

larger ring size but larger tooth spacing resulted in significant reductions in terms of weight and numbers of around 10%. Ring size and possibly tooth spacing had an influence on selectivity. No effect was found for mesh size and no significant interactions among the three factors were found.

Computer aided design software was used to simulate interactions between the scallops and likely selection features of the gear, while varying the size and shapes of those features. These results suggest that there may be scope for further increases in ring size while still retaining 100mm scallops.

Discussion: Adductor muscle energy charge is an index of a discarded scallop's vitality & likely survival.

Ghost fishing: Lost gillnets and unaccounted fishing mortality in the Greenland halibut fishery. Dag Furevik, Norway, presented by Ole Arve Misund

Abstract: In the gillnet fishery off the coast of Norway gillnets are lost from time to time but the magnitude of these losses is unknown. Further, the change in fishing capacity over time for lost gillnets is difficult to estimate. During a retrieval cruise using a heavy bottom grapnel system to recover lost gillnets, four fleets of recovered Greenland halibut gillnets were examined, with 27, 47, 30, and 30 nets in the four fleets respectively. Fish in these recovered nets were counted and classified as live, freshly dead, old, and unidentifiable. By assuming the maximum time a caught fish could remain in the "live" or "fresh" condition was one week, and knowing the time of loss of the gillnets, it was possible to estimate the catch rates. These were projected to be 9.8 to 18.7 tonnes of Greenland halibut per year per fleet.

Discussion: Norway has been conducting gillnet cleanup operations for about 8 years at a cost of around NOK 2.5 million/year. Losses are due to currents submerging the marker buoys and buoy lines being cut by other trawlers. Canadian ghost gillnet studies have shown similar estimates of ghost-fishing catch rates. Cleanup operations are coordinated to avoid gear being actively fished. Each year about 5,000 lost gillnets are recovered.

Possibilities for discard reducing in the shrimp (*Crangon crangon*) fisheries by means of electric pulses as an alternative stimulation. Hans Polet, Belgium

Abstract: In Belgium brown shrimps (*Crangon crangon*) are caught in the coastal zone by small beam trawlers with a maximum engine power of 221 kW (300 hp). Each vessel tows two beam trawls with a legal minimum cod-end mesh opening of 20mm. Once on board, the catch is processed with a rotating shrimp riddle that separates the commercial shrimp from the by-catch. Besides marketable fish, this by-catch often contains high numbers of undersized fish and a wide variety of benthic species, which is the catch fraction to be returned to the sea.

Several attempts have been made to reduce this by-catch by means of sieve nets or sorting grids. These methods are based on selection through net meshes or bar openings. The success will depend on the size of the animals and behaviour will play only a minor role, which is a problem in the shrimp fishery since the shrimps have a comparable size to the main part of the discards. An ideal selectivity device would induce a different behaviour between the target species (brown shrimps) and the non-marketable animals. The possibilities of electric pulses to reach this goal are being investigated in the present project. The project started in November 1997 and the first project phase, consisting of only lab-experiments to study behaviour and survival, was recently concluded. The aim of the project is to reduce the by-catch of juvenile flatfish, non-commercial fish species and benthic organisms and to reduce seafloor disturbance by reducing the bottom contact of the fishing gear.

With an electric pulse of 60 V and a frequency of 5 Hz brown shrimp will jump out of their resting position in the sand into the water column to a height between a few centimetres to 50 centimetres. Following species stayed on the bottom without moving under the influence of the pulses: plaice, sole, turbot, *Myoxocephalus scorpius*, *Agonus cataphractus* and shellfish species. Other species like dab, *Callionymus lyra*, *Cilliata mustela*, *Gobius spp* and several crab species like *Liocarcinus holsatus* and *Carcinus maenas* started a nervous movement but stayed very close to the bottom.

It is the intention to use this difference in behaviour to increase the selectivity of the groundrope. The bobbin rope will be altered to reduce bottom contact and avoid mechanical stimulation and to give the non-reacting species the opportunity to escape underneath the belly of the trawl. The electric pulses will be used as an alternative stimulation to bring the shrimps into the water column and within the reach of the net.

Survival experiments with animals in an electric field have been carried out for all species mentioned above and the survival was 100 % in all cases.

The second phase of the project, which started early this year, will focus on sea trials and further lab experiments with electric pulses with other characteristics.

Discussion: Most of the non-shrimp organisms stayed in their resting positions when experiencing the electrical stimulus, although some were seen experiencing tremors at a frequency similar to the pulse. Power is supplied either by cable from the vessel or by a battery pack attached to the beam.

Effects of cutting holes in lower panel of a beam trawl. Bob van Marlen, Holland

Abstract: Trials were conducted on RV TRIDENS in October 1997 and October 1998 to investigate whether the capture of benthic organisms could be reduced by cutting large meshes in the lower panel of a 12-m beam trawl. The 1997 experiments in which relatively small holes were cut out did not show any effect, and in 1998 it was decided to take bigger steps. The result was that some benthic species were indeed released more from the trawl (*Pagurus* spp. L.; *Acanthocardia echinata* L.; *Artica islandica* L. and *Aphrodita aculeata* L.) The penalty however was a significant reduction in target flatfish species, particularly sole, and to a lesser extent plaice and turbot. Further research is advocated to find a configuration that releases benthos without causing these losses in the target species.

Discussion: Most mortality of benthos was suffered by animals hit and passed over by the gear, not the ones picked up into the net, so allowing all of these to escape will have little beneficial impact. Sole very actively plunged downwards once over the footrope, even at the high towing speeds (4.5 kn) used in the studies. Belgian studies of large release openings for benthos showed similar results, and suggested that benthos "floated" down towards the codend. Holes cut into the after parts of the net might be more effective at releasing benthos, but at high risk of losing fish.

Effects of shrimp-trawling on abundance of benthic macro-fauna in a Swedish fjord. Mats Ulmestrand, Sweden, presented by P.-O. Larsson.

Abstract: The Gullmar fjord on the West Coast of Sweden has been protected from trawling since 1990. A large-scale experiment replicated in time and space was performed during 1996-97 to evaluate the potential effects of a resumption of shrimp trawling on the abundance and total biomass of benthic macro-fauna.

Samples were taken at six sites during four replicate times in July-November 1996. Three of these sites were thereafter trawled weekly until November 1997. Samples were taken at all sites at four times during the period July-November 1997. (In total 480 samples). This sampling design tests the hypothesis that the temporal variability in mean abundance and biomass of fauna in trawled areas will be different from areas that are not trawled.

Of the tested variables, the number of echinoderms was significantly affected by trawling. More specifically, the number of brittlestars, mainly *Amphiura chiajei* decreased by, on average, 30% in trawled sites whereas the number at the control sites did not change. Total abundance and total biomass were not significantly affected by trawling, although there was an overall tendency for a reduction at all sites during the experiment. The abundance of individual species generally decreased. After trawling, a larger number of species decreased in abundance at trawled sites than at control sites. However these differences were not consistent among sites. Except for the echinoderms, the power to detect trawl effects was very low for the total number of individuals, total biomass, and abundance of the major phyla (power <0.1). This indicates that the effect of trawling was very small compared to the natural variability.

The results of this experiment differ in many respects from most previous experiments on effects of trawling and dredging on benthic fauna. Compared to previous studies, the most striking difference is the relative weakness of observable effects of trawling on individual taxa. Most analyses in this study show strong temporal variability among trawled sites and among control sites, emphasising the need for replicated treatment sites or at least replicated control sites in order to logically interpret potential trawling effects.

A study of the gross effects of water jet dredging for razor clams in some Western Isles populations. Dr. Norman Graham, United Kingdom

Abstract: The effects of water jet dredging for *Ensis* spp. on the seabed and benthos were examined through experimental fishing. Immediate physical effects were apparent, with the dredge leaving visible trenches in the seabed. While these trenches had started to fill after five days, and were no longer visible after 11 weeks, the sediment in fished tracks remained fluidised beyond this period. The majority of the infaunal community is adapted morphologically and behaviourally to a dynamic environment, and other than initial removal through dispersal, is not greatly affected by the dredge. Species that are likely to be affected (e.g. *Echinocardium cordatum*, *Artica islandica*, and other large bivalves) were very rare in infaunal samples, but present in dredge catches, where damage was noted, and ranged on average from 10 – 28%. Epifauna were scarce in the study area, and unaffected by the fishing, except that epifaunal scavenging species were attracted to the fished tracks. On the evidence of the present study it would appear that there was little difference between the biological impact of hydraulic and suction dredging, although the latter may have a greater physical impact (larger trenches).