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Catch and release efficiency for bycatch and target species in shrimp fishery by using a Nordmøre grid or a sieve net

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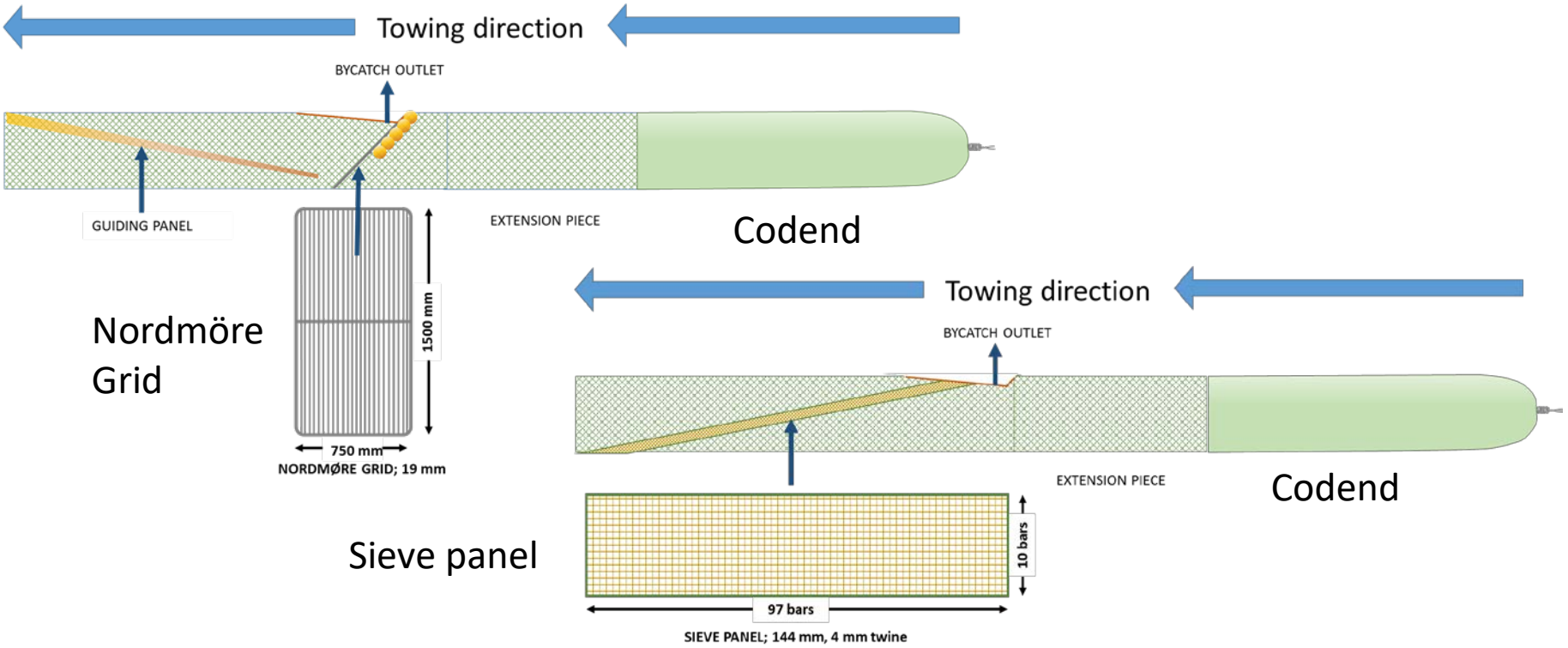
Background

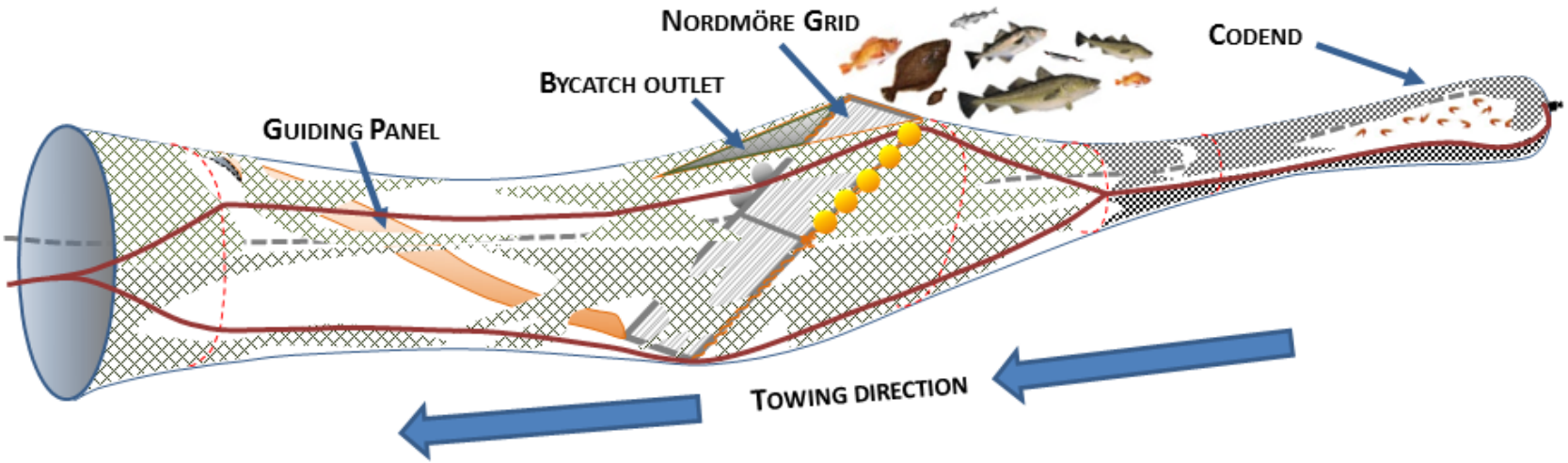
- The Nordmöre grid and the sieve net are two of the main devices to reduce bycatch of fish species in trawl fisheries targeting shrimp species.



- However, even with such devices mounted some small sized fish enter the codend of the trawl together with the targeted shrimp.
- Therefore, bycatch reduction remains to be a problem in some shrimp fisheries.

Northeast Arctic deep-water shrimp fishery

- One fishery with bycatch problems is the Northeast Arctic deep-water shrimp (*Pandalus borealis*) fishery.
- where it is mandatory to use a Nordmöre grid.



Objectives/hypothesis

- In the present study, we tested whether a sieve net could be an alternative to using the Nordmöre grid to mitigate bycatch of fish species in the Norwegian trawl fishery targeting deep-water shrimp;
- or if it would be an advantage to use a sieve panel in front of the mandatory Nordmöre grid.
- We hypothesized that with a sieve net with a low inclination angle installed in the extension piece, fish would be easier able to escape through the bycatch outlet not making physical contact or at least not selectivity contact with the sieve panel.
- In this manner, a low angle sieve net may be better at guiding fish to the escape outlet.
- In addition, we believed that such a sieve panel could sort shrimp efficiently due to that the area for the shrimp to contact the net in a way that it was subjected to a size selection process was increased compared to the Nordmöre grid.

Research questions

The trials presented in this study were designed to answer the following research questions:

- Does a sieve panel mounted with a low inclination angle represent a realistic alternative for bycatch mitigation in Norwegian trawl fishery targeting deep-water shrimp?

- Would there be any benefit in the Norwegian deep-water shrimp fishery regarding bycatch reduction by combining the use of a sieve panel and the mandatory Nordmöre grid?

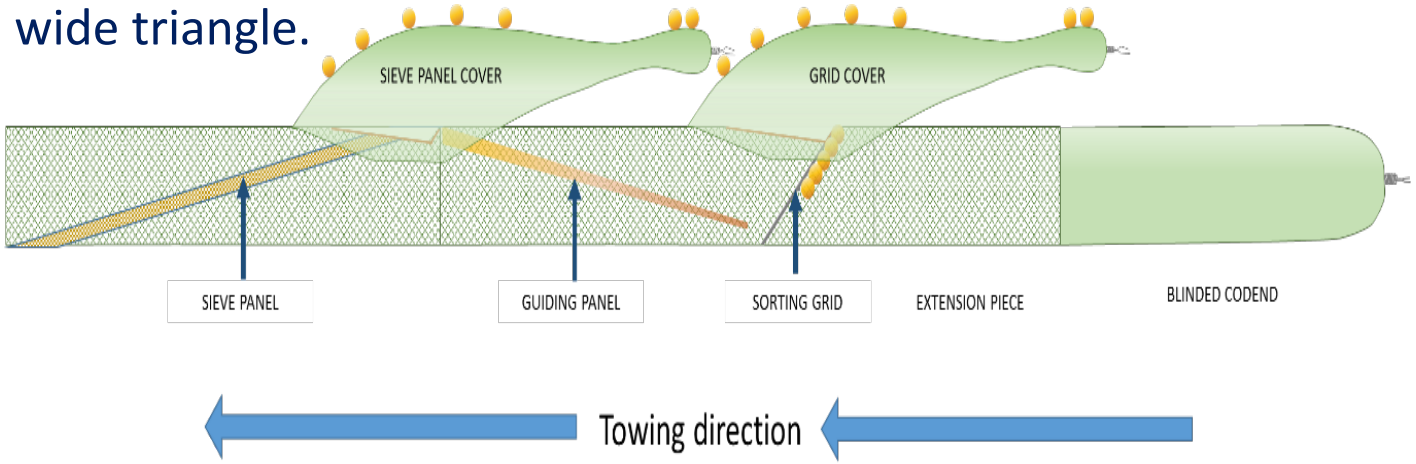
- What would the loss of the targeted deep-water shrimp be for a sieve net compared to for the Nordmöre grid and is this loss dependent on the sizes of the shrimp?

Fishing trials

The fishing trials were carried out onboard the Research Vessel (R/V) "Helmer Hanssen" (63.8 m Length Overall and 4,080 HP) between the 16th and 28th of February 2016 in the North of the Barents Sea.

Experimental design

- The trawl was equipped with a four-panel grid section. The grid, which was the standard grid used by the Norwegian coastal fleet targeting shrimp, was 1500 mm long and 750 mm wide. It was made of stainless steel, mounted so that it would be maintained at an angle of 45 degrees while fishing and had a bar spacing of 19 mm.
- The escape opening on the top panel of the grid section was cut as a 35-mesh long and 70-mesh wide triangle.
- A sieve panel was mounted in the trawl section in front of the grid section. The sieve panel was constructed of 144 mm square meshes (4 mm PE twine). It was 97 bars long and 10 bars wide and installed with an angle of ca. 10°. The escape opening on the top panel of the sieve panel section was cut as a 35-mesh long and 70-mesh wide triangle.



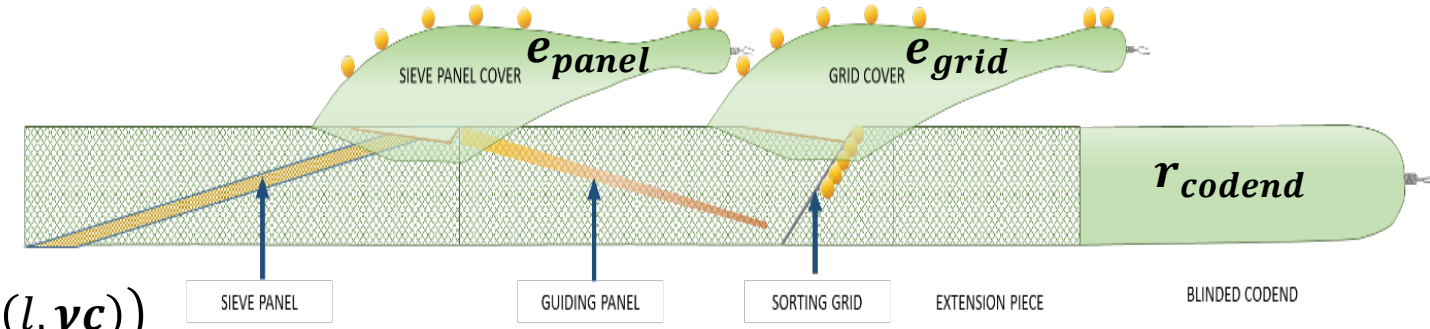
- The fish and shrimp escaping from the escape openings of the sieve panel and sorting grid were collected by covers with small mesh size and codend was blinded with similar mesh size

Modeling experimental data: three compartment

$$e_{panel}(l, \boldsymbol{\nu}_{panel}) = 1.0 - p_{panel}(l, \boldsymbol{\nu}_{panel})$$

$$e_{grid}(l, \boldsymbol{\nu}_{panel}, \boldsymbol{\nu}_{grid}) = \left(1.0 - p_{grid}(l, \boldsymbol{\nu}_{grid})\right) \times p_{panel}(l, \boldsymbol{\nu}_{panel})$$

$$r_{codend}(l, \boldsymbol{\nu}_{panel}, \boldsymbol{\nu}_{grid}) = p_{panel}(l, \boldsymbol{\nu}_{panel}) \times p_{grid}(l, \boldsymbol{\nu}_{grid})$$



Device passage probability:

$$p(l, \boldsymbol{\nu}) = C \times \left(1.0 - rc(l, \boldsymbol{\nu c})\right)$$

Device model is applied independently for the sieve panel the Nordmöre grid. The probability for making contact with the grid or sieve panel is modeled by the length independent parameter C which has a value in the range of 0.0 to 1.0. S-shaped size selection models: *Logit*, *Probit*, *Gompertz* and *Richard* (Wileman et al., 1996) as candidates for $rc(l, \boldsymbol{\nu c})$.

maximizing the likelihood for the observed data in form of the length dependent number of individuals measured as retained in the codend (nc_l) versus collected in the sieve panel cover (np_l) and in the Nordmöre grid cover (ng_l).

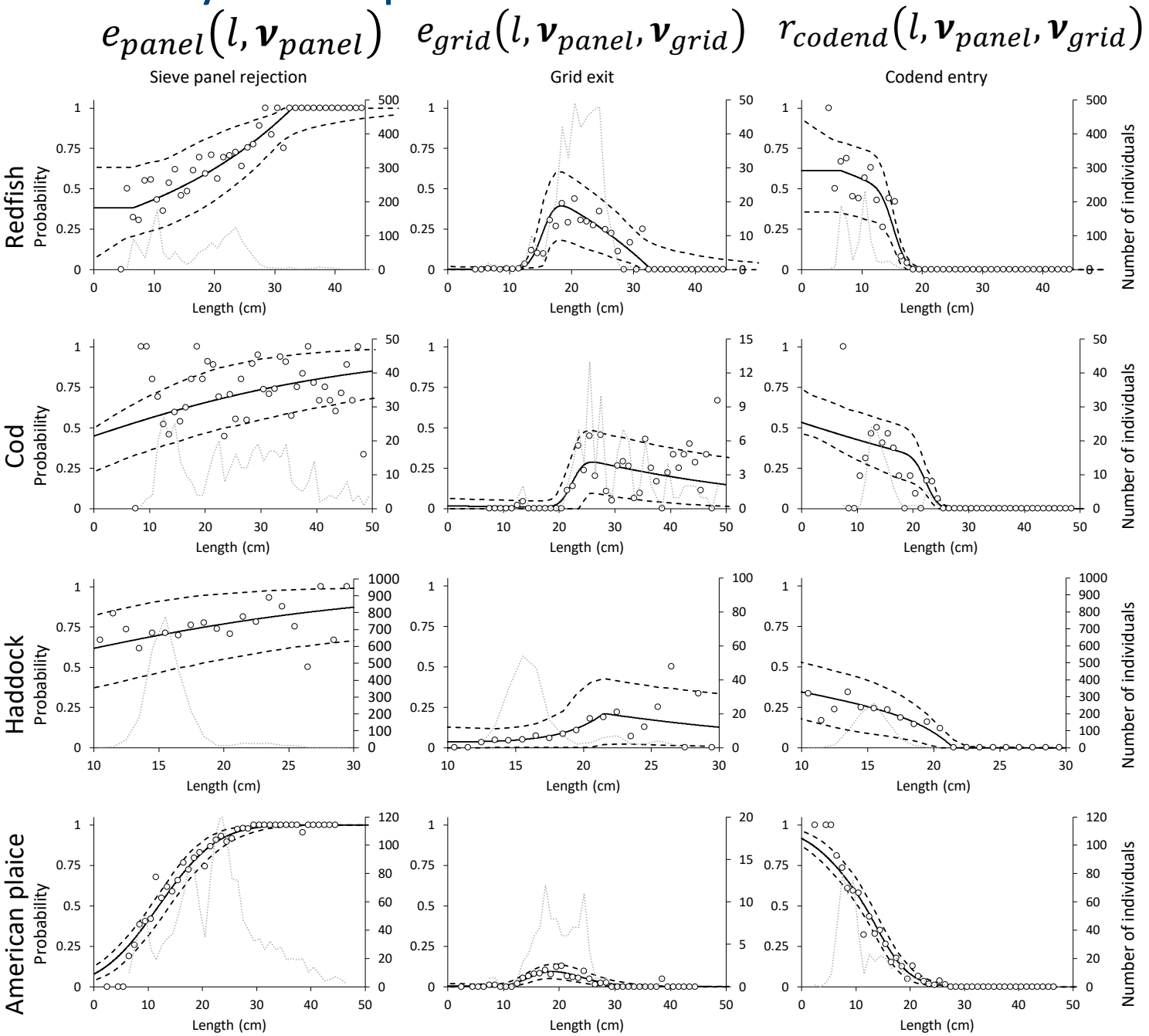
$$-\sum_{l}\sum_{i=1}^{m}\left\{\frac{np_{il}}{qp_i} \times ln\left(e_{panel}(l, \boldsymbol{\nu}_{panel})\right) + \frac{ng_{il}}{qg_i} \times ln\left(e_{grid}(l, \boldsymbol{\nu}_{grid})\right) + \frac{nc_{il}}{qc_i}\right.$$

Experimental data

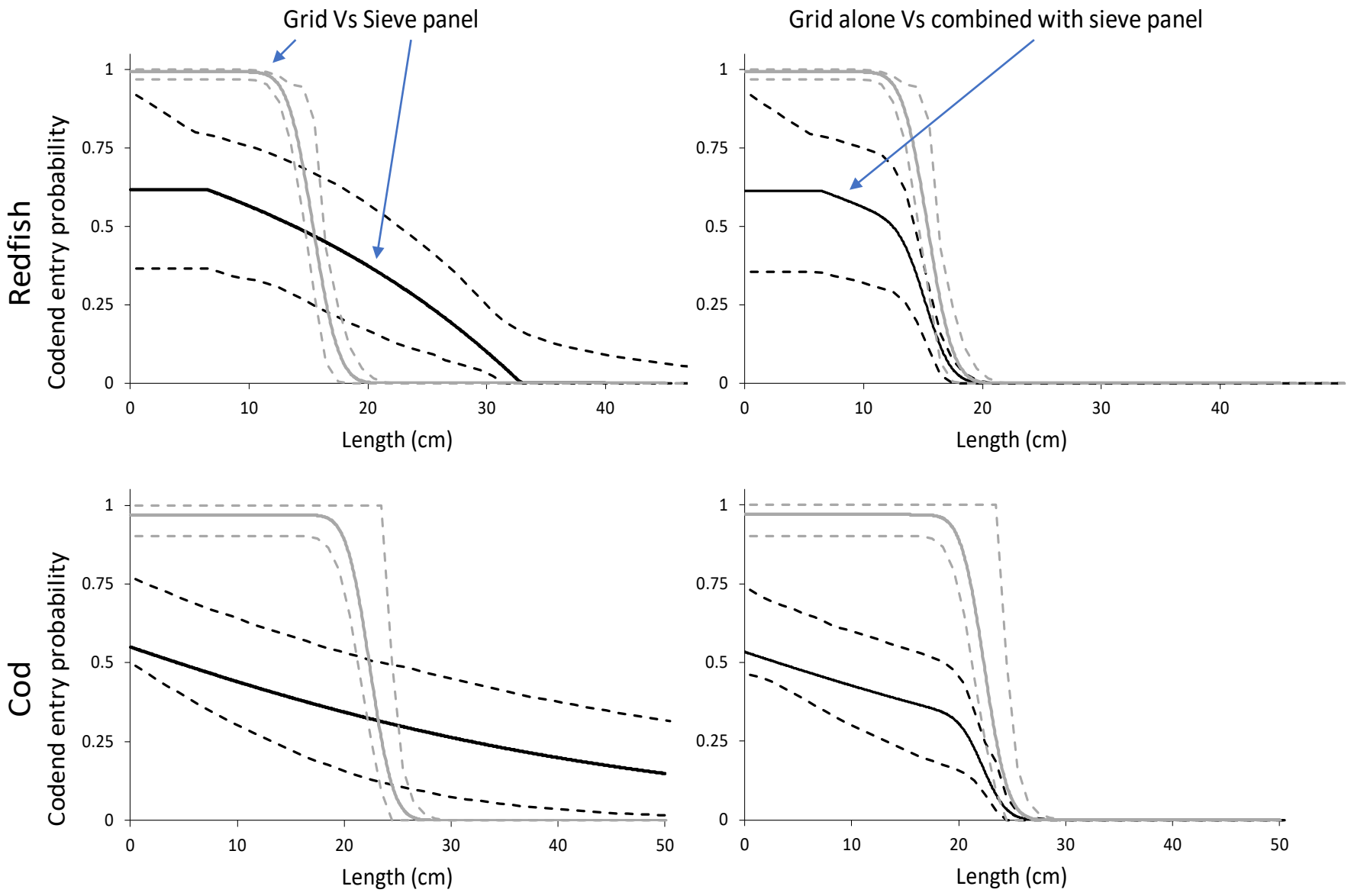
- **We carried out a total of 8 hauls during the experimental period.**
- **Of all the relevant bycatch species in the Northeast Atlantic deep-water shrimp fishery, cod (*Gadus morhua*), haddock (*Melanogramus aeglefinnus*), American plaice (*Hippoglossoides platessoides*) and Redfish (*Sebastes spp.)* were captured in sufficient numbers to be included in the analyses (Table 1).**
- **We length measured a total of 3037 shrimp, 2802 redfish, 2184 American plaice, 643 cod and 3492 haddock. Subsampling was only necessary for the deep-water shrimp.**

	Deep-water shrimp			Redfish			American Plaice			Cod			Haddock		
Haul	*ns*	*ng*	*nc*	*ns*	*ng*	*nc*	*ns*	*ng*	*nc*	*ns*	*ng*	*nc*	*ns*	*ng*	*nc*
1	159(5.0)	6	188(4.1)	93	40	32	200	9	83	38	4	5	24	3	35
2	163(9.6)	13(86.7)	175(4.5)	117	67	7	206	28	56	64	9	2	41	1	4
3	164(20.8)	9	196(11.6)	42	8	10	211	5	90	15	0	0	66	0	18
4	151(14.4)	5	240(8.2)	72	8	15	207	16	55	13	0	4	110	2	19
5	175(7.4)	3	252(7.7)	94	4	35	264	6	59	22	0	1	207	0	15
6	191(3.9)	14	227(8.6)	545	45	101	212	6	25	97	3	10	1097	2	67
7	137(21.5)	6	216(4.2)	156	195	303	86	21	58	63	63	37	353	176	393
8	148(6.6)	0	199(3.5)	416	36	361	225	5	51	130	16	47	583	19	257
sum	1288	56	1693	1535	403	864	1611	96	477	442	95	106	2481	203	808

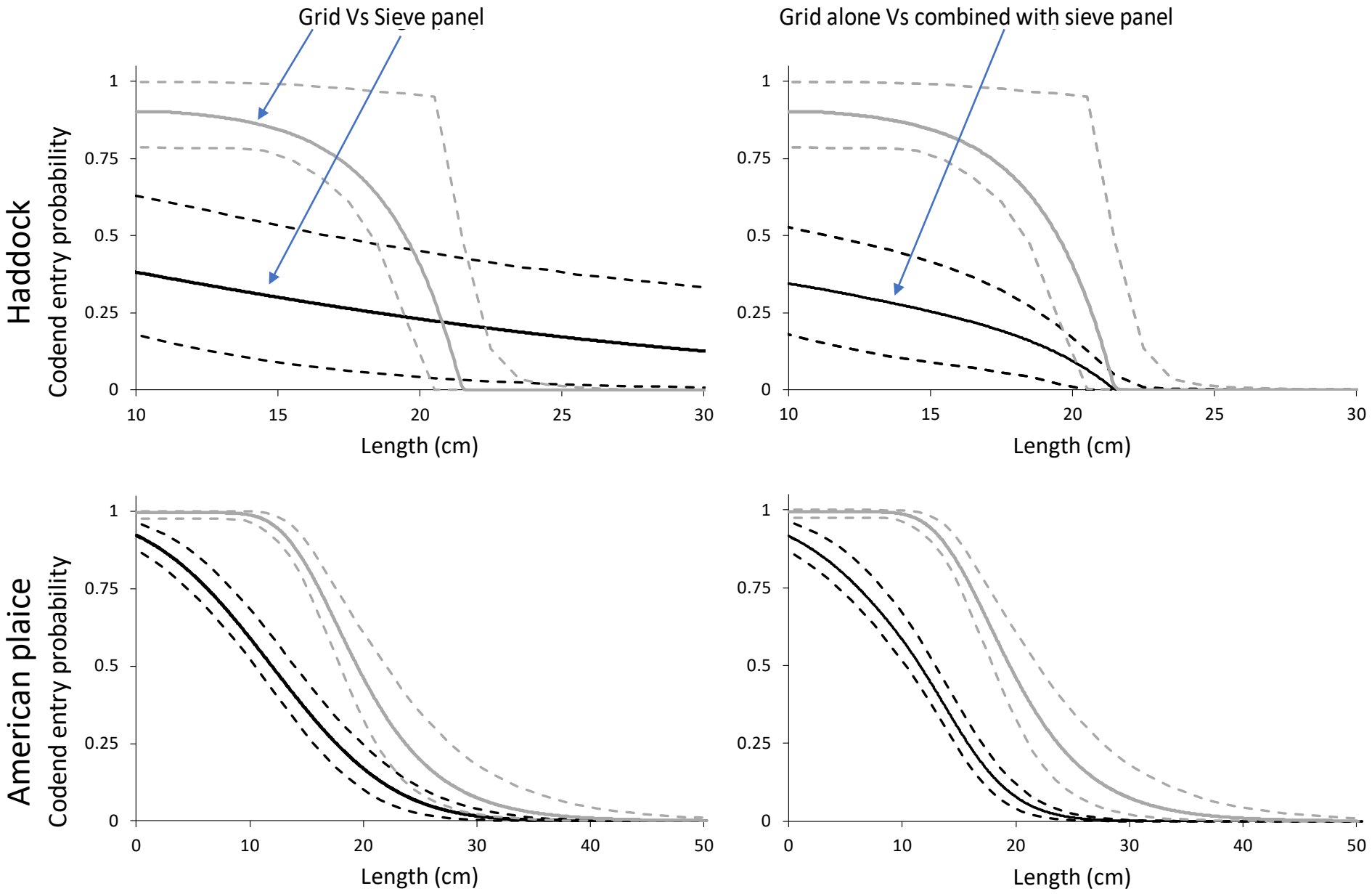
Model fit for bycatch species



Bycatch species: Sieve panel versus grid and combined



Bycatch species: Sieve panel versus grid and combined



Bycatch species: Conclusion

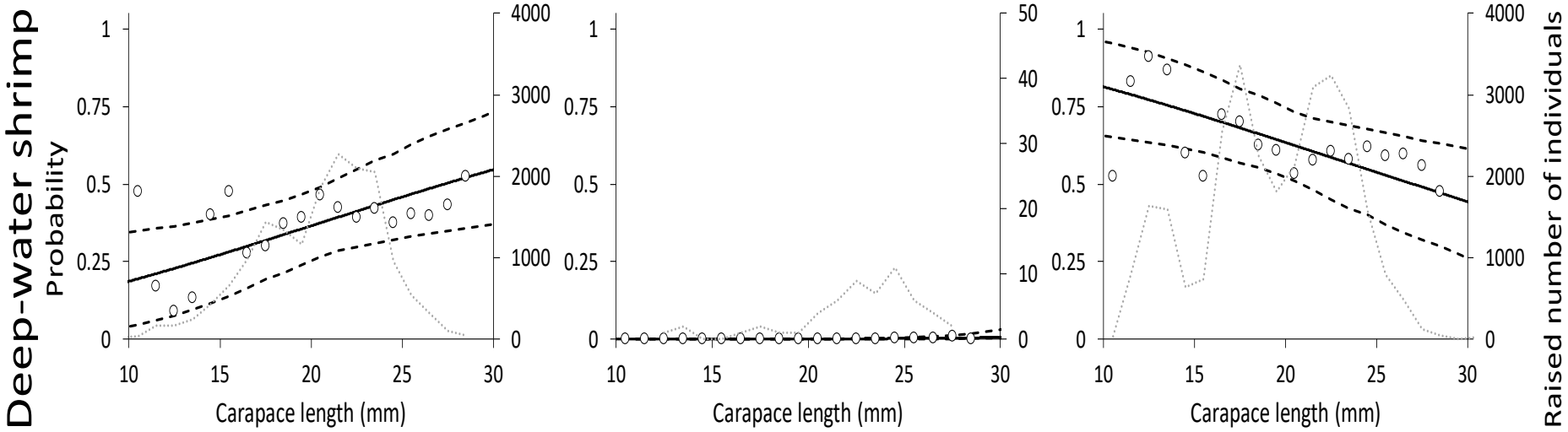
- Sieve panel and Nordmøre grid have different size dependent patterns for device passage probability.
- Especially, sieve panel have lower and higher probability for respectively small and bigger fish.
- Therefore, combining them can reduce codend entry for the bycatch species.

But what about the target species?

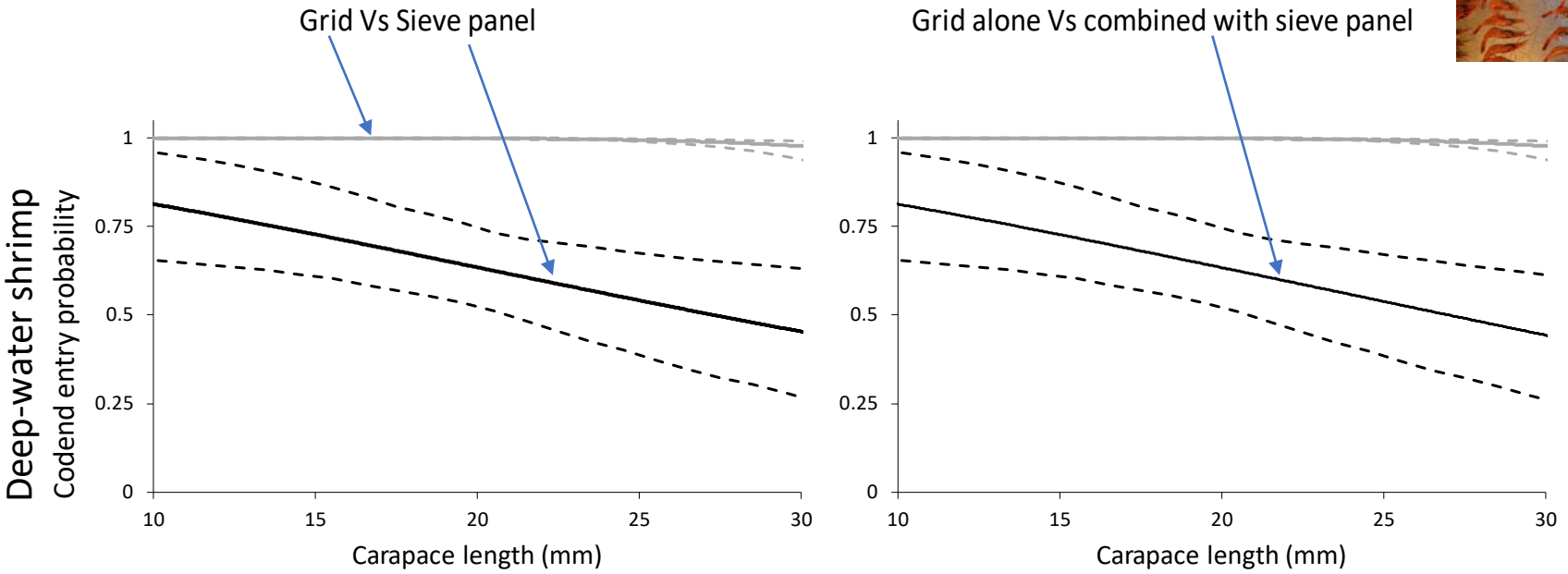
Deep-water shrimp

Modelling experimental data: Fine!

$e_{panel}(l, \boldsymbol{\nu}_{panel})$ $e_{grid}(l, \boldsymbol{\nu}_{panel}, \boldsymbol{\nu}_{grid})$ $r_{codend}(l, \boldsymbol{\nu}_{panel}, \boldsymbol{\nu}_{grid})$



Target species: Sieve panel versus grid and combined



- while the loss of commercial sized shrimp was only between 0 and 2% for the Nordmøre grid,
- it was estimated to be between 37 and 66% for the tested sieve net,
- which makes its application unacceptable for commercial fishing.
- Therefore, before a sieve net can be considered for the fishery, alternative sieve net designs with significantly lower loss in shrimp catches need to be found.

Acknowledgements

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AND

For you to listen!

Thanks!