulsive for cod.
The catch rates of cod were affected by artificial light: pots with white light of highest intensity gave 17 times increase in catch rate, white light of lowest intensity gave 5 times increase and green light had no effect.
Most cod caught in pots with light had krill and arrowworm (Sagitta sp.) in their stomachs, and the video footage showed that cod inside the pot were feeding on

dense swarms of these prey items.

Discussion of the results

Krill responded to the artificial light sources, and their swimming activity and degree of attraction were related to the wavelength of the emitted light. Cod showed indifference or a weak avoidance response to the tested light stimuli. Thus, artificial light sources emitting light within the wavelength of 448-560 nm may be used to attract krill without causing pronounced avoidance responses in cod. Krill constitutes an important prey item for cod, and the field experiment showed that artificial light had a pronounced effect on the catching efficiency of baited cod pots. The light source of highest intensity gave larger catch increases than the light sources of lower intensity, and the high-intensity source was also more efficient in attracting krill and arrowworm. Also, cod caught in pots with light had more krill and arrowworm in their stomach and were observed feeding on these prey after becoming caught. An illuminated swarm of krill produces a strong visual stimulus to foraging cod, and it is most likely that cod were attracted by the dense swarm of prey and not the light per se.

How practical is it for a fisherman to implement this improvement, technically and financially?

The implementation of light to pot fisheries is much dependent on battery and led light development. There is a need for long-lasting batteries and high-intensity lights.

Is there sufficient evidence to support wider adoption of the method/technology?

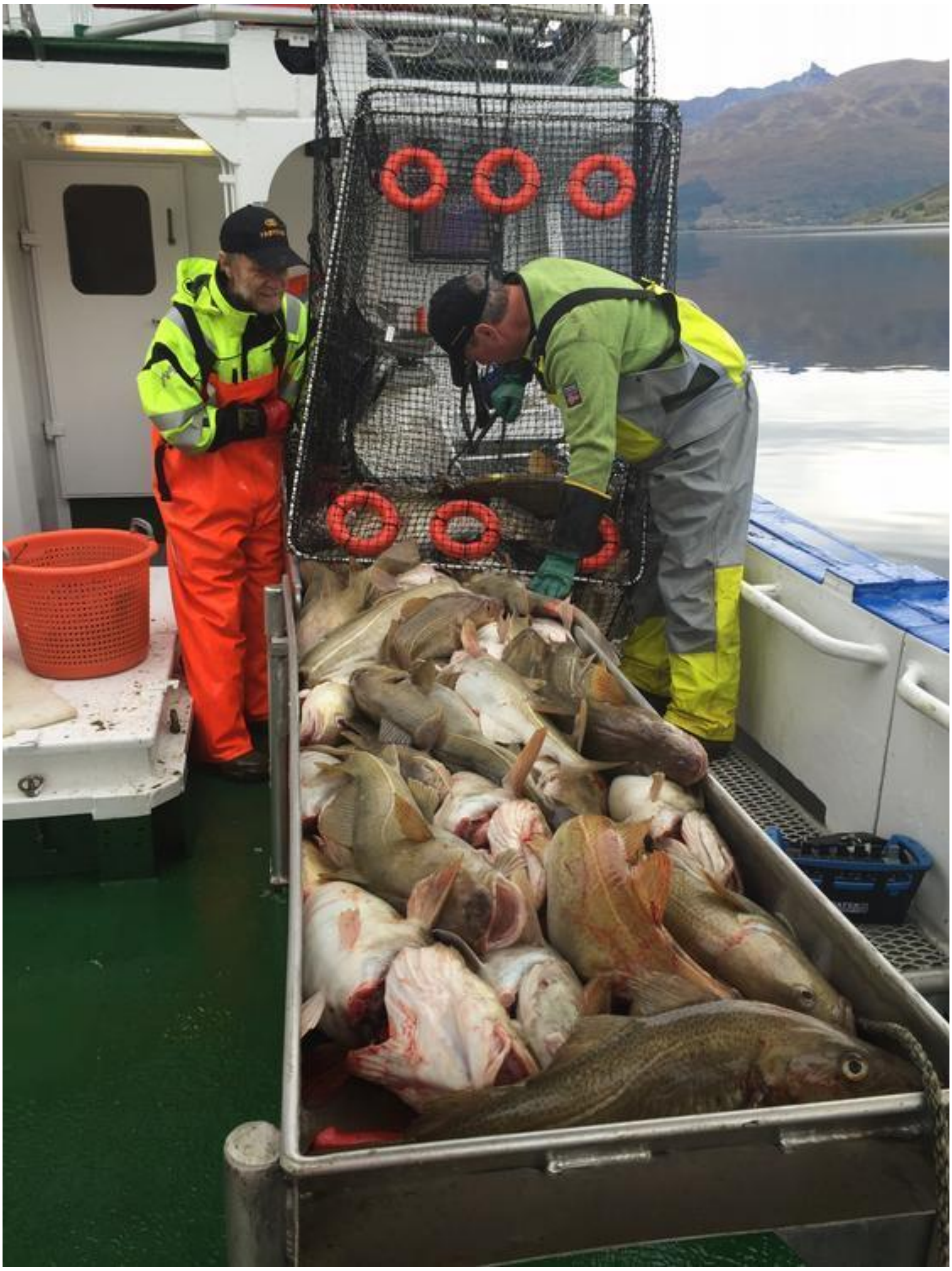
We still need more knowledge of the basic biology of krill and its attraction to light sources of different intensity, as well as the feeding behaviour of cod and its attraction to krill. Studies should be carried out in different areas and during different seasons to determine variations in distribution of krill and changes in cod feeding behaviour.

CONCLUSION

Pots typically have low capture efficiency for most groundfish species. The present findings suggest that an artificial light source may improve the efficiency of pots. Discards are low in pot fishery operations, and bycatch discard mortality is low (Davis 2002; Rudershausen et al. 2014). Thus, the development of a financially viable pot fishery as an attractive alternative to traditional fishing practices (e.g. gillnet) will lead to reduced discards.

Davis, M.W. 2002. Key principles for understanding fish bycatch discard mortality Can J Fish Aquat Sci 59: 1834–1843.

Rudershausen, P.J., Buckel, J.A. and Hightower, J.E. 2014. Estimating reef fish discard mortality using surface and bottom tagging: effects of hook injury and barotrauma. Can J Fish Aquat Sci 71: 1–7.



A catch of over 200 kg of large cod in a single pot surprises both the researchers and fishers onboard!

A cod, having already entered the fish pot, inspects a large swarm of krill and arrow worms attracted by white artificial light. Squid in the blue bait bag likely attracted the cod to the fish pot, while the visual stimulus of the swimming krill and arrow worms enticed it to enter.

Cod captured in pots with artificial lights had stomachs full of recently consumed krill, suggesting they were feeding on the swarms attracted to the light.

The MINOUW Consortium

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