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First Attempts to Quantify Variations in Behaviour of Groundfish Otter Trawls Used by the Federal Republic

of Germany in North Atlantic surveys

by

Michael Kroeger

Institute for Fishing Gear Technology Palmaille 9, D-2000 Hamburg 50, Federal Repubic of Germany

and

Karl-Hermann Kock

Institute for Sea Fisheries of the Federal Research Center for Fisheries Palmaille 9, D-2000 Hamburg 50, Federal Republic of Germany

1. Introduction

Estimates of stock biomass based on the virtual population analysis are entirely dependant on the accuracy and reliability of commercial catch and effort statistics and on accurate estimations of fishing mortality in most recent years. These data are not always available with sufficient reliability due to several reasons, particularly in more recent years. Therefore, direct biomass estimates from research vessel surveys are of growing importance for assessments of exploited fish populations.

The swept area method based on a stratified random sampling design was used in bottom trawl surveys of the Federal Republic of Germany's research vessels. This method requires estrapolation of data from the area swept by the survey trawl to the much larger area of the corresponding stratum. Important parameters for the definition of the area swept and the proportion of the fish within the trawls path which is actually caught are the operational characteristics of the survey trawl.

Due to the lack of quantitative data on trawl behaviour most biologists tend to consider bottom trawls to be in a quasisteady-state during the tow. In fact, however a number of variables, e.g. trawling speed through the water, warp length and tension in relation to depth, ocean currents, weather conditions, various types of sea beds (for extensive discussion, see CARROTHERS, 1981), submits the trawl to continually changing conditions which may bias the abundance estimates from research vessel surveys to a considerable but unknown extent. Additionally, different behaviour of the target fish species forms another important source of bias which has to be taken into account (see CARROTHERS, 1981).

In 1981 the Institute for Fishing Gear Technology and the Institute for Sea Fisheries of the Federal Research Centre for Fisheries started a series of investigations to quantify these variables. A first set of experiments determining the influence of different ship speeds and fishing depths ($\hat{=}$ warp lengths) on trawl headline height and wing spread was carried out with FRV "Walther Herwig" in the Rockall area in August 1981. Since the area provided rather even trawling grounds down to 700 m depth and the season was selected when weather conditions could be expected to be comparatively stable, external conditions for the experiments could be considered as quasi-steady within a set of measurements.

2. Measuring Techniques and Data Analysis

The net under investigation was a 140 feet groundfish otter trawl (see fig. 1-3) which is one of the two standard trawls used by the Institute for Sea Fisheries for bottom trawl surveys in the North Atlantic. Ship speed ranged from 3.0 - 5.0 kn and was changed in 0.5 kn intervals. The depth fished ranged from about 150 to 700 m (\cong 700 to 2000 m warp length) but varied only within 10m in each set of measurements.

Headline height and wing spread were measured by means of a multi-netsonde monitoring several recorders on headline and tips of the wings. Measurements were taken by turns each minute. When monitoring one recorder (~ 60 sec), ship speed was registered parallely each five sec by means of an Ott Current Meter and a pitotmeter. Wind speed and direction were recorded each 60 sec. Wave height was estimated by an experienced meteorologist each 4 hours. All signals were compiled for each measuring period under constant conditions. They were later discriminated into 1 sec invervals and their means and variances evaluated. Each mean represents one "y" value in tabs. 1 and 2 (right column), the number of measurements for each mean are given in the column "DATA".

3. Results

The amount of data so far collected has not been fully analysed at present. However some preliminary conclusions seem to be obvious.

In fig. 4 all measurements of headline height (a) and wing spreas (b) (regardless of the different fishing depth, course

etc.) are plotted against ship speed. It is clearly demonstrated that the variations of both parameters decrease considerably with increasing ship speed and remain more or less constant from about 4.2 kn onwards.

To find out which variables are major contributors to these variations data were further grouped on the basis of particular warp lengths. The trawl parameters are relatively stable at all speed levels for 700 and 850 m warp length (fig. 5 and 6). However, as indicated in fig. 7 to 9; variation of headline height and wing spread is higher at lower speed ranges with warp lengths above 1450 m. It may therefore be assumed that warp length may contribute to the variance at least in a critical speed range and at greater fishing depths.

The first conclusion from this experiment is that trawling speed of FRV "Walther Herwig" should be about 4.5 ± 0.5 kn in order to keep trawl height and wing spread relatively stable.

4. Literature

CARROTHERS, P.J.G.

1981 : Catch variability due to variations in groundfish otter trawl behaviour and possibilities to reduce it through instrumented fishing gear studies and improved fishing procedures.

in : Bottom Trawl Surveys, Doubleday, W.G. & Rivard, D. (ed.) : 247-257, Dept. Fish. and Oceans Ottawa.

Acknowledgement :

We are very much indebted to Mr. Winston Phillips, Sea Fish Industry Authority, Hull (UK) for his valuable help. فسيصب فبالأبيسانية والمستقيلة بالمستعمان والمنادي المصور والمستقل المتعاور المراجع

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DEPTH	WARP	WIND-	WIND-	COURSE	WAVE	#DATA	SPEED	Y-VALUE	
(M)	(#)	(KN)	(DEG.)	(DEG)	(M)		(KN)	(#)	
			5		i				
157	700	,	290	82	1 0	23	5.0	4 7	
156	700	7	290	81	1.0	21	4:5	5.2	
155	700	7	290	81	1.0	19	. 4 . 1	5.4	
155	700	7	290	83	1.0	21	3.7	5.6	
156	700	4	0	250	5	14	5.1	3.7	
156	700	4	. 0	250	. 5	17	4.3	5.1	
155	700	4 4	0	250	.5	16	3.5	56	
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	• • • • • •		· · · · · · · ·						
215	850	25	270	245	2.5	25	4.9	3.3	
212	850	25	270	245	2.5	16	4.6	3.1	
210	850	25	270	245	2.5	17	4.2	5.1	
207	850	25	270	240	2.5	16	3.4	5.5	
206	850	25	270	240	2.5	23	2.9	J.6. 7.4	
203	850	25	270	240	2.5	15	4.5	3 3	
201	850	25	270	239	2.5	13	4.0	4.3	
201	850	25	270	240	. 2.5	21	3.5	5.3	
203	850	25	270	238	2.5	27	3.0	5.3	
207	850	25	270	40	2.5	21	5.0	4.1	
208	850	25	270	41	2.5	22	4.5	4 1	
208	850	25	270	40	2.5	21	3.5	6.0	
208	850	25	270	40	2.5	20	3.0	8.1	
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DEPTH (M)	₩ARP (M)	WIND- (KN)	WIND- (DEG)	COURSE (DEG)	WAVE (M)	ØDATA	SPEED (KN)	Y-VALUE (M)	
DEPTH (M)	UARP (M)	WIND- (KN)	WIND- (DEG)	COURSE (DEG)	WAVE (M)	0 DA TA	SPEED (KN)	Y-VALUE (M)	•
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DEPTH (N) 438 452 445 445 447 449 442 455 457 459 464 452 452 453 453 456 452 453 456 452 453 456 452 459 454 449 453 459 451 459 451 459 451 459 451 459 451 459 453 459 455 455 455 455 455 455 455 455 455	WARP (M) 1450 1450 1450 1450 1450 1450 1450 1450	UIND- (KN) 18 18 18 18 18 18 18 18 18 18 18 18 18	UIND- (DEG) 250 250 250 250 250 250 250 250 250 250	C OURSE (DEG) 58 28 40 41 227 224 231 231 231 231 231 231 231 231 231 231	WAVE (M) 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0	<pre>ØDATA 23 14 14 18 13 12 29 18 21 22 23 17 17 12 24 16 16 16 16 28 25 13 23 29 15 21</pre>	SPEED (KN) 5.0 4.4 3.8 3.2 2.8 5.0 4.4 1 3.8 5.0 4.1 3.8 5.0 4.1 3.8 5.1 4.5 4.0 5.1 4.5 4.0 5.0 4.1 3.7 3.7 3.7 3.5.0 4.1 3.7 3.7 3.5.0 4.1 3.7 3.7 3.7 3.7 3.7 4.1 3.7 4.1 4.5 4.5 4.1 3.7 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0	Y - VALUE (N) 3.2 3.0 2.8 2.8 2.8 2.8 3.3 3.2 3.8 4.1 3.4 1 3.4 1 3.4 1 3.4 1 3.5 3.3 3.4 4.1 3.5 3.3 4.1 4.1 2.6 2.7 3.3 4.1 4.1 3.5 3.3 3.4 4.1 4.1 3.5 3.3 3.4 4.1 4.1 5.5 3.3 3.4 4.1 4.1 5.5 3.3 3.4 4.1 4.1 5.5 3.3 3.4 4.1 4.1 5.5 3.3 5.5 3.4 4.1 4.1 5.5 5.5 5.5 5.5 5.5 5.5 5.5 5.5 5.5 5	• • • • • • • • • • • • • • • • • • • •
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DEPTH (N) 438 452 445 445 445 447 449 442 455 457 459 464 453 456 453 456 453 456 453 456 453 456 454 449 453 451 450 448 443	WARP (M) 1450 1450 1450 1450 1450 1450 1450 1450	UIND- (KN) 18 18 18 18 18 18 18 18 18 18 18 18 18	WIND - (DEG) 250 250 250 250 250 250 250 250 250 250	C OURSE (DEG) 28 40 41 227 224 231 231 231 231 231 231 231 231 231 231	WAVE (M) 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0	C DATA 23 14 14 13 12 29 16 12 29 18 21 22 23 17 17 12 24 16 28 25 13 23 29 15 21 25 21 25 21 25 21 25 21 25 29 16 29 16 29 16 29 16 29 16 29 17 12 29 16 29 16 29 16 29 16 29 16 29 16 29 16 29 16 29 17 17 22 23 17 17 22 24 16 28 29 18 21 22 23 17 17 22 24 16 28 29 18 21 22 23 17 17 22 24 16 28 29 18 21 22 23 23 17 12 24 16 28 29 18 29 18 20 21 22 23 23 23 23 23 23 23 23 23	SPEED (KN) 5.0 4.4 3.8 3.2 5.0 4.1 3.8 5.0 4.1 3.8 5.1 4.1 3.8 5.1 4.0 3.7 3.7 3.7 3.7 3.7 3.7 3.7 3.7 4.1 3.7 3.7 4.1 3.7 3.7 4.1 3.7 3.7 3.7 5.0 4.1 3.7 5.0 5.0 5.0 4.1 4.1 3.7 5.0 5.0 5.0 4.1 8 5.1 4.0 5.0 5.0 5.0 4.1 8 5.0 5.0 4.1 8 5.1 8 5.0 7.0 5.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0 7	Y - VALUE (M) 3.2 3.0 2.8 2.9 3.3 3.8 4.1 3.4 1.3.4 1.3.4 1.3.4 1.3.4 1.3.5 3.3 3.5 3.7 3.3 4.1 4.1 3.5 3.7 3.4 4.1 4.1 3.5 3.7 3.4 4.1 4.1 5.5 3.4 4.1 5.5 3.4 4.1 5.5 3.4 4.1 5.7 7.1 2.9 7.1 2.9 7.1 2.9 7.1 2.9 7.1 2.9 7.1 7.1 7.1 7.1 7.1 7.1 7.1 7.1 7.1 7.1	
DEPTH (N) 438 452 445 445 447 449 449 442 455 457 459 464 452 452 452 453 454 462 453 454 459 454 459 453 451 459 453 451 459 453 451 459 453 451 459 453 451 459 453 459 453 459 459 459 459 459 459 459 459 459 459	WARP (M) 1450 1450 1450 1450 1450 1450 1450 1450	UIND- (KN) 18 18 18 18 18 18 18 18 18 18 18 18 18	UIND- (DEG) 250 250 250 250 250 250 250 250 250 250	C OURSE (DEG) 58 28 40 41 227 224 231 231 231 231 231 231 231 231 231 231	WAVE (M) 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0	<pre>#DATA 23 14 14 18 12 16 12 29 18 21 22 23 17 17 12 24 16 16 16 16 28 25 13 23 29 15 121 25 16 24 9 19</pre>	SPEED (KN) 5.0 4 4 3.8 3.2 2.8 5.0 4.4 1 3.6 5.0 4.4 1 3.6 5.1 4.5 4.0 5.1 4.5 4.0 5.0 4.5 4.0 5.0 4.5 4.5 4.5 4.5 4.1 3.7 3.7 3.7 3.7 3.5 0 4.4 4.1 3.7 3.7 3.7 3.7 3.2 2.2 4.5 4.1 3.7 3.7 3.7 3.7 3.7 3.7 3.7 3.7 3.7 3.7	Y - VALUE (N) 3.2 3.0 2.8 2.8 2.8 2.8 3.3 3.2 3.8 4.1 4.1 3.4 1 3.4 1 3.4 1 3.4 1 4.1 3.4 1 4.1 3.4 1 4.1 3.4 1 4.1 3.4 1 4.1 4.1 3.5 3.3 4.1 4.1 4.1 5.3 3.4 4.1 4.1 5.3 3.3 7 3.3 4.1 4.1 4.1 5.3 3.3 7 3.3 4.1 4.1 4.1 5.3 3.3 7 3.3 4.1 4.1 4.1 5.3 3.3 7 3.3 4.1 4.1 4.1 5.3 3.3 7 3.3 4.1 4.1 4.1 5.3 3.3 7 7 3.3 4.1 4.1 4.1 5.3 7 3.3 7 7 3.3 4.1 4.1 4.1 4.1 5.3 7 7 3.3 7 7 7 3.3 4.1 4.1 4.1 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	
DEPTH (N) 438 452 445 445 447 449 448 442 455 457 459 464 452 452 453 454 459 454 459 459 453 451 459 459 453 451 444 442 442 442 442 442 442 442 442 44	WARP (M) 1450 1450 1450 1450 1450 1450 1450 1450	UIND- (KN) 18 18 18 18 18 18 18 18 18 18 18 18 18	#IND- (DEG) 250 260 260 260 260 260 260 260 260	C OURSE (DEG) 28 40 41 227 224 231 231 231 231 231 231 231 231 231 231	WAVE (M) 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0	©DATA 23 14 14 18 12 29 29 29 29 29 29 29 29 29 2	SPEED (KN) 5.0 4.4 3.8 3.2 2.8 5.0 4.4 4.1 3.6 3.7 3.0 4.5 4.5 4.5 4.5 4.5 4.5 4.5 4.4 4.1 3.7 3.0 4.5 4.4 4.1 3.7 3.2 4.6 5.3 2.2 5.3 2.2 5.3 2.2 5.3 2.2 5.3 2.2 5.3 2.2 5.3 2.2 5.0 4.4 4.1 3.7 5.0 4.5 4.5 5.0 4.5 5.0 4.5 5.0 4.5 5.0 4.5 5.0 5.0 5.0 4.5 5.0 4.5 5.0 4.5 5.0 4.5 5.0 4.5 5.0 4.5 5.0 4.5 5.0 4.5 5.0 4.5 5.0 4.5 5.0 4.5 5.0 4.5 5.0 4.5 5.0 4.5 5.0 4.5 5.0 5.0 5.0 4.5 5.0 4.5 5.0 7.7 5.0 5.0 4.5 5.0 4.5 5.0 4.5 5.0 4.5 7.7 5.0 5.0 4.5 7.7 5.0 5.0 4.5 7.7 7.3 7.0 5.0 4.5 7.5 7.7 7.3 7.0 7.5 7.0 4.5 7.5 7.5 7.5 7.5 7.5 7.5 7.5 7.5 7.5 7	Y - VALUE (N) 3.2 3.0 2.8 2.8 2.8 2.8 3.3 3.2 3.8 4.1 3.4 3.5 3.7 3.3 4.1 4.1 3.4 3.5 3.7 3.3 4.1 4.1 4.6 2.7 3.3 4.1 4.6 2.7 3.4 4.1 5.5 3.4 4.1 5.7 7.1 2.9 3.2 9 3.2 9 3.2 9 3.4 4.1 2.7 3.4 4.1 3.4 9 2.7 7.1 2.9 3.2 7.1 2.9 3.2 7.2 7.3 7.2 7.3 7.2 7.3 7.3 7.3 7.3 7.3 7.3 7.3 7.3 7.3 7.3	

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Tab. 1: (cont.)

		DEPTH (M)	UARP (M)	WIND- (KN)	WIND- (DEG)	COURSE (DEG)	WAVE (M)	*DATA	SPEED Y (KN)	-VALUE (M)
		595 594 602 601 599 597 596 612 612 602 604 598 598 598 599 597 596 607 604 599 598 599 598 599 598 599 598 599 598 599 598 599 598 599 599 598 599 598 599 598 599 598 599 598 599 598 599 599 598 599 599 598 599 599 598 599 599 599 598 599 599 599 598 599 599 599 599 598 595 599 595	1800 1800	9 9 9 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	330 330 330 330 160 160 160 160 160 160 160 160 160 16	28 32 42 41 208 208 210 30 40 42 44 42 44 38 211 210 200 208 203 38 39 45 45 45	1.0 1.0 1.0 5.5 5.5 5.5 5.5 5.5 5.5 5.5 5	20 23 19 19 24 17 14 21 14 21 24 16 36 40 24 23 35 35 22 20 22 20	5.1 4.4 3.9 3.4 3.0 5.1 4.4 4.1 3.8 5.1 4.0 3.5 4.0 5.0 5.0 4.1 3.5 4.1 3.5 4.1 3.5 4.1 3.5 4.1 3.5 7 4.1 3.5 7 4.1 3.5 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	3.3 3.4 5.5 7.6 3.4 3.4 5.3 2.2 4 2.4 2.4 2.4 2.4 2.4 2.9 2.4 2.4 2.5 2.4 2.5 2.4 2.7 2.5 2.4 2.7 2.5 2.4 2.7 2.5 3.1 2.7 3.1 2.7 3.1 2.7 3.1 3.1 3.1 3.1 3.1 3.1 3.1 4.2 5.5 7.6 3.1 4.2 5.5 7.6 7.6 7.6 7.6 7.6 7.6 7.6 7.6 7.6 7.6
						••• •••••		20	3.U	0.1
		DEPTH (M)	948P (#)	WIND- (KH)	WIND- (deg)	COURSE (DEG)	WAVE (M)	#DATA	SPEED Y	-VALUE (M)
		703 695 701 685 704 688 689 702 704 707 702 701 698 690 713	2000 2000 2000 2000 2000 2000 2000 200	19 19 19 19 19 19 19 19 19 13 13 13 13	250 250 250 250 250 250 250 250 250 250	228 190 194 225 223 218 215 35 42 16 20 39 38 40 30	1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0	26 33 22 58 17 20 26 20 37 46 16 18 23 34 56	5.1 4.0 3.5 5.0 4.7 5.0 4.7 5.0 4.2 3.6 3.2 4.9 4.5 4.0 3.6	3.4 3.0 4.0 6.5 9.4 3.7 3.3 3.3 3.3 3.9 3.4 3.3 3.3 3.3 3.3 3.3 3.3 3.4 3.5 3.3 3.4 3.2 3.1 3.8
`ab.	2:	Wing	Spre	ad of	140	вт (y-Valu	ıe)		· · ·
		DEPTH (M)	WARP (H)	(KN) MIND-	WIND- (DEG)	COURSE (DEG	WAVE (M)	UDATA	SPEED (KN)	Y-VALUE (M)
		157 156 155 155 156 156 155	700 700 700 700 700 700 700 700	7 7 7 4 4 4 4	290 290 290 290 0 0 0	82 81 83 250 250 250 250	1.0 1.0 1.0 5.5 5.5 5.5	17 19 22 23 17 17 20 23	5.0 4.5 4.1 3.7 5.1 4.3 4.0 3.5	22.8 23.6 23.1 20.1 23.3 23.5 23.9 22.9
		DEPTH (M)	WARP (M)	(KN) MIND-	WIND- (DEG)	COURSE (DEG)	WAVE (M)	8DATA	SPEED (KN)	Y-VALUE (M)
		215 212 210 207 206 205 204 201 201 203 207 208 208 208	850 850 850 850 850 850 850 850 850 850	25 25 25 25 25 25 25 25 25 25 25 25 25 2	270 270 270 270 270 270 270 270 270 270	2 4 5 2 4 5 2 4 5 2 4 0 2 4 0 2 4 0 2 4 0 2 4 0 2 4 0 2 3 9 2 4 0 2 3 9 2 4 0 2 3 8 4 0 4 1 4 1	2 . 5 2 . 5 5 2 . 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	23 21 16 11 12 12 17 13 14 14 33 23 17 18	4 . 9 4 . 6 4 . 2 3 . 4 5 . 0 4 . 5 3 . 0 5 . 0 5 . 0 4 . 5 4 . 0 3 . 5 3 . 0 5 . 0	22.9 23.2 23.4 23.4 23.4 23.5 23.4 23.5 23.4 23.5 23.4 23.6 23.4 22.7 22.9 23.0 21.8 12.9

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438 1450 18 250 58 1.0 23 5.0 23 445 1450 18 250 28 1.0 19 4.4 23 445 1450 18 250 28 1.0 17 3 8 23 445 1450 18 250 29 1.0 17 3 8 23 445 1450 18 250 24 1.0 14 3 2 3 445 1450 18 250 227 1.0 16 5.0 2 449 1450 18 250 231 1.0 23 4.1 20 442 1450 18 250 37 1.0 16 4 5 2 445 1450 18 250 30 1.0 37 3.0 19 453 1450 18 250 230 1.0 </th <th>1) . 4 . 2 . 6</th>	1) . 4 . 2 . 6
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448 1450 17 260 35 1.0 7 4 8 21. 444 1450 17 260 35 1.0 13 4 5 22. 443 1450 17 260 34 1.0 11 4.2 22. 442 1450 17 260 55 -1.0 13 3.5 21. 447 1450 17 260 52 1.0 23 3.5 21. 447 1450 17 260 52 1.0 23 3.5 21.	.7
443 1450 17 260 34 1.0 11 4.2 22 442 1450 17 260 55 -1.0 13 3.5 21 447 1450 17 260 55 -1.0 13 3.5 21 447 1450 17 260 52 1.0 20 3.2 19	. 4
447 1450 17 260 52 1.0 20 3.2 19.	1
450 1450 17 260 240 1.0 23 5.1 21	3
427 1450 17 260 225 1.0 11 4.5 21 440 1450 17 260 220 1.0 14 4.1 19	3
445 1450 17 260 225 1.0 19 3.5 10 447 1450 17 260 230 1.0 21 3.2 12	. 4
	ى. سەر ھەلىكى مەس
DEPTH WARP WIND- WIND- COURSE WAVE #DATA SPEED Y-V	ALUE
(M) (M) (KN) (DEG) (DEG) (M) (KN) (I	FI)
595 1800 9 330 28 1.0 25 5.1 22 593 1800 9 330 32 1.0 27 4.4 23	.0.
594 1800 9 330 42 1.0 21 3.9 21 602 1800 9 330 43 1.0 14 3.4 19	. 5 . 8
601 1800 9 330 41 1.0 20 3.0 18 599 100 9 140 208 5 26 5 1 22	. 9
597 1800 8 160 208 5 48 4.4 23 597 1800 8 160 208 5 48 4.4 23	1
597 1800 8 160 210 5 17 3.8 19 596 1800 8 160 210 .5 17 3.8 19 546 1800 8 160 210 .5 17 3.8 19	0
612 1800 8 160 40 5 42 4 5 23	.7
612 1800 8 160 42 5 51 4.0 23 602 1800 8 160 44 5 24 3.5 21	. 9
607 1800 8 160 38 5 40 3.0 19 604 1800 8 160 211 5 25 5.0 22	. 5
598 1800 8 160 210 5 13 4 7 24 607 1800 8 160 200 5 22 4 1 20	.0.8
606 1800 8 160 208 5 35 3.5 17 599 1800 8 160 203 5 28 3.0 19	. 6
598 1800 13 180 38 5 17 4.9 21 595 1800 13 180 39 5 21 4.5 22	. 8
599 1800 13 180 45 5 15 4 1 23 600 1800 13 180 45 5 17 3 6 23	.7.
605 1800 13 180 44 .5 24 3.0 22	. 7
DEPTH WARP WIND- WIND- COURSE WAVE ODATA SPEED Y-	VALUE
(H) (K) (KR) (DEG) (DEG) (M). (KN)	(M)
703 2000 19 250 228 1.0 22 5.1 2 696 2000 19 250 190 1.0 24 4.4 2	1.5
701 2000 19 250 194 1.0 40 4.0 2 645 2000 19 250 225 1.0 45 3.5 1	0.1
704 2000 19 250 223 1 0 31 3 0 1 688 2000 19 250 218 1 0 31 5 0 2	5.5
689 2000 19 250 215 1.0 13 4.7 2 202 2000 19 250 25 1.0 13 5.0 2	2.5
700 2000 19 250 42 1.0 15 4.7 2	22.1
704 2000 19 250 42 1.0 16 4.2 2 707 2000 19 250 16 1.0 27 3.6 2	23.2
702 2000 19 250 20 1 0 19 3 2 2 701 2000 13 180 39 5 12 4 9 2	21.1
698 2000 13 180 38 5 21 4.5 2 690 2000 13 180 40 5 14 4.0 2	21.8



Fig. 1: 140'BT Netting and Frame Lines

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Fig. 2: 140'BT Attachments

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Fig. 4a,4b: 140'BT, headline height and wing spread (warp 700-2000 m)

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Fig. 5a,5b: 140'BT, headline height and wing spread (warp 700 m)

a. 1. 1-4

Fig. 6a,6b: 140'BT, headline height and wing spread (warp 850 m)

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Fig. 7a,7b: 140'BT, headline height and wing spread (warp 1450 m)

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Fig. 8a,8b: 140'BT, headline height and wing spread (warp 1800 m)

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Fig. 9a,9b: 140'BT, headline height and wing spread (warp 2000 m)

