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Cruise Report

Cruise no. 836 of FRV "Solea"
12. – 20.06.2024

Acoustic Investigations on small pelagic fishes in the Bornholm Basin

Scientist in charge: Dr. Stefanie Haase (Thünen-OF)

1. Main purpose of the cruise

The aim of the cruise was to investigate the vertical and horizontal distribution of fish, especially sprat, herring, and cod, in the Bornholm Basin in high resolution. To this end, hydroacoustic measurements were carried out with accompanying pelagic fishing hauls and linked to the results of corresponding hydrographic measurements. The cruise is therefore an extension of the BASS (Baltic Acoustic Spring Survey, taking place in May), which allows only very limited time for investigating specific issues such as the vertical distribution of shoaling fish.

2. Cruise objectives

Main objectives of the cruise were:

- Hydroacoustic measurements of small pelagic fishes in the Bornholm Basin (ICES subdivision 25, figure 1) for investigations of the diurnal vertical fish distribution
- Fishing with a pelagic trawl according to hydroacoustic indications and subsequent biological measurement of catches (species, length composition, sex, maturity and age)
- Sampling of herring and sprat (whole fish, otoliths, stomachs and gonads) for further analysis at the Thünen-OF
- Depth-stratified sampling of Plankton
- Hydrographic measurements with a CTD probe on predetermined stations and after each fishing station when distant from the planned CTD station
- Camera observation of fish inside the trawl to better understand the vertical distribution

3. Cruise narrative and preliminary results

3.1 Cruise narrative

"Solea" departed from the harbour of Rostock-Marienehe in the morning of June 12th after the boarding of the scientist and the loading of the equipment. "Solea" first sailed to Mecklenburg Bay (west of Rostock) to conduct trials with a ROTV ("Companion") and carry out a test haul with the pelagic trawl net before returning to Rostock. After a day's work in the harbour of Rostock-Marienehe, during which repairs and optimizations were made to the scientific equipment, the cruise was continued on June 14th, when "Solea" travelled towards the research area but had to interrupt the cruise again to help in a maritime emergency in the area North of the Darß peninsula. On June 15, work began on the hydroacoustic transects in the Bornholm Sea, with three transects oriented in a north-south direction being surveyed on three consecutive days. During the night of June 17-18, parts of the transects were surveyed again to investigate differences in fish distribution between day and night. The hydroacoustic recordings were accompanied by regular measurements of water parameters throughout the water column using a CTD probe. In addition, reference fishery hauls were conducted using a pelagic trawl equipped with a multisampler, i.e., several successively closable codends. The investigations into plankton composition at various water depths using a multi-net, which began on June 18, had to be discontinued due to malfunctions of the winch. These technical problems and a progressive deterioration in weather conditions led to the end of work in the Bornholm Basin, and "Solea" sailed to the east coast of Bornholm, off which the calibration of the hydroacoustic equipment was carried out on June 19. Afterwards, "Solea" travelled back towards Rostock and returned on June 20th to Rostock-Marienehe, where the scientific crew disembarked and unloaded the scientific equipment marking the end of the cruise.

3.2 Hydroacoustic recording

The "Solea" is equipped with a Simrad EK80 wideband echosounder with four centre frequencies (18, 38, 120 and 200 kHz). As during the standard acoustic survey (BASS = Baltic Acoustic Spring Survey in May) and in accordance to the Manual for International Baltic Acoustic Surveys (ICES 2017), this survey was conducted with the 38 kHz frequency narrow band mode (pulse length = 1024 µs; pingrate = 500 ms) but all frequencies were also recorded in wideband mode to test the applicability of subsequent filtering of the target frequency (38 kHz) echoes. Each echosounder was calibrated. Calibration procedure itself was carried out as described in the "Manual for International Baltic Acoustic Surveys (IBAS)" (ICES 2017).

Hydroacoustic data were recorded for all transects covered, however the processing and analyses of the raw data is still not finalized.

3.3 Biological sampling

Trawling was done with the pelagic gear "PSN388" equipped with a multisampler that allows the use of three distinct codends which where remotely closed in different water depths. For each haul and codend, the total catches have been recorded as well as species composition and length distribution of the distinct species. Sub-samples of herring and sprat were taken to investigate the distribution of sex, maturity and age of the catches. Samples of whole fish and parts of different organs/tissues were also taken for later investigations in the laboratory. Detailed biological analyses were made according to the IBAS standard procedure (i.e. sex, maturity, otolith dissection). At the time of writing, the fish otoliths are still being processed to analyse individual fish age.

A total of 11 fishing hauls were carried out, two of which were invalid due to insufficient catches or technical problems. Altogether 5,173 fish of 7 distinct species were measured (Table 1) and 271 fishes (136 sprat, 110

cod, and 25 herring) were further analysed (individual biometrics, sex, maturity and otoliths; age reading still in progress). Details on fishing stations and catches are given in Figure 1 and Tables 1 - 3. The catches were dominated by sprats, and preliminary comparisons of catch quantities in the various codends indicate an inhomogeneous vertical distribution of fish (Tables 2 and 3). Once the raw data from the hydroacoustic recordings has been processed and analysed together with the videos and images taken within the net, further analyses will be conducted to investigate the extent to which certain environmental factors (oxygen, temperature, salinity) influence the vertical and horizontal distribution of fish depending on the time of day.

Table 1: Presence of distinct fish species in the 9 valid fishery hauls and number of length measurements per species.

Species	Common name	Length measurements	Number of hauls where present
Clupea harengus	Atlantic herring	423	8
Cyclopterus lumpus	Lumpfish	2	2
Gadus morhua	Atlantic cod	110	6
Gasterosteus aculeatus	Three-spined stickleback	2	2
Platichthys flesus	European flounder	2	2
Scomber scombrus	Atlantic Mackerel	1	1
Sprattus sprattus	European sprat	4,633	9

A total of three hauls were carried out using the multi-net to sample plankton communities at various depths before the data collection had to be abandoned due to a defect in the winch. The samples taken have yet to be analysed.

3.4 Hydrography

A Seabird-CTD-probe (SBE 19plus V2) equipped with a water sampler and oxygen sensor was used for hydrographic measurements. Vertical profiles were taken along the hydroacoustic tracks. Additional CTD casts were performed after or before each biological sampling activity. The profiles covered the entire water column to about 2 m above the seafloor. Altogether 44 CTD casts were performed during the cruise.

The measurements showed strong stratification of the water bodies with a large range of temperature variation (5 - >20°C) and several thermoclines, one of which was particularly pronounced at water depths of around 20 meters (Figure 2). In terms of salinity, the measured values ranged between 3 PSU (directly at the surface) and > 16 PSU (near the bottom of the Bornholm Basin) with a sharp halocline at a depth of approximately 60 meters. This depth range also represents a sharp boundary for dissolved oxygen, with values of less than 2 mg/l below a water depth of 60 meters (Figure 2).

4. Cruise participants

Name	Function	Institution
Dr. Stefanie Haase	Cruise leader	Thünen-OF
Dr. Daniel Stepputtis	Hydroacoustics / Fishery biology	Thünen-OF
Kerstin Schöps	Fishery biology	Thünen-OF
Verona Henning	Fishery biology	Thünen-OF
Sebastian Mammitzsch	Electronics / Fishery biology	Thünen-OF
Jesper Stepputtis	Fishery biology	Thünen-OF (student assistant)

5. Acknowledgements

We hereby thank all participants and the crew of FRV “Solea” for their outstanding cooperation and commitment.

6. Literature

ICES. 2017. Manual for the International Baltic Acoustic Surveys (IBAS). Series of ICES Survey Protocols SISP 8 - IBAS. 47 pp.; http://doi.org/10.17895/ices.pub.3368;

Dr. Paul Kotterba (Thünen-OF)

pp Stefanie Haase

(Scientist in charge)

7. Figures

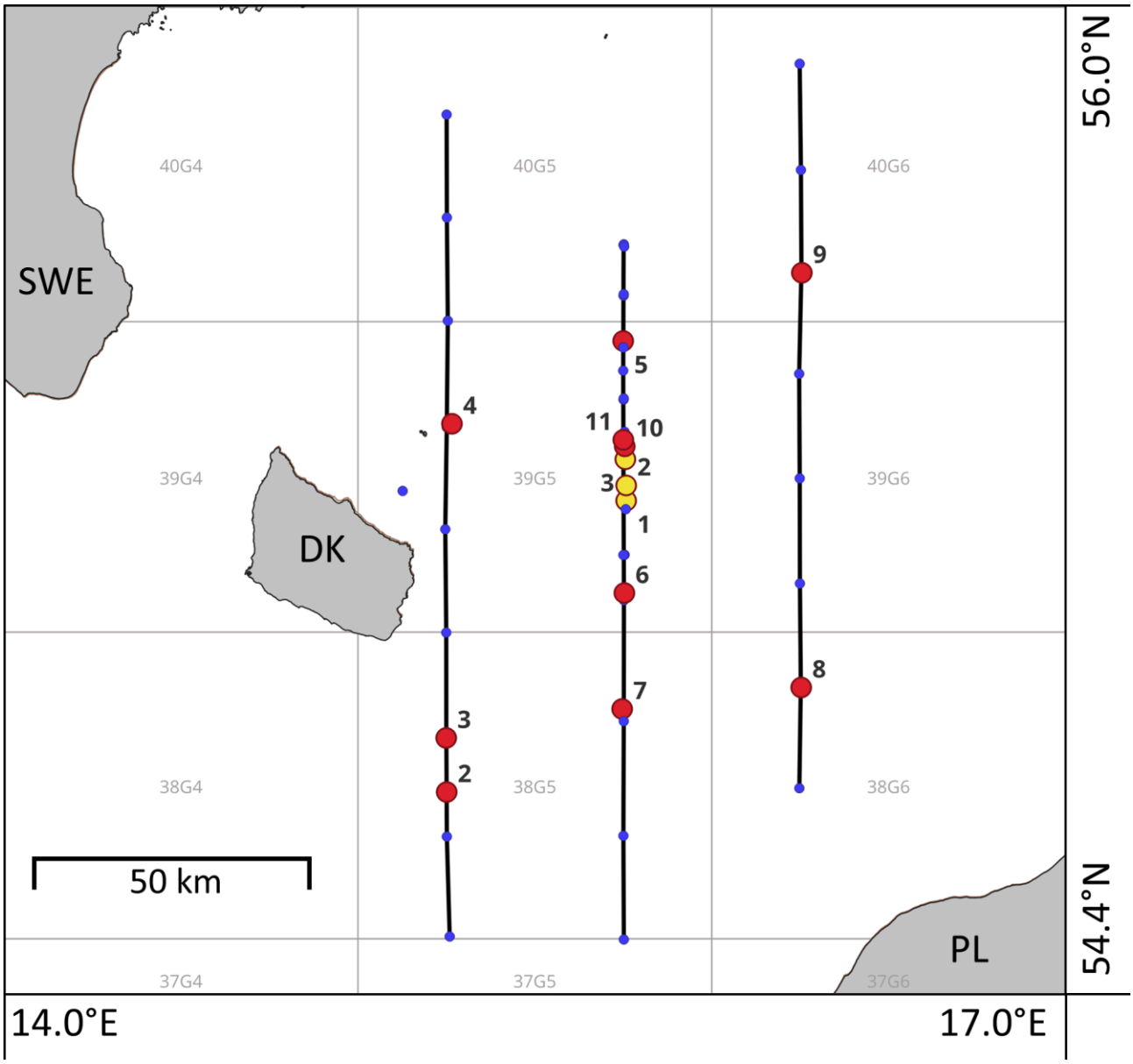

Figure 1: "Solea" cruise 836 in the Bornholm Basin (including ICES rectangles). Black lines indicate the three hydroacoustic transects conducted during the cruise. Red dots indicate stations of pelagic fishing (including the invalid haul #2) while yellow dots represent the stations sampled with the Plankton net (numbers indicate respective running haul numbers). Small blue dots show the CTD stations along the transects and during calibration. Please note: tests of the ROTV and pelagic trawling on June 12 (Bay of Mecklenburg) are not shown.

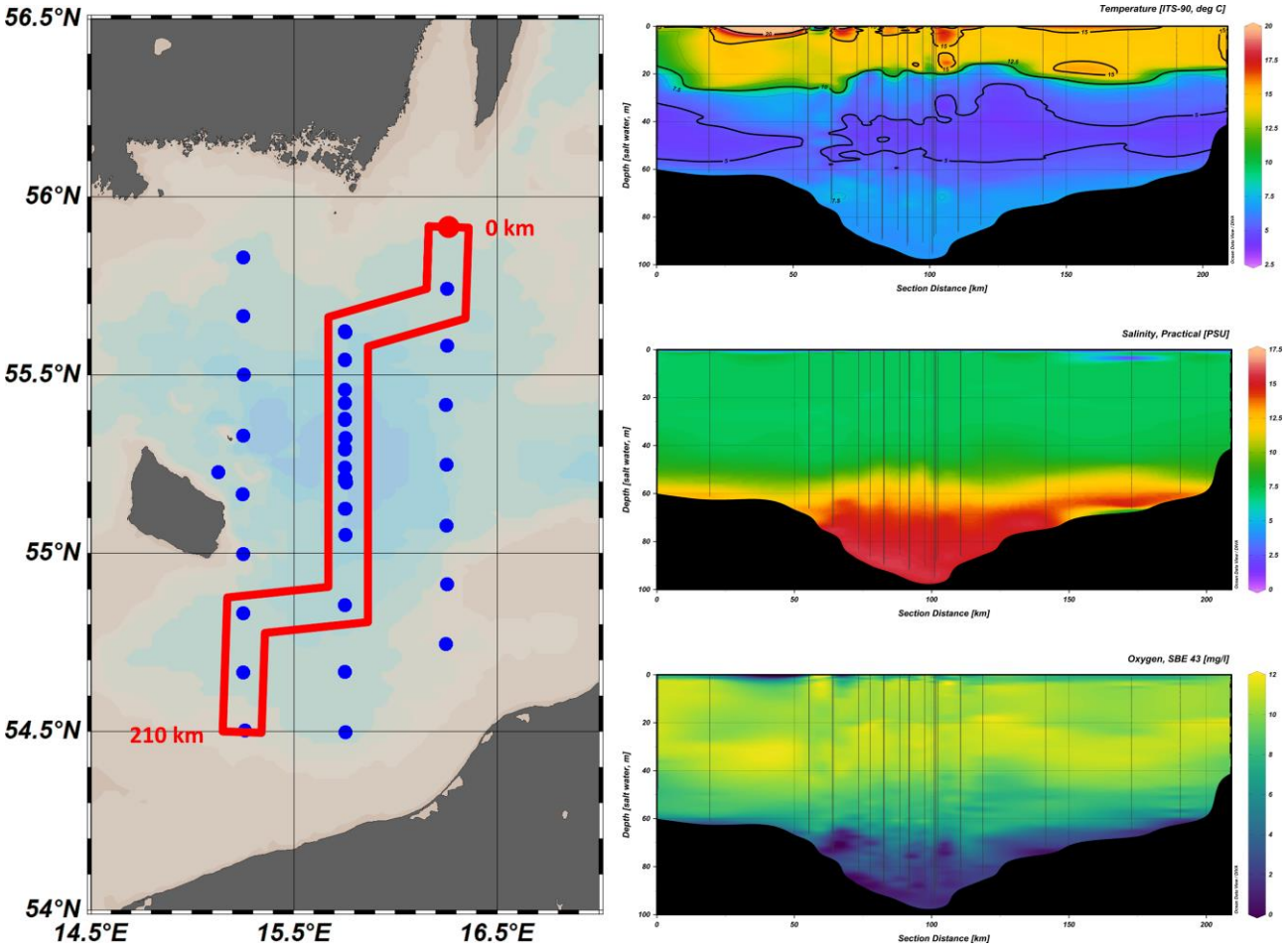

Figure 2: "Solea" cruise 836: Temperature (upper right panel), salinity (middle right panel) and oxygen (lower right panel) interpolated from CTD casts along a north/east - south/west transect as shown in the left panel (red line). CTD casts coordinates are displayed as blue dots on the map in the left panel.

Table 2: FRV "Solea" cruise 836: Numerical catch composition per haul and net (codend of the multisampler) given in absolute numbers and expressed as catch per unit effort (numbers per 30 minutes of trawling). Catch duration is given in minutes, catch depths (minimum and maximum) in meters. No catch are indicated by "-". Species are indicated by their 3-alpha code (HER = *Clupea harengus;* LUM = *Cyclopterus lumpus;* COD = *Gadus morhua*; GTA = *Gasterosteus aculeatus*; FLE = *Platichthys flesus*; MAC = *Scomber scombrus;* SPR = *Sprattus sprattus*).

Date	haul	ICES rectangle	net	Start (utc)	duration minutes	depth min	depth max	catch in absolute numbers							catch per unit effort (n per 30 min trawling)						
								HER	LUM	COD	GTA	FLE	MAC	SPR	HER	LUM	COD	GTA	FLE	MAC	SPR
20240615	2	38G5	A	713	11	NA	NA	-	-	-	-	-	-	2428	-	-	-	-	-	-	6622
			B	724	21	NA	NA	18	-	-	-	-	-	105	26	-	-	-	-	-	150
			C	745	5	NA	NA	3	-	-	-	-	-	158	18	-	-	-	-	-	948
			total	**713**	**37**	**NA**	**NA**	**21**	**-**	**-**	**-**	**-**	**-**	**2691**	**17**	**-**	**-**	**-**	**-**	**-**	**2182**
20240615	4	39G5	A	1430	16	7.5	40.1	6	-	-	-	-	-	11	11	-	-	-	-	-	21
			B	1446	13	45	67.9	-	-	-	-	-	-	101	-	-	-	-	-	-	233
			C	1500	6	58.3	72.9	-	-	-	-	-	-	4521	-	-	-	-	-	-	22605
			total	**1430**	**35**	**7.5**	**72.9**	**6**	**-**	**-**	**-**	**-**	**-**	**4633**	**5**	**-**	**-**	**-**	**-**	**-**	**3971**
20240616	5	39G5	A	611	24	13.8	21	2	-	-	1	-	1	1727	3	-	-	1	-	1	2159
			B	636	10	57.5	67	-	-	2	-	-	-	441	-	-	6	-	-	-	1323
			C	647	10	69.2	76	1	1	4	-	1	-	711	3	3	12	-	3	-	2133
			total	**611**	**44**	**13.8**	**76**	**3**	**1**	**6**	**1**	**1**	**1**	**2879**	**2**	**1**	**4**	**1**	**1**	**1**	**1963**
20240616	6	39G5	A	1110	14	7.1	50.3	-	-	-	-	-	-	28	-	-	-	-	-	-	60
			B	1125	13	61.3	64.5	-	-	1	-	-	-	31	-	-	2	-	-	-	72
			C	1139	10	69.1	75.8	8	-	1	-	-	-	307	24	-	3	-	-	-	921
			total	**1110**	**37**	**7.1**	**75.8**	**8**	**-**	**2**	**-**	**-**	**-**	**366**	**6**	**-**	**2**	**-**	**-**	**-**	**297**
20240616	7	38G5	A	1346	12	51.7	63	2	-	16	-	1	-	200	5	-	40	-	3	-	500
			B	1359	12	36.4	49.7	2	-	-	-	-	-	53	5	-	-	-	-	-	133
			C	1412	10	14.4	25.6	1	-	-	-	-	-	204	3	-	-	-	-	-	612
			total	**1346**	**34**	**14.4**	**63**	**5**	**-**	**16**	**-**	**1**	**-**	**457**	**4**	**-**	**14**	**-**	**1**	**-**	**403**
20240617	8	38G6	A	619	12	9.1	16	-	-	-	-	-	-	334	-	-	-	-	-	-	835
			B	632	15	17.6	21.9	1213	-	-	-	-	-	10397	2426	-	-	-	-	-	20794
			C	647	1	15	15	4	-	-	-	-	-	2283	120	-	-	-	-	-	68490
			total	**619**	**28**	**9.1**	**21.9**	**1217**	**-**	**-**	**-**	**-**	**-**	**13014**	**1304**	**-**	**-**	**-**	**-**	**-**	**13944**
20240617	9	40G6	A	1219	12	9.9	22.4	-	-	-	-	-	-	8707	-	-	-	-	-	-	21768
			B	1232	10	32	49.9	3	-	4	1	-	-	2780	9	-	12	3	-	-	8340
			C	1244	10	54.6	61.3	-	-	-	-	-	-	1713	-	-	-	-	-	-	5139
			total	**1219**	**32**	**9.9**	**61.3**	**3**	**-**	**4**	**1**	**-**	**-**	**13200**	**3**	**-**	**4**	**1**	**-**	**-**	**12375**
20240618	10	39G5	A	1446	10	79.8	82.3	-	-	54	-	-	-	-	-	-	162	-	-	-	-
			B	1457	11	52	69.9	-	-	4	-	-	-	43	-	-	11	-	-	-	117
			C	1509	10	10.9	36.9	-	-	-	-	-	-	18	-	-	-	-	-	-	54
			total	**1446**	**31**	**10.9**	**82.3**	**-**	**-**	**58**	**-**	**-**	**-**	**61**	**-**	**-**	**56**	**-**	**-**	**-**	**59**
20240618	11	39G5	A	2009	13	8.3	24.4	264	1	-	-	-	-	14	609	2	-	-	-	-	32
			B	2022	10	35.7	61.8	36	-	1	-	-	-	-	108	-	3	-	-	-	-
			C	2034	11	53.2	83.4	28	-	23	-	-	-	1	76	-	63	-	-	-	3
			total	**2009**	**34**	**8.3**	**83.4**	**328**	**1**	**24**	**-**	**-**	**-**	**15**	**289**	**1**	**21**	**-**	**-**	**-**	**13**

Table 3: FRV "Solea" cruise 836: Catch composition (biomass) per haul and net (codend of the multisampler) given in absolute values and expressed as catch per unit effort (kg per 30 minutes of trawling). Catch duration is given in minutes, catch depths (minimum and maximum) in meters. No catch are indicated by "-". Species are indicated by their 3-alpha code (HER = *Clupea harengus;* LUM = *Cyclopterus lumpus;* COD = *Gadus morhua*; GTA = *Gasterosteus aculeatus*; FLE = *Platichthys flesus*; MAC = *Scomber scombrus;* SPR = *Sprattus sprattus*).

Date	haul	ICES rectangle	net	Start (utc)	duration min	depth min	depth max	catch in kg							catch per unit effort (kg per 30 min trawling)						
								HER	LUM	COD	GTA	FLE	MAC	SPR	HER	LUM	COD	GTA	FLE	MAC	SPR
20240615	2	38G5	A	713	11	NA	NA	-	-	-	-	-	-	37.96	-	-	-	-	-	-	103.53
			B	724	21	NA	NA	0.92	-	-	-	-	-	1.67	1.31	-	-	-	-	-	2.38
			C	745	5	NA	NA	0.16	-	-	-	-	-	2.36	0.97	-	-	-	-	-	14.17
			total	**713**	**37**	**NA**	**NA**	**1.08**	**-**	**-**	**-**	**-**	**-**	**41.99**	0.87	-	-	-	-	-	34.04
20240615	4	39G5	A	1430	16	7.5	40.1	0.27	-	-	-	-	-	0.17	0.50	-	-	-	-	-	0.31
			B	1446	13	45	67.9	-	-	-	-	-	-	1.44	-	-	-	-	-	-	3.31
			C	1500	6	58.3	72.9	-	-	-	-	-	-	64.00	-	-	-	-	-	-	320.00
			total	**1430**	**35**	**7.5**	**72.9**	**0.27**	**-**	**-**	**-**	**-**	**-**	**65.60**	0.23	-	-	-	-	-	56.23
20240616	5	39G5	A	611	24	13.8	21	0.07	-	-	+	-	0.82	24.32	0.08	-	-	+	-	1.03	30.40
			B	636	10	57.5	67	-	-	0.36	-	-	-	6.88	-	-	1.07	-	-	-	20.64
			C	647	10	69.2	76	0.03	0.01	0.51	-	0.12	-	9.67	0.10	0.02	1.52	-	0.37	-	29.01
			total	**611**	**44**	**13.8**	**76**	**0.10**	**0.01**	**0.86**	**+**	**0.12**	**0.82**	**10.34**	0.07	0.01	0.59	+	0.08	0.56	7.05
20240616	6	39G5	A	1110	14	7.1	50.3	-	-	-	-	-	-	0.41	-	-	-	-	-	-	0.88
			B	1125	13	61.3	64.5	-	-	0.24	-	-	-	0.44	-	-	0.54	-	-	-	1.01
			C	1139	10	69.1	75.8	0.43	-	0.30	-	-	-	4.28	1.30	-	0.91	-	-	-	12.83
			total	**1110**	**37**	**7.1**	**75.8**	**0.43**	**-**	**0.54**	**-**	**-**	**-**	**5.12**	0.35	-	0.44	-	-	-	4.15
20240616	7	38G5	A	1346	12	51.7	63	0.08	-	4.49	-	0.25	-	2.75	0.20	-	11.23	-	0.62	-	6.88
			B	1359	12	36.4	49.7	0.09	-	-	-	-	-	0.73	0.23	-	-	-	-	-	1.83
			C	1412	10	14.4	25.6	0.06	-	-	-	-	-	2.27	0.17	-	-	-	-	-	6.82
			total	**1346**	**34**	**14.4**	**63**	**0.23**	**-**	**4.49**	**-**	**0.25**	**-**	**5.76**	0.20	-	3.96	-	0.22	-	5.08
20240617	8	38G6	A	619	12	9.1	16	-	-	-	-	-	-	4.92	-	-	-	-	-	-	12.29
			B	632	15	17.6	21.9	32.04	-	-	-	-	-	154.12	64.08	-	-	-	-	-	308.24
			C	647	1	15	15	0.11	-	-	-	-	-	32.04	3.18	-	-	-	-	-	961.20
			total	**619**	**28**	**9.1**	**21.9**	**32.15**	**-**	**-**	**-**	**-**	**-**	**191.08**	34.44	-	-	-	-	-	204.72
20240617	9	40G6	A	1219	12	9.9	22.4	-	-	-	-	-	-	117.98	-	-	-	-	-	-	294.95
			B	1232	10	32	49.9	0.11	-	0.76	0.01	-	-	36.87	0.32	-	2.27	0.02	-	-	110.61
			C	1244	10	54.6	61.3	-	-	-	-	-	-	23.50	-	-	-	-	-	-	70.50
			total	**1219**	**32**	**9.9**	**61.3**	**0.11**	**-**	**0.76**	**0.01**	**-**	**-**	**178.35**	0.10	-	0.71	+	-	-	167.20
20240618	10	39G5	A	1446	10	79.8	82.3	-	-	9.82	-	-	-	-	-	-	29.46	-	-	-	-
			B	1457	11	52	69.9	-	-	1.35	-	-	-	0.64	-	-	3.68	-	-	-	1.73
			C	1509	10	10.9	36.9	-	-	-	-	-	-	0.25	-	-	-	-	-	-	0.75
			total	**1446**	**31**	**10.9**	**82.3**	**-**	**-**	**11.17**	**-**	**-**	**-**	**0.89**	-	-	10.81	-	-	-	0.86
20240618	11	39G5	A	2009	13	8.3	24.4	13.81	0.01	-	-	-	-	0.20	31.87	0.02	-	-	-	-	0.47
			B	2022	10	35.7	61.8	1.92	-	0.33	-	-	-	-	5.77	-	1.00	-	-	-	-
			C	2034	11	53.2	83.4	1.18	-	6.66	-	-	-	0.02	3.23	-	18.16	-	-	-	0.04
			total	**2009**	**34**	**8.3**	**83.4**	**16.92**	**0.01**	**6.99**	**-**	**-**	**-**	**0.22**	14.93	0.01	6.17	-	-	-	0.19