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Report of the Study Group on Turned 90o Codend Selectivity, focusing on Baltic Cod Selectivity (SGTCOD)

4-6 May 2011

MRI, Reykjavik, Iceland

ICES International Council for the Exploration of the Sea

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Executive summary

The third meeting of the ICES Study Group on Turned 90° Codend Selectivity, focusing on Baltic Cod Selectivity (SGTCOD) was held 4 - 6 May 2011 at IMR in Reykjavik, Iceland. The meeting was hosted by IMR and was attended by 7 scientists from 5 different nations and partly by 2 members from the local industry (netmaker Hampidjan).

The Study Group, chaired by Bent Herrmann and Waldemar Moderhak, was planned to run for 2009 - 2011. The objectives for the planned three year run of the group are:

- Evaluate the effect of turning diamond netting by 90⁰ (T90) on codend selectivity;
- Improve knowledge on the size selection processes in T90 codends compared to T0 codends (normal direction of diamond netting);
- Attempt to quantify the magnitudes of the effects of different factors (construction, generic netting properties, stock specific morphology, catch composition);
- Develop a guide on T90 codend constructions with respect to size selection properties and optimal construction; and,
- Review available data on fish survival and in particular cod escaping from T90 codends.

These objectives were planned to be reached by combining field experiments, laboratory experiments with nettings, laboratory experiments with fish morphology specific to Baltic cod and theoretical approaches (structural mechanics and computer simulations).

A number of presentations were therefore given during the third meeting on new experimental data and the analysis of these data since the second meeting. The importance of considering the number of meshes in the codend circumference for the size selection of cod in T0 and T90 codends based on some of these new data on Baltic cod was demonstrated in a scientific paper (Wienbeck et al. (2011)). Comparing these results with results from another set of new data further demonstrated that the effect of turning netting (from T0 to T90) is very dependent on netting twine characteristics. Based on acknowledgement of this new information, an experiment to study the effect of twine characteristics on size selection of Baltic cod in T0 and T90 codends in a systematic way was carried out since the second SGTCOD meeting. This research demonstrated that L50s for both single and double twine codends tend to decrease with twine thickness for traditional diamond mesh codends. For similar T90 codends the effect is not the same.

In January 2010, the mesh regulation for the fishery targeting Baltic cod was changed. Because of this size selection results from new experimental fishing with T90 and BACOMA codends complying with the new regulation were also presented at the meeting. An analysis of these results indicated increased evidence of a dual selection process in the BACOMA codend. This is probably a consequence of an increased imbalance between the window mesh size and the mesh size in the lower diamond mesh panel. A clear dual selection signature could lead to high selection range and could potentially lead to high discard rates or considerable loss of fish of legal size through codend size selection. To be able to investigate selective properties linked to survival rates of escapees, an experimental cruise was carried out to investigate and compare when during the fishing process Baltic cod escape from the T90

codend and to investigate if this pattern is different from what takes place in the other legal design, the BACOMA codend. The results demonstrated similar escapement patterns between the two types of codends except that more small cod escaped from the BACOMA codend during the towing process along the seabed.

Besides the new experimental data for size selection of Baltic cod in T0 and T90 codends, new data for size selection of cod from T90 codends applied in other fisheries were also presented at the meeting. This information included data from Norway and Denmark. The meeting also revealed that the planned data collection of morphology of Baltic Sea cod had also been carried out in accordance with the planned schedule, but that analysis of these data still remains to be carried out.

In general, much of the progress achieved by the group been possible due to the extensive vessel time provided by Germany for the experimental fishing necessary for the work of the group. Several other members of the group have participated in these cruises through planning the experimental design for the cruises, through joining the cruises and with analysis of the obtained experimental data. Overall, the meeting concluded that good progress has been made towards achievement of the final goals for the work of the group and that a very good collaboration has been established between the members of the group but that it will be difficult to complete the work within the planned three year life frame for the group, therefore the members of the group have agreed to ask ICES to extend the life frame of the group.

The report includes a short description of the main findings and the identified new actions necessary to help achieving the final objectives.

1 Introduction

Chairs: Bent Herrmann

Waldemar Moderhak

Rapporteur: Bent Herrmann

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- Attempt to quantify the magnitudes of the effects of different factors (construction, generic netting properties, stock specific morphology, catch composition);
- Develop a guide on T90 codend constructions with respect to size selection properties and optimal construction; and,
- Review available data on fish survival and in particular cod escaping from T90 codends.

These objectives were planned to be reached by combining field experiments, laboratory experiments with nettings, laboratory experiments with fish morphology specific to Baltic cod and theoretical approaches (structural mechanics and computer simulations).

2 Adoption of the agenda

The group adopted the following agenda for the meeting:

4 May

09:30 – 09:45 Welcome, Housekeeping Issues, program for the meeting (Host/Chairs)

09:45 – 10:00 Brief information on aims, goals and works done of the SGTCOD (Chairs)

10:00 – 10:15 Coffee break

10:15 – 10:45 Gear research in Iceland with attention to T90 (H. Einarsson)

10:45 – 11:30 Underwater observations of T90, T0 and Bacoma codends (W. Moderhak)

11:30 – 12:00 Mesh penetration experiments with live fish on Solea 636

(L. Krag)

12:00 – 13:00 Lunch

13:00 – 14:30 Presentation from netmaker Hampidjan on deployment of T90 constructions in trawl for Icelandic fishery (H.)

14:30 – 15:30 The effect of twine characteristics on size selection of Baltic cod

in T0 and T90 codends:

A: data collection on Solea cruise 636, including movie (H. Wienbeck)

B: modeling and analysis of data (B. Herrmann)

15:30 – 15:50 Coffee break

15:50 – 16:20 Analysis of discard from T90 compared to T0 and BACOMA (W. Moderhak)

16:20 – 16:50 Comparison of the escapement pattern from a T90 codend and a BACOMA codend – data from Solea cruise 630

(B. Herrmann)

16:50 – 17:20 Follow up on planned actions from last meeting (Chairs)

5 May

09:00 – 17:00 ***Excursion*** to one Icelandic trawl maker that use T90 constructions in trawl manufacturing and visiting fishing harbor including a trawler which uses T90 constructions.

6 May

09:00 – 10:00 General discussion, the way ahead after three years run of SGTCOD (Chair)

10:00 – 10:15 Coffee break

10:00 – 12:00 Discussion on new actions of the group (Chairs)

12:00 – 13:00 Lunch break

13:00 – 15:00 preparation of report (Chair)

15:00 – 15:30 Concluding remarks and closure of the meeting (Chairs)

Summary of relevant results from presentations and other activities during the meeting (third meeting)

2 Summary of relevant results from the presentations and other activities during the meeting (third meeting)

According to the agenda were a number of presentations given during the meeting. Below is given a short summery of the most important results reported in the presentations and from the workshop.

2.1 Combined analysis of experimental data for four different codends made of *Redline* netting

Initiated by an action proposed at the first meeting (A1.4 , see section 3) the size selectivity of four different codends made of same type of netting was assessed on a German research cruise (Solea 610) with Harald Weinbeck as cruise leader and a number of the other members of SGTCOD participating (Waldemar Moderhak, Daniel Stepputtis, Bent Herrmann). The objective of the experiment was to be able to assess to what extent turning codend netting 90 degrees (T90) and halving the number of meshes (from 92 to 46) in the codend circumference contribute alone and in combination to the improvement of codend size selection of Baltic cod compared to in a traditional diamond mesh codend (T0). Although the netting used was not identical to that used in a previous simulation-based study on haddock most results were find to be in line with the predictions with predictions from simulations. Both halving the number of meshes in the codend circumference and turning the netting direction 90 degrees had a statistical significant and positive effect on the size selection of Baltic cod. The best results were obtained in the codend in which both factors were applied together. For this codend, very little between-haul variation in the size selection, especially compared to the reference codend in which none of the factors were applied was observed. These results demonstrate that turning the codend netting 90 degrees can significantly improve the size selection of Baltic Sea cod compared to a traditional diamond mesh codend. But results from the data analysis (using the SELNET tool) also showed that for the specific netting type applied that 71% of the total increase in L50 for Baltic cod by applying both factors (turning netting 90 degrees and halving number of meshes in codend circumference) and be achieved by only halving the number of meshes in the codend circumference. Because the current Baltic fishery management is based on detailed technical regulations, the results also demonstrate how important it is that the implemented T90 legislation takes into account the number of meshes in the codend circumference. A further consequence of the importance of meshes around in codend circumference on the selective properties of a T90 codend is, that this effect has to be considered when comparing size selection for T90 and BACOMA codends. Thus, this comparison should preferable be done for an optimized T90 regarding number of meshes around. Results reported are specific for the netting applied (5 mm single twine polytit COMPACT) and should in general not be extrapolated to codends made of other twine constructions. Fig. 1 show the netting applied stretched as T0 (left) and as T90 (right).

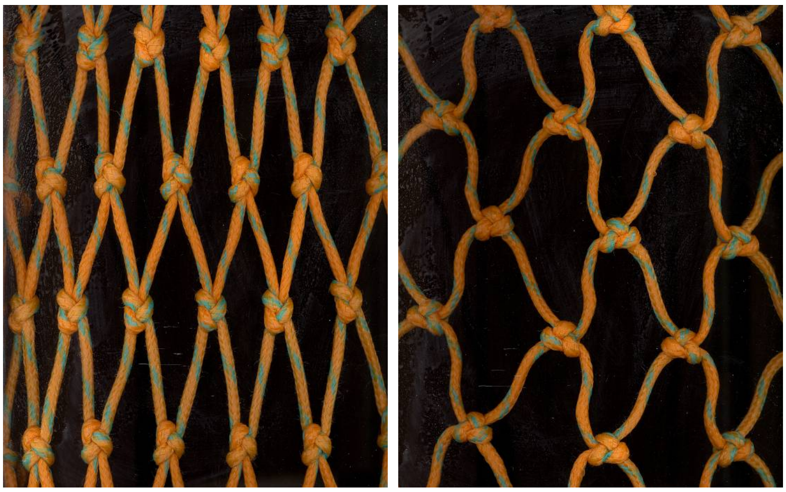

Fig. 1. Polytit COMPACT (redline) applied for the codends.

Fig. 2 show mean Selection curves for the four codends tested.

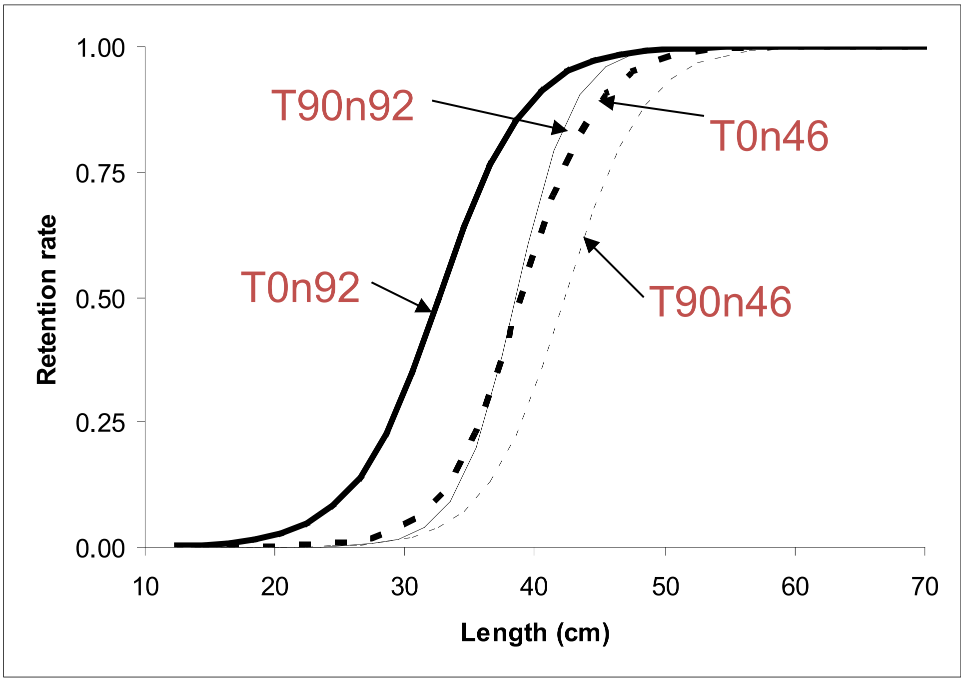

Fig. 2. Mean selection curves for the four codends tested.

The study reported here is detailed described in a scientific paper being published in the journal Fisheries Research ("Effect of netting direction and number of meshes around on size selection in the codend for Baltic cod (Gadus morhua)" by Wienbeck, H., Herrmann, B., Moderhak, W., Stepputtis, D. Doi: 10.1016/j.fishres.2011.01.019).

2.2 New experimental results obtained for codends made of Dyneema netting

A German research cruise (Solea 619) carried out in MAR 2010 tested the size selection of Baltic cod in codends made of 2.5 mm single twine dyneema netting (double knotted). Three codends were tested T0n88 (standard diamond mesh codend with 88 open meshes in codend circumference), T0n44 (standard diamond mesh codend with 44 open meshes in codend circumference) and T90n44 (90 degree turned netting (T90) codend with 44 open meshes in circumference). The objective of the study was two-fall: 1) to establish basic values for the L50 for Baltic cod size selection in the thin twine Dyneema netting; 2) to demonstrate using the results reported in section 2.1 that the relative effect of turning netting by 90 degrees or halving the number of meshes in the codend circumference can be considerable dependent on the twine characteristics of the codend netting. The German research cruise had participation of a number of the members of SGTCOD: Harald Wienbeck (cruise leader), Daniel Stepputtis, Waldemar Moderhak, Ludvig Krag, Bent Herrmann. Fig. 3 show the netting and one of the codends.

Fig. 3. Dyneema single 2.5 twine and codend (right) applied during the cruise.

The data analysis was carried out in the analysis tool SELNET using the method described by Fryer (1991) considering netting direction and number of meshes in codend circumference as fixed effects. The analysis showed that halving the number of meshes in the codend circumference statistical significantly increased L50 for Baltic cod. While no additional effect was obtained by additional turning the netting to T90. Fig. 4 show the mean selection curves for the three codends tested during the cruise.

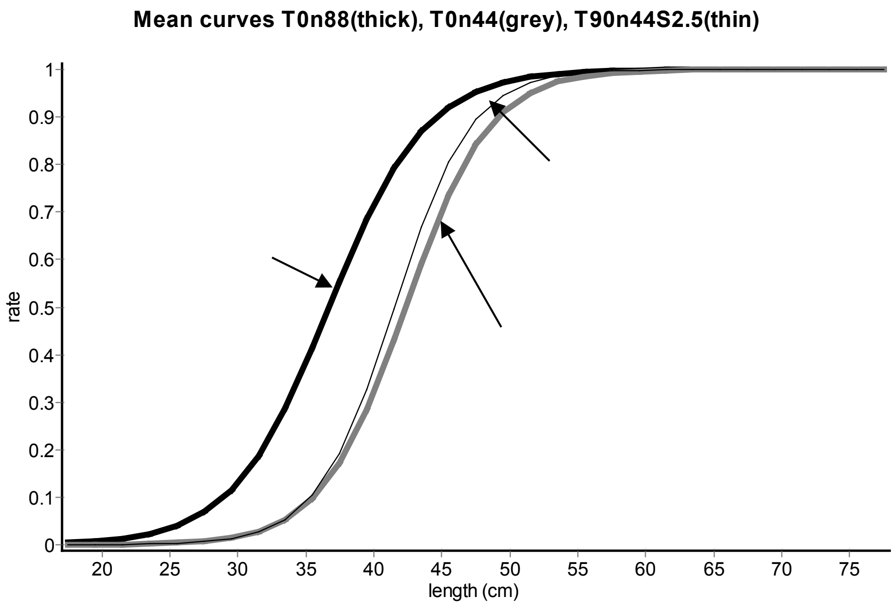

Fig. 4. Mean selection curves for the three codends (T0n88, T0n44, T90n44) tested during the cruise.

Based these results together with the one reported in section 2.1 it is evident that codend twine characteristics will have considerable influence on the achievable improvement of size selection of Baltic cod by turning codend netting 90 degrees compared to a traditional diamond mesh codend. Based on this observation the need for a systematic investigation of the effect of codend twine characteristics on the size selection of Baltic cod was obvious. This resulted in the proposal for a new action for the group (see section 4 action A2.1).

2.3 New experimental results obtained for codends complying with the new regulation in Baltic Sea

The German research cruise Solea 619 mentioned in section 2.2 additional included experimental fishing with both a T90 codend and a BACOMA codend which comply with the new legislation for the Baltic Sea (from 2010). Thus besides a T90 codend with mesh size of 127 mm a BACOMA codend with square mesh panel mesh size 129 mm and a lower layer diamond mesh panel with mesh size 105 mm was tested using the codend method. Fig. 5 show results from analysis of the average selection for the two codends based on using a double bootstrapping method in the analysis tool SELNET using the S2Logit curve to describe the experimental data.

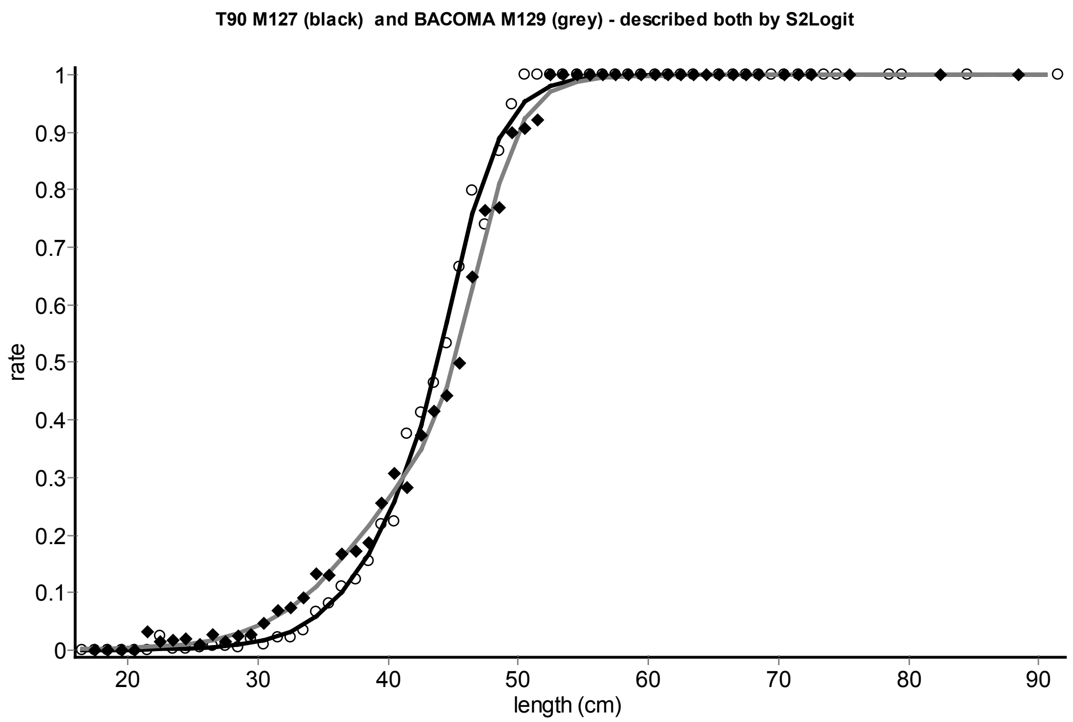

Fig. 5. Average size selection for new T90 codend (black curve) and new BACOMA codend (grey curve).

Even through the BACOMA M129 have a bigger average L50 than the T90 M127 codend it will retain more small individuals as the lower part of the selection curve is very flat. This flat part of the BACOMA codend average selection curve could be interpreted as an indication of increased signature of a dual selection process in the BACOMA codend probably resulting from increased unbalance between the window mesh size and the lower layer mesh size in the diamond mesh panel. A clear dual selection signature could lead to high selection range and could potentially lead to high discard rates or considerable loss of fish of legal size through codend size selection. The dual selection hypotheses is further supported by that the traditional Logit curve mostly applied to describe experimental selection data is very poor at describing the BACOMA size selection data for Baltic cod compared to a S2Logit curve (implemented in SELNET) which can account for a dual process. This is demonstrated on Fig. 6.

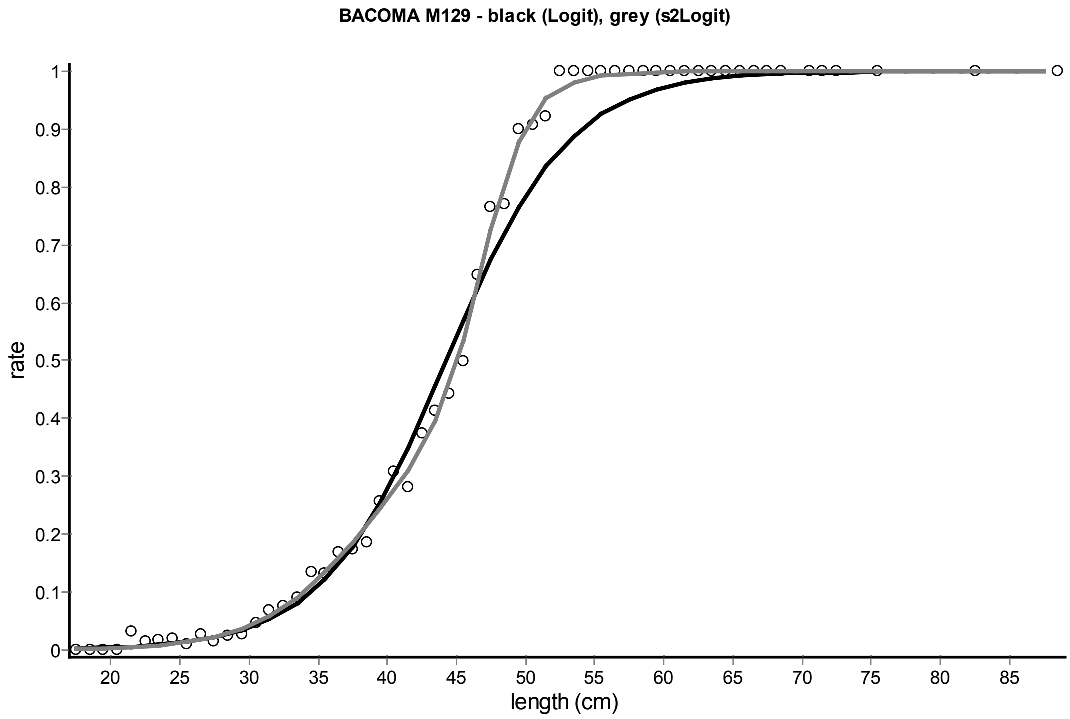

Fig. 6. Fit of Logit curve (black) and S2Logit curve (grey) to the BACOMA average size selection data.

From Fig. 6 it is clear that using a traditional Logit curve in estimation of for example estimate expected discard rates or loss of legal sizes could lead to considerable bias in results and thus very unreliable results.

The SGTCOD group agreed that it would be relevant to study this phenomena more in detail because the BACOMA codend at the time being is the only legal alternative to the T90 codend (new A2.3, see section 4).

2.4 Danish selectivity experiments comparing T0 and T90 with focus on escapement during different phases of the fishing process

Sea trials were carried out in the Northern Kattegat and the Skagerrak. The objective of the experiment was to compare the size selectivity of a T90 codend with a standard codend constructed of the similar netting mounted in standard direction. The codends are fished simultaneously in a twin trawl rig but using the covered codend method. A new codend cover design with two separate collecting bags was developed to assess escape during haul-back separately from during towing at the seabed, because escape during haulback might cause additional unaccounted mortality. Sea trials were conducted from commercial vessel with Niels Madsen as cruise leader. The two codends were made of the same nominal 90 mm 4 mm double Polyethylene (PE) netting. Both codends had 100 meshes in circumference including 4 meshes in each selvedges. The analysis for each codend was analyzed fitting a dual sequence model to the data. The dual sequence model can explicit account for that not necessary all individual are able attempt to escape from the codend during the towing along the seabed. Therefore is this type of model is especially suited to describe the three-compartment experimental data with separate collecting covers of escapists during towing and during haulback operation (including at the surface) which results from the experimental design applied. Data was analysed to model the length dependent overall codend retention, escapement during towing and escapement during haulback operation on average for the group of hauls. To mitigate underestimation of parameter confidence limits by a double bootstrap method accounting for both within and between-haul variation in the escapement processes was applied. Data was analysed using the software tool SELNET.

Fig. 7 plot the average results obtained for cod during the experiments.

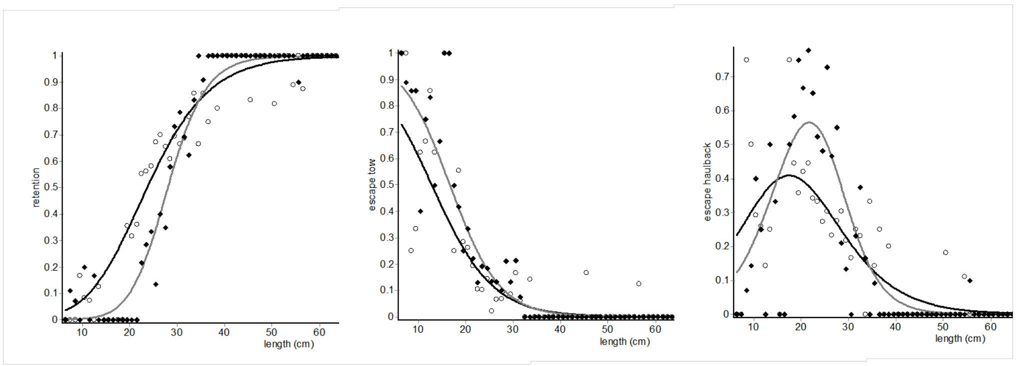

Fig. 7. Results for cod for T0 (black curve) and T90 (grey curve): overall codend retention (left), escape during towing (middle), escape during haulback operation (right).

As Fig. 7 indicate was the escapement rates during towing (middle plot) higher for T90 compared to the for T0 codend. While there was a weak indication of that more very small cod might be escaping during haulback which in turn could affect their mortality in a negative direction. Overall the results indicate that the T90 codend might have a bigger L50 for cod compared to the similar T0 codend. But unfortunately was none of the results for size selection of cod in the T0 and T90 codends statistical significantly different. However this can be related to the limits number of cod in the trial. Term conclusions for cod can thus not be made on basis of this dataset. It was therefore also impossible to judge whether or not all cod actually attempt to escape during towing or not from analysis of this dataset.

Besides data for cod did the experiment provide results for plaice and nephrops and these data were much stronger compared to for cod. Fig. 8 plots the results for plaice while Fig.9 contains results for Nephrops.

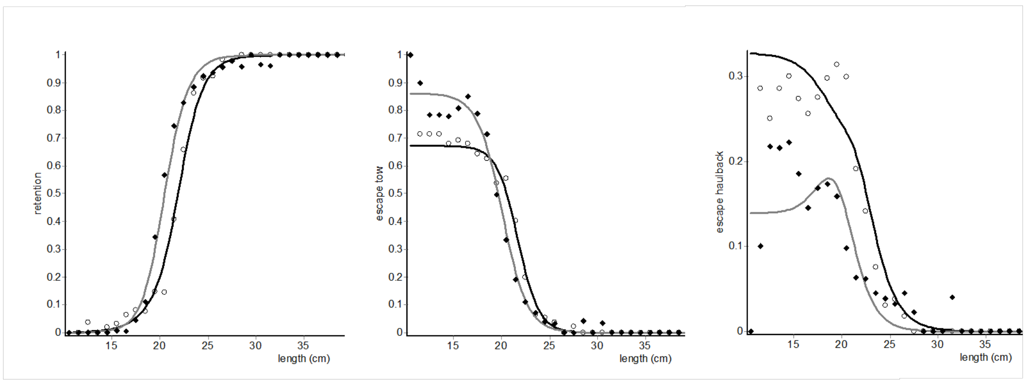

Fig. 8. Results for Plaice for T0 (black curve) and T90 (grey curve): overall codend retention (left), escape during towing (middle), escape during haulback operation (right).

For plaice the overall L50 was found to be significant small for the T90 codend compared to for the T0 codend (left plot on Fig. 8). This could likely be related to that the morphology of a flatfish like plaice fits better to a more closed diamond mesh compared to a more open T90 mesh having a shorter inside horizontal opening. Interesting does the results for both T0 and T90 codends show that not all plaice actually make attempt to escape during towing (middle plot in Fig. 8). This effect is statistical significant. The curves indicate that more very small plaice escape from the T90 codend during towing (< 18 cm) compared to the T0 codend. But it has not yet been investigated if this effect is statistical significant. In general is the escapement rate higher for the T0 codend during haulback operation (right plot in Fig. 8) compared to for the T90 codend.

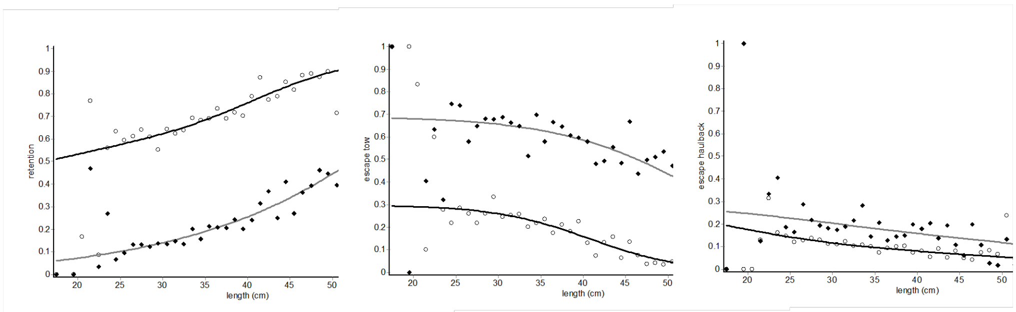

Fig. 9. Results for Nephrops for T0 (black curve) and T90 (grey curve): overall codend retention (left), escape during towing (middle), escape during haulback operation (right).

For Nephrops was the retention rates generally much higher for the T0 codend for all cl compared to for the T90 codend (left plot in Fig. 9). The difference for was significant different for all length between 25 and 49 mm. For both codend did most of the escapement occur during towing (compare middle and right plot in Fig. 9). With a minimum landing size at 40 mm the results demonstrate that introducing this T90 design into the fishery would result in a considerable loss of legal sizes compared to the T0 codend.

Results from this experiment will be detailed described in a scientific paper.

2.5 T90 experiments from Norway

These experiments were carried out onboard *R/V Jan Mayen* (63.8 m LOA and 4080 HP) during March and April 2010. The fishing grounds were off the coast of Troms (north of Norway. The experiments were conducted by the University in Tromsø with the Manu Sistiaga and Roger Larsen in charge of the experiments. Data was collected for cod and haddock. The covered codend method was applied. The purpose of the cruises to test a 135 mm (nominal) mesh size T90 codend constructed of 8 mm polyethylene single twine (type: Cotesi greenline Fig. 10). The codend had a total length of 12.50 m and was constructed in two panels with three sections that included a 2½ T0 diamond mesh section in front and a 4½ T0 diamond mesh section closest to the codeline. The main T90 diamond mesh section was built from 150 x 25 meshes. Two meshes from each side of each panel were fixed to the lastridge.

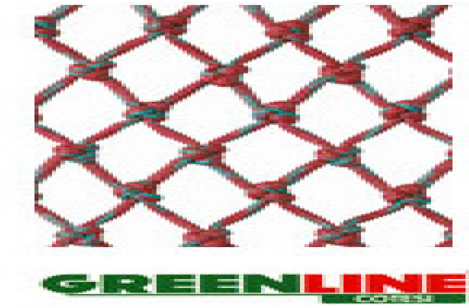

Fig. 10. codend netting applied during the cruises.

Contrary to the scientific cruises conducted in the Baltic Sea with T90 did the Norwegian cruise enable testing how the size selectivity of T90 codends might be affected by very big amounts of catch in the codend. The cruises included hauls where the total catch in the codend exceeded 4000 kg. Analysis was carried out in SELNET considering codend catch weight at end of haul as a fixed effect and using the method described in Fryer (1991) for handling fixed effects. For one of the two datasets was L50 for cod found to decrease significantly with increased codend catch. This is shown on Fig. 11.

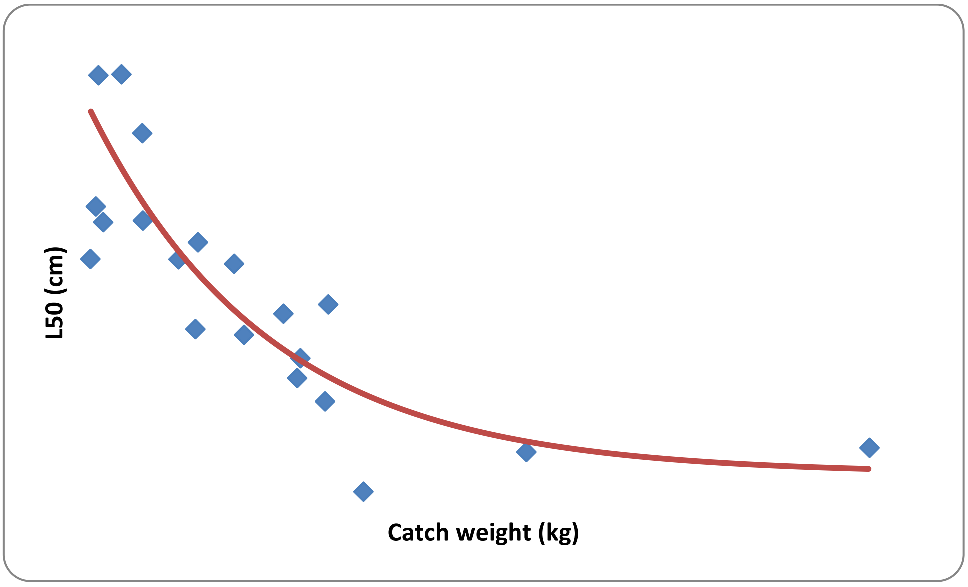

Fig. 11. L50 for cod vs codend catch weight for T90 codend applied during norwegian experimental fishing. The marks represent experimental results for individual hauls while the curve represents the fit of formula (1) to the data applying the method described in Fryer (1991).

The model applied in SELNET on the graph in Fig. 11 is of an exponential type (formula 1) because this provided a better description based on AIC-value than the simple polynomial models offen applied. The following model was applied:

$$L50 = L50_{intercept} + \Delta L50_{w} \times \exp\left(-\frac{w}{1000}\right) \qquad (1)$$

The results from Norway demonstrate the relevance of including data in the analysis at commercial catch levels if possible when investigating the size selective properties of T0 and T90 codends.

2.6 The FISHSELECT approach to investigate codend selection in Baltic Sea

According to what was planned at the first SGTCOD FISHSELECT data (see Herrmann et al. 2009) was collected for Baltic Sea cod. This information will help investigating the relationship between the size selection and fish morphology and codend mesh geometry in T0, T90 and BACOMA constructions. The data collection was carried out on Solea Cruise 619. Besides for cod was FISHSELECT data as well collected for plaice, flounder, dab, turbot and whiting. Except for turbot was very strong datasets collected for all the species. The analysis of data has not yet been completed but all morphometric data have been processed.

2.7 Theoretical approach to the T90 codends selectivity

The selective properties of a T90 codend depend on the proper shape of the T90-meshes. The mesh opening is determined by the forces acting on mesh bars, and by the twine stiffness (thickness). Based on the opening mechanism of T90 meshes and the cross sectional shape of Baltic cod, it is possible on a way of theoretical calculation to find the optimal mesh bar thickness that will create the best conditions for release of juvenile and undersized cod (Figure 12 and Figure 13). Both at low and at high values of stiffness (thickness) the length of escaping cod is smaller. At low twine thickness the T90 mesh is far stretched and then meshes are relative small open, and at high thickness the lengthwise opening is also small.

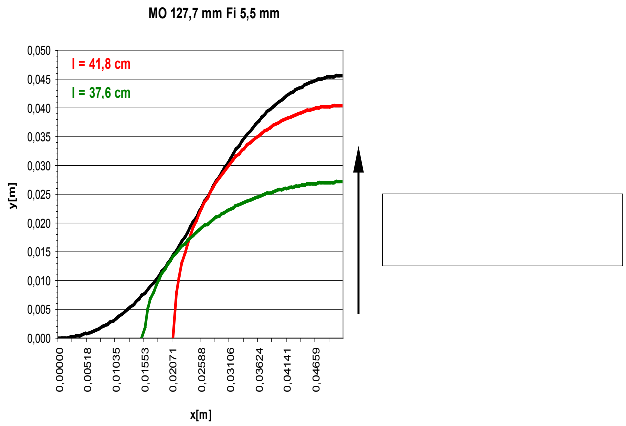

Fig. 12. Length that cod can escape from a T90 codend (black is the deformed T90 mesh bar and red ("Vertical" position of cod) or green ("Horizontal" position of cod) the cross section of the fish).

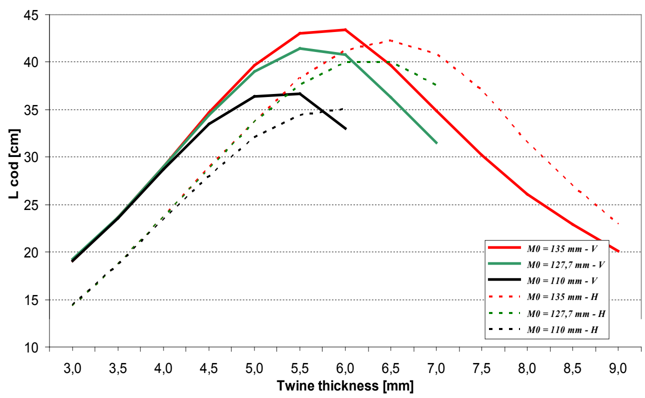

Fig. 13. Calculated length of cod vs. twine thickness for T90 codends.

3 Follow up on actions from the previous meetings

During the first SGTCOD meeting (Ancona MAY 2009) and the second meeting (Hirtshals August-September 2010) a number Action Items (tasks) were proposed for the group to be able to achieve the terms of reference. Totally 13 actions (A1.1 – A1.10 + A2.1-A2.3) were proposed to the group. Since the first meeting considerable progress has been made for many of the actions and some have been finalized. For a few actions no progress has through been achieved and it is questionable if it will be possible for the group to make progress on these. The table below summarize the actions from the first meeting and comment on their status.

Action Item Title/No.	Responsibility	Schedule/Status	Comments
Collection of Morphology data for Baltic Sea Cod and Flounder. A1.1	Harald Wienbeck & Bent Herrmann	Oct 2009 Data has been collected for 6 speices including cod and flounder. Data are partly processed but analysis remain.	Use FISHSELECT in Lab. Fac. In Rostock. Combined with sea trials. Data collection was carried out at sea (Solea cruise 619)
Review existing underwater recordings and propose new recordings for different netting materials. A1.2	Harald Wienbeck Waldemar Moderhak Bent Herrmann	Partly being carried out. But Some new recording would be benificial	Waldemar to visit Harald July 2009
Systematically go through and review selectivity data collected so far (All T0, T90, BACOMA). A1.3	Harald Wienbeck Waldemar Moderhak Bent Herrmann	In good progress	Scientific papers planned
Propose new German sea trials to collect covered codend selectivity data for 4 different codend designs. A1.4	Harald Wienbeck to coordinate with Bent Herrmann	Before May 2010. Finalized. Data collected on Solea cruise 610. Data analyzed and a scientific paper published (Wienbeck et al. 2010)	Redline PE, twine single 5mm, mesh size 110mm nom. A: T0n92, B: T0n50, C:T90n92, D:T90n50. n means number of open meshes. The experimental design has to comply with the scientific justification for the work of the group. Extension pieces to be identical for all four designs (T90 n50?). Maybe there are some practical problems that will lead to a lower number of meshes around for the n92 designs. This needs clarification before the experiment is done.
To propose to UIT to conduct a T0, T45 and T90 selectivity experiment in the Barents Sea (cod and haddock). A1.5	Manu Sistiaga to consult Waldemar Moderhak on design	Before May 2011. A sea trial with a T90 codend was been carried out in Barents Sea. Provisorial results presented at SGTCOD 2010 meeting.	Setup preferable in a twin rig with covers on both side. Mesh size 135 mm. in all cases n is identical.

To propose to CNR to conduct a T0, T45 and T90 selectivity experiment in the Mediterranean Sea (Red mullet and Hake). A1.6	Antonello Sala To consult Waldemar Moderhak on design	Sept. 2010 No progress reported during third meeting	Setup covered codend method. Mesh size 40 mm. Matrix design with 6 configurations (n 280 as baseline design + n expected optimal for T90 design)
To make lab. Experiments with different nettings used as T0 and T90 under different loading conditions record and analyze shapes of single meshes. A1.7	Bent Herrmann Harald Wienbeck to help on providing specific nettings	Before end of 2009. Netting provided. But experiments have not been carried out yet.	NETVISION method. The group to help defining and providing relevant nettings for the experiment.
To carry out testing of mesh opening stiffness, breaking elongation and neutral angle for the same nettings materials as had or will be used during the sea trials. A1.8	Antonello Sala	No progress reported during third meeting	To apply a similar procedure as in EU project PREMECS
To use two different models to estimate shapes of T0 and T90 codends (Baltic Sea) for different amount of catches. With the intention to use PRESEMO to simulate size selection of cod. A1.9	Daniel Priour Waldemar Moderhak Bent Herrmann	Shape calculations for codends used in A1.4 have been provided by Priour.	Designs to be defined June 2009. Catch weights up to 10000 kg. Model 1: FEMNET (Priour) Model 2: model of Moderhak.
To use two different models to estimate shapes of T0 and T90 codends (Mediterranean Sea) for different amount of catches. With the intention to use PRESEMO to simulate size selection of Red Mullet and Hake. A1.10	Daniel Priour Waldemar Moderhak Antonello Sala Bent Herrmann	No progress reported during the third meeting	Designs to be defined June 2009. Catch weights up to 500 kg. Model 1: FEMNET (Priour) Model 2: model of Moderhak.

Propose new German covered codend sea trials to systematically investigate the influence of twine characteritics on codend size selectivity of Baltic cod. A2.1	Harald Wienbeck Bent Herrmann Waldemar Moderhak	The sea trial was carried out succesfully Marts 2011. Data are partly analyzed. Preliminary results was presented during the third meeting	The same netting should be applied for both T0 and T90 codends. Both single (s) and double(d) twine netting should be tested. Meshsize should the same for all designs (120 mm to comply with new regulation) and number of open meshes in codends circumference should be the same (50). Number of meshes in selvedges should be the same. The follwing design configurations should the used both as T0 and T90 : 3d, 4s, 4d, 6s, 6d, 8s. The same type of material should be applied to construct all codends (could be Polytit COMPACT). All codends should tested attached to the same extention piece (T90 d5, 50 open meshes around, meshsize 120)
Propose new German covered codend sea trials with dual sampler to escapement pattern of Baltic cod escaping from T90 and BACOMA codends. A2.2	Bernd Mieske Niels Madsen Daniel Stepputtis Ludvig A Krag Bent Herrmann	The sea trial was carried out succesfully November 2010. Data are partly analyzed. Preliminary results was presented during the third meeting	Bernd Mieske to consult Niels Madsen to build on experience and equipment from DTU AQUA
To investigate further the dual selection in BACOMA codends including proposal of new German sea trials to improve knowledge and find designs to mittigate this effect. A2.3	Bent Herrmann Harald Wienbeck Daniel Stepputtis Bernd Mieske	Some new German data was collected with splitted cover setup between december 2010 and february 2011. Based on discussions between members of SGTCOD was the content in this proposed action extended. This	Re-analyse existing data collected by Harald Wienbeck and split coverdata collected by Bernd Mieske. Consider new experiments.

4 New actions proposed at the third meeting

Based on the discussions during the presentations two new actions for the group were identified and proposed (A3.1, A3.2). These new actions are listed in the table below.

Action Item Title/No.	Responsibility	Schedule/Status	Comments

Propose new German sea trials on research vessel which together with in between long term testing on German and Danish commercial vessels enables investigating effect longterm use (ageing of codends) has on the size selection of cod in T90 and BACOMA codends applied in Baltic sea. A3.1	Daniel Stepputtis Bernd Mieske Bent Herrmann Ludvig Krag	To conduct the initial trials October 2011	Three pairs of a T90 (m120 double 4 mm twine) and a BACOMA (120 mm) codends are initially fished on a research vessel to assess their size selectivity as new codends. Then two of the pairs are fished commercially (one on a German vessel and one on a Danish vessel) for a considerable period. After the use of the gears under the commercial conditions the two pairs are again test om a research vessel together with the last pair in selectivity trials. Selectivity trials are preferable carried out in a double covered twin setup to boost the power in the comparisons.
Propose new sea trials to further study the dual selection processes in BACOMA codends and compare the they size selection to those a reference T90 codend and those of a full square mesh codend. A3.2	Harald Wienbeck Bent Herrmann	September 2011	The main purpose is to further investigate the potential dual selection process in BACOMA codends for trawl fishery targeting Baltic cod. The baseline for the research will be the legal BACOMA 120 design (design 1) which is expected to show some weak indication of dual selection. Mitigating the dual selection properties of the standard BACOMA 120 design is attempted by increasing the selective properties of the lower panel diamond mesh netting by replacing the existing 105 mm double 4 mm twine with a 130 mm single 4 mm with reduced numbers in circumference (design 3). To further demonstrate the risk of dual selection in BACOMA-like designs a special BACOMA 140 design is made where the selective properties between the upper and lower panel is increased by using the diamond 105 double 4 mm in the lower panel (design 2). This should make extreme dual signature in BACOMA if possible and by such highlighting the mechanism. Another way (than design 3) to try to remove a dual process is to base selection only on the square-mesh BACOMA window, which will also explore the full selective potential of this is to make a codend completely of ultra cross 120 (two panel construction))(same as applied for the window in design 1 and 3). This is done in design 4. To have a reference to the other legal design a 5. Design being T90 120 sin-

			gle 4 (polytit compact) with 50 meshes around is also used. The same extension piece should be used for all designs. Extension should be T0 diamond mesh 105 double 4 two panel construction with 100 open meshes around. 9 hauls should be made with each design also enabling investigating if the between haul variation for the different design would be different. Maybe for example the full square mesh codend would show less between-haul variation in the selection process compared to the BACOMA's and the T90. But maybe the T90 is a cost effective way to get something with nearly the same selective properties.

5 Conclusion

The work of the group is in good progress including gaining knowledge of the fundament mechanisms of importance for size selection in T0 and T90 codends. Scientific documentation of the work of the group is in progress. But it will be difficult to finish the work and the documentation of it within the planned three year run of the group.

So far the following provisional scientific conclusion can be made on the basis of the progress in the understanding:

- Number of meshes around needs to be considered. (effect being experimentally predicted by Galbraith et al. 1994 and theoretically for other species by O'Neill & Herrmann 2007, Herrmann et al 2007 and Sala et al 2007). – is considered in current legislation for use of T90 in Baltic Sea trawl fishery.
- The "T90-effect" (= the improvement of size selectivity by turning a specific codend netting by 90 degrees compared to the same T0 design) is very dependent on netting properties (Twine, material,..) – it depends on simple mechanical properties!!
- We begin to understand these mechanisms meaning we can begin to move from religion to science regarding the "magic" about T90!!
- A lot of old data can now be re-analyzed in the frame of the new scientific view being established

Regarding the participation in the second SGTCOD meeting would we have hoped that more than the 8 participants covering 3 different nations around the Baltic Sea would have participated (Annex 1). But obviously did the cancelation and rescheduling of the meeting prevent some members from participation. Together the members of the group represent experiences and skills on the necessary scientific disciplines both experimentally and theoretically to enable the necessary work to be carried out. Even more importantly do members of the group have access to vessel time to carry out the experimental fishing proposed as actions for the group being vital for the fulfilment of the terms of reference. Members in the group also represent practical knowledge about the fishery in the Baltic Sea to ensure the case study for the Baltic Sea cod can be carried out in a relevant way. It is though critical that the members are able to continue participating in the group work in the final year of the group.

Request to ICES

SGTCOD request ICES to prolong the lifespan of SGTCOD with one year to cover the period 2009-2012. The justification for this request is simply that given the amount of experimental data that needs to be analyzed together with the availability to conduct additional experiments which will be helpful for meeting the terms of reference for SGTCOD makes it necessary to prolong the time for SGTCOD to take advantage of the opportunity to improve the outcome of the group. The decision to request the prolongation of the time span for SGTCOD was supported by all participants at the third SGTCOD meeting.

Annex 1: List of participants

Name	Institute	E-mail
Bent Herrmann	Denmark Technical University	bhe@aqua.dtu.dk
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Annex 2: SGTCOD Draft Resolution for the 2012 meeting

The **Study Group on Turned 90˚ Codend Selectivity, focusing on Baltic Cod Selectivity** [SGTCOD] (Co-Chairs: Bent Hermann*, DIFRES, Denmark and Waldemar Moderhak* MIR, Poland) will have a meeting in Rostock, Germany on 3 - 7 September 2012 to:

a) evaluate the effect of turning diamond netting by 90° (T90) on codend selectivity.

a) improve knowledge on the size selection processes in T90 codends compared to T0 codends (normal direction of diamond netting).

b) attempt to quantify the magnitudes of the effects of different factors (construction, generic netting properties, stock specific morphology, catch composition)

c) develop a guide on T90 codend constructions with respect to size selection properties and optimal construction; and

d) to compare the selective properties of T90 codends with those of the other legal designs in the fishery targeting Baltic cod.

e) review available data on fish survival and in particular cod escaping from T90 codends.

SGTCOD will report by 15 October 2012 for the attention of the SGESST.

Supporting Information

Priority:	The current activities of this Group will lead ICES into issues related to the effectiveness of technical measures to change size selectivity and fishing mortality rates. Consequently these activities are considered to have a very high priority
Scientific justification and relation to action plan:	Action Item 3.16, 3.17, 3.18, 5.8, 5.11, 5.16, 6.3 The use of T90 codends is legal in the Baltic Sea cod fishery and there is an increasing global interest in using T90 for towed fishing gears. The basic mechanisms governing T90 performance are, however, not well understood or quantified. In order to address this it is proposed to set up a Study Group specifically to look at all issues relating to the use of T90 netting as a means of improving selectivity. The objectives will be reached by combining field experiments (size selectivity experiments), laboratory experiments with nettings (loading by different forces comparing mesh openness), laboratory experiments with fish morphology specific on Baltic cod (FISHSELECT) and theoretical approach (structural mechanic for bending of mesh bars under load and computer simulations). A case study on Baltic cod will be conducted. We expect that the benefit of T90 on size selectivity will depend on the netting panel construction (twine thickness, twine stiffness, single/double twine, ratio between mesh sizes (mesh bar)/twine thickness). Therefore all T90 experiments should be evaluated against a baseline of experiments with similar diamond mesh codends (T0) made of the same netting and having the same number of meshes around. For the comparison of results from sea trials regarding the performance of T90 it is important that the trawl designs in front of the codends (T0 and T90) are identical. It is also important that the experimental design take into account potential confounding effects like vessel size. The level of unaccounted mortality of cod escaping through T90 codends will also be

	considered specifically for the Baltic.
Justification of Venue (in a non-ICES Member Country)	See Justification under WGFAST Terms of Reference.
Resource requirements:	The research programmes, which provide the main input to this group, are already underway, and resources are already committed. The additional resource required to undertake additional activities in the framework of this group is negligible.
Participants:	The Study Group is likely to attract 10–15 participants from Baltic countries and a further 5 experts in the field.
Secretariat facilities:	None.
Financial:	No financial implications.
Linkages to advisory committees:	ACOM
Linkages to other committees or groups:	There is a very close working relationship with all the groups of the Fisheries Technology Committee. It is also very relevant to the Working Group on Ecosystem Effects of Fisheries and Baltic Fisheries Committee
Linkages to other organizations:	The work of this group is closely aligned with the EU and Baltic Sea Regional Advisory Council.