ALKOR-Berichte

Monitoring winter spawning activity of Western Baltic cod (Gadus morhua) (2021-25)

Cruise No. AL568b

January 24th – February 1st 2022
Kiel (Germany) – Kiel (Germany)
Winter cod 2021-25

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2022

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1 Cruise Summary

1.1 Summary in English

The Western Baltic cod stock is currently in distress. This is believed to be linked to the low level of recruitment success over several years. The reasons behind are not yet well understood. There are indications of a (potentially climate-induced) shift in the spawning phenology of the stock, with spawning activity shifting to earlier time periods (peak spawning usually occured in March). This can cause poor larval survival, as the probability for mismatch situations between cod larvae and its prey (zooplankton species) increases.

This cruise was the second out of five proposed cruises in the framework of the winter cod 2021-25 cruises of the IMF, which aim to investigate the early winter spawning activity of Western Baltic cod. For this purpose, ichthyoplankton samples and cod samples were taken on a for-defined station grid. Cod samples were used to investigate maturity stages and condition of adult cod. Plankton samples were analysed with a focus on the occurrence of cod eggs and larvae. The data will be used to identify whether there is a shift towards earlier spawning activities of Western Baltic cod, and how spawning activity differs spatially between parts of the Belt Sea.

During the cruise AL568b, spawning cod were found in the Kiel Bight, the Mecklenburg Bight and the Fehmarn Belt. Moreover, first analyses of BONGO-net samples revealed the occurrence of cod larvae in the Little Belt and Kiel Bight. The observation of cod larvae in this region and the observation of ripe, spawning cod in the Mecklenburg Bight and Fehmarn Belt in January gave further evidence for the hypothesised shift in spawning phenology of cod in the Belt Sea.

1.2 Zusammenfassung

Der Dorschbestand der westlichen Ostsee befindet sich derzeit in einer Notlage. Der schlechte Zustand des Bestandes wird mit dem geringen Rekrutierungserfolg der letzten Jahre in Zusammenhang gebracht. Die Gründe für die anhaltende geringe Rekrutierung sind bisher nicht ausreichend geklärt. Hinweise deuten auf eine (möglicherweise klimatisch bedingte) Verschiebung der Laichphänologie hin. Die Laichaktivität (die normalerweise im März ihren Höhepunkt erreicht) findet zu einem immer früheren Zeitpunkt statt. Dies führt wahrscheinlich zu einem Missverhältnis zwischen den Dorschlarven und ihrer Nahrung, dem Zooplankton. Dies hat ein schlechteres Überleben der Larven zur Folge.

Diese Fahrt war die zweite von fünf beantragten Fahrten im Rahmen der Winterdorsch 2021-25 Fahrten des IMF, die das Ziel haben, die frühe Winterlaichaktivität des westlichen Ostseedorsches zu untersuchen. Zu diesem Zweck wurden Ichthyoplanktonproben und Dorschproben auf einem vorher festgelegten Stationsraster genommen. Die Dorschproben dienen der Untersuchung der Reifestadien und des Zustands der adulten Dorsche. Die Planktonproben wurden insbesondere auf das Vorkommen von Dorscheiern und -larven untersucht. Anhand der Beprobungsdaten sollte festgestellt werden, ob es eine frühe Laichaktivität des westlichen Ostseedorsches gibt, und ob es darüber hinaus, räumliche Unterschiede in der Laichaktivität des westlichen Ostseedorsches zwischen den verschiedenen Teilen der Beltsee gibt.

Während der Fahrt AL568b wurden laichende Dorsche in der Kieler Bucht, dem Fehmarn Belt und in der Mecklenburger Bucht gefunden. Darüber hinaus zeigten erste Analysen von BONGO-Netz-Proben das Vorkommen von Dorschlarven in der Kieler Bucht und dem Kleinen Belt. Die Beobachtung von Dorschlarven in diesem Areal und die Beobachtung von laichreifen Individuen

in der Mecklenburger Bucht lieferte weitere Belege für die vermutete Verschiebung der Laichphänologie des Dorsches in der Beltsee.

2 Participants

2.1 Principal Investigators

Table 2.1. List of Principal Investigators of the Winter cod cruises 2021-25.

Name	Academic title	Institution
Möllmann, Christian	Prof., Dr. rer. nat.	IMF
Funk, Steffen	Dr. rer. nat.	IMF

2.2 Scientific Party

Table 2.2. List of scientific party of cruise AL568b.

Name	Discipline	Institution
Funk, Steffen, Dr. rer. nat.	Chief scientist; PostDoc	IMF
Klinger, Richard	PhD student	IMF
Gjeitsund Thorvaldsen, Kjetil	PhD student	DTU Aqua
Heckler, Svenja	MSc student	IMF
Höper, Anton	MSc student	IMF
Kondratowicz, Stephanie	Technician	IMF
Neuenfeldt, Stefan, Dr. rer. nat.	Senior scientist	DTU Aqua
Nowicki, Margarethe	PhD student	IMF
Plonus, Rene-Marcel	PhD student	IMF
Rodriguez-Tress, Paco	PhD student	DTU Aqua
Saathoff, Merten	PhD student	IMF
Smialek, Nicole, Dr. rer. nat.	PostDoc	IMF

2.3 Participating Institutions

IMF Institute of Marine Ecosystem and Fisheries Science, University of Hamburg
DTU Aqua National Institute of Aquatic Resources, Danish Technical University

3 Research Program

3.1 Description of the Work Area

The working area of AL568b was located in the Kiel Bight, Little Belt, Great Belt, Fehmarn Belt, and Mecklenburg Bight, which are all part of the Belt Sea (ICES subdivision (SD)22). The Belt Sea is a stratified, brackish-water area (common salinity range: 10 to 25 PSU), which together with the Arkona Sea (SD24) and the Sound (SD23) forms the Western Baltic Sea (WBS) (Fig. 3.1). The Western Baltic Sea is characterized by several shallow obstacles such as the Darss Sill, limiting inflows of water with high salinities from the Kattegat region to the eastern parts of the Baltic Sea. This limited saltwater inflow in combination with river runoffs results in a constant decrease of salinity from the western to the eastern parts of the Baltic Sea. The Belt Sea is microtidal (tidal range: ~ 10 cm) and characterized by wind-induced fluctuations in hydrographic conditions (Leppäranta and Myrberg, 2000; Snoeijs-Leijonmalm and Andrén, 2017). This is caused by changes in inflow of more saline bottom water from the Kattegat and surface outflow of less saline water from the central and southern Baltic Sea through the Danish Straits and the Darss sill. SD22 and SD23 are known as the distributional core area of the Western Baltic cod (*Gadus morhua*) stock. Here, stock mixing with the more easterly distributed Eastern Baltic cod (*Gadus morhua callarias*) is considered negligible (ICES, 2019).

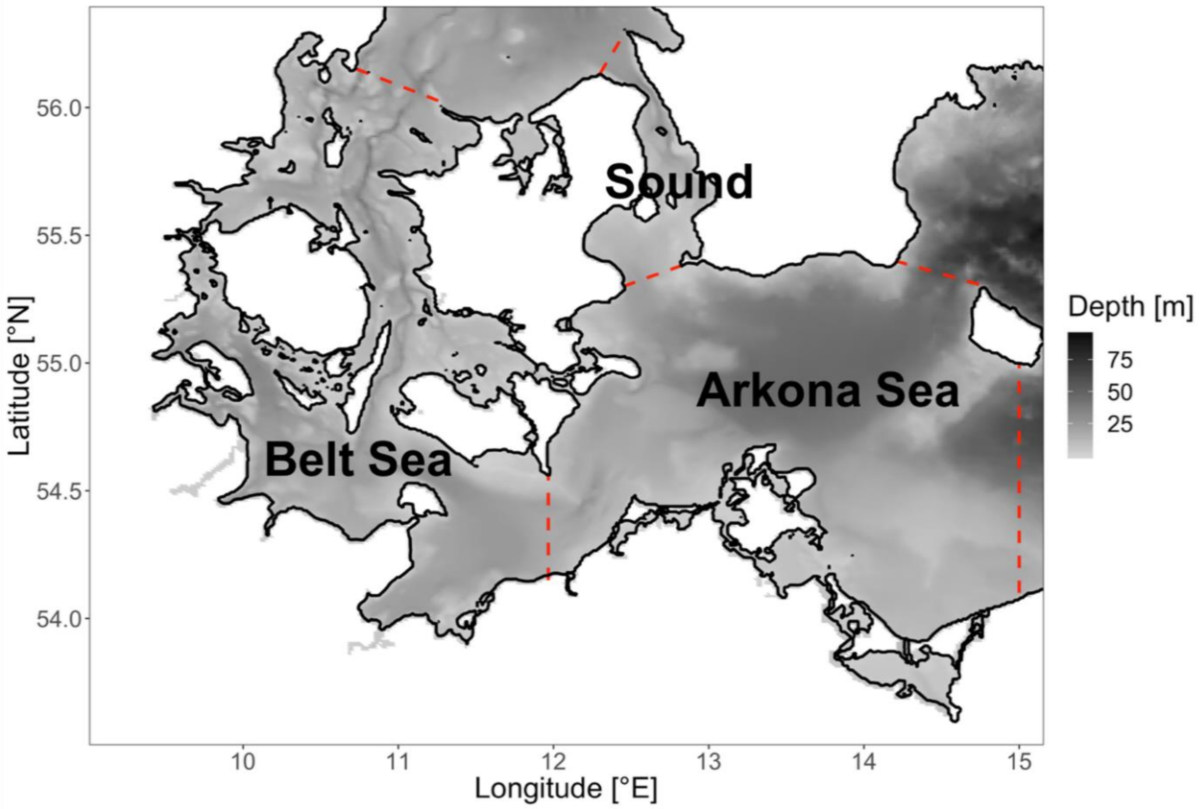

Figure 3.1. Bathymetry of the Western Baltic Sea. Dashed red lines indicate borders between ICES Subdivisions (SD22 – Belt Sea; SD23 – Sound, and SD24 – Arkona Sea). Figure was taken from Funk, 2020.

3.2 Aims of the Cruise

The Western Baltic cod stock (WBC) is currently in distress. This is believed to be linked to the low level of recruitment success over several years. The reasons behind are not yet well understood. There are indications of a (potentially climate-induced) shift in the spawning phenology of the stock, with spawning activity shifting (peak spawning usually occurred in March [Bleil and Oeberst, 1997; Bleil et al., 2009]) to an earlier time period. This has already been observed for other stocks of Atlantic cod as well (e.g., McQueen and Marshall, 2017). The shift probably causes a mismatch situation between the cod larvae and its main prey (zooplankton), which can result in poor larval survival and consequently lower recruitment success. There is an indication that accelerated gonad maturation is already an ongoing process in the study area. Post-spawning cod individuals have been observed more frequently during the Baltic international trawl survey (BITS) conducted in the 1st quarter between the end of February and mid-March each year (pers. comm. U. Krumme, Thuenen Institute of Baltic Sea Fisheries, Rostock). Furthermore, local

gillnet fishers located in the harbours of Burgstaaken and Heiligenhafen (Schleswig-Holstein, Germany) observed increasing numbers of spawning cod individuals already in January. The mature fish occur increasingly earlier on their traditional spawning grounds within the channels of the Kiel Bight, Mecklenburg Bight and Fehmarn Belt (pers. comm. S. Funk with local gillnetters). In contrast, former studies indicate that spawning migrations towards these areas occur mainly in February and March. (Bleil and Oeberst, 1997; Bleil et al., 2009). Due to its internationally coordinated timing, the official monitoring programme (i.e., Baltic International Trawl Survey [BITS]) will continue to be carried out during the end of February to mid-March and is therefore likely to miss this potentially important early-winter stock dynamics of WBC. The proposed cruises in the framework of winter cod 2021-25 will thus provide important insights into the reproductive ecology of the WBC population, crucial for its sustainable management.
On the one hand, new insights into a potential shift in the spawning phenology of cod in the Western Baltic Sea may provide a better understanding of its recruitment dynamics and the interannual variability of recruitment success. On the other hand, these findings could be used to adapt management measures such as seasonal closures or catch restrictions by taking into account shifts in the cod spawning season.

Therefore, cruise AL568b aimed to:

1. investigate spatial distribution of mature, adult cod inhabiting traditional spawning grounds in the Belt Sea in late January including sampling positions in the channels of the Kiel Bight, Little Belt, Great Belt (i.e., Langeland Belt), Fehmarn Belt and Mecklenburg Bight.
2. investigate the spatial distribution of cod eggs and larvae in the Belt Sea in late January.

To realize these goals, we defined a station grid of 43 sampling positions, which should be used for zooplankton and especially ichthyoplankton sampling using a BONGO net, including 19 positions in the Kiel Bight, three positions in the Little Belt, two positions in the Great Belt, three positions in the Fehmarn Belt and 16 positions in the Mecklenburg Bight (Fig. 3.2). This plankton station grid was based on a station grid sampled also during previous winter and spring cruises (including winter cod cruise in 2021, AL549) of the University of Hamburg. These previous plankton samples, dating back to 2016, were analysed in cooperation with the Danish Technical University (DTU) in the project FORTORSK. Data collected and analysed in this framework can be used as a baseline for comparison of egg and larvae numbers observed in early winter (i.e., January) during the winter cod cruises with those observed during peak spawning periods (February and March of previous years). Furthermore, findings of cod eggs and larvae at several stations of the plankton station grid in previous years prove that at least occasionally cod eggs and larvae can be found at these stations.
In addition, we defined 13 trawl positions at known spawning grounds in the Belt Sea (Fig. 2), where it was planned to sample cod using a bottom trawl net (TV3/520, the standard net used during the Baltic international trawl surveys). Due to a malfunction of the fishing winch, which occurred immediately before the start of cruise AL568b, the planned bottom trawl fishery had to be cancelled.
To nevertheless collect data on length, maturity and condition distribution of adult cod in the Belt Sea during the cruise, it was decided to conduct rod and reel fishery, i.e., angling stations. The angling stations were selected according to the knowledge on preferred cod feeding and spawning

grounds. This included both the deeper channels as well as wrecks and stone fields, of which most were located at the slopes and borders to the deeper channels of the western Baltic Sea.

The chosen angling positions at the spawning grounds in the deeper channels of the Belt Sea, where located in the Vejsnæs channel in the Kiel Bight and in the Mecklenburg Bight. The decision to fish there was based on the successful fishing experiences from the last years, where highest numbers of spawning individuals were caught at these positions. In the cruise report of AL549 we also mentioned the Fehmarn Belt to be a well-known traditional spawning ground of WBC (Funk and Möllmann, 2021). However, hard structured grounds with rocky reef structures strictly limits our range of activity during standard bottom trawling. Hence, we decided to take advantage from the special situation that we were forced to use rod and reel fishery instead of standard bottom trawling, which is not restricted in use by habitat properties and thus, decided to focus especially on hard-structured fishing locations near to the Fehmarn Belt area. For this purpose, we selected a number of both known and unknown wreck sites in 17 to 24 m depth near to the Fehmarn Belt for angling.

Due to the omission of trawl stations, initially MULTINET sampling stations were shifted to near GS stations. MULTINET samples were planned to give insights about egg and larvae vertical distributions at these locations. This could then be set into relation to the number of adult cod at the corresponding spawning grounds.

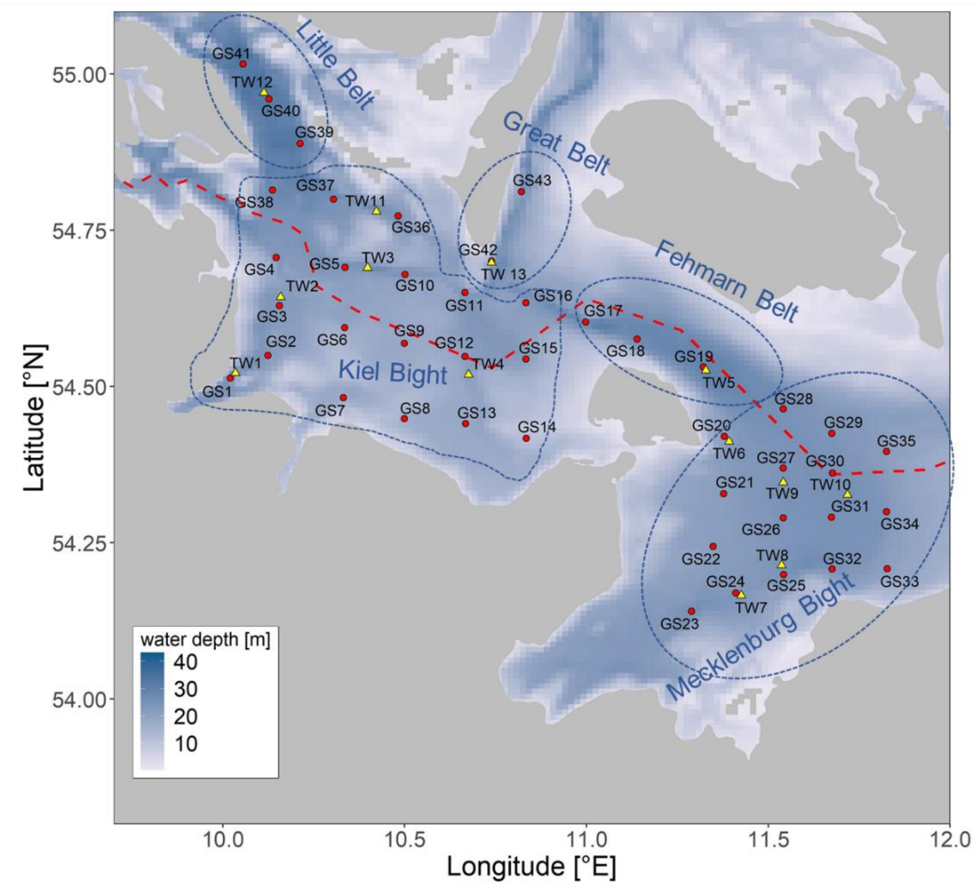

Figure 3.2. Planned zooplankton and trawl fishery stations for the winter cod cruise AL568b. Red dots indicate CTD and BONGO net stations. Blue triangles indicate trawl and MULTINET stations. Red dashed line depicts EEZ borders and blue circles indicate stations allocated to a

specific subregion in the work area, i.e., Kiel Bight, Fehmarn Belt, and Mecklenburg Bight, Great Belt and Little Belt.

3.3 Agenda of the Cruise

It was planned to realize a plankton grid sampling consisting of 35 BONGO net and CTD stations complemented by 10 stations with trawl fishery and MULTINET hauls including the following objectives:

Hydrographic data

Detailed collection of the hydrographic conditions at the working area including fluorescence, oxygen, salinity, pH and temperature.

Zoo- and ichthyoplankton data

Cod larvae of BONGO net 500 µm should be collected directly out of the samples, and deep frozen at -80°C for subsequent condition analyses in the laboratory. BONGO- and MULTINET-samples should be preserved in formalin for later detailed zoo- and ichthyoplankton community and size composition analyses at the laboratory of the University of Hamburg.

Fishery data

Sampling of the occurring fish fauna at for-defined sampling stations at traditional cod spawning grounds including the collection of individual fish data of cod and whiting. In detail it was planned to document: full weight, gutted weight, liver weight, sex, maturity stage, gonad weight, stomach fullness, and otolith samples, as well as in the case of cod samples of stomachs, liver and fin clips. The documentation of length and weight data was planned for all other caught fish species.

- Cod and whiting stomach samples were taken to supplement the Western Baltic cod stomach data base of the University of Hamburg dating back to 2016 (see Funk et al., 2021b).
- Cod fin clips were taken for potential cod stock discrimination analyses using genetics.
- Cod liver samples were taken in the framework of a PhD thesis (Richard Klinger, Supervisors: Prof. Dr. A. Temming [IMF], and Dr. U. Krumme [TI-OF]) at the University of Hamburg investigating the size-specific relations between cod liver size and weight and fat energy contents.
- Cod and whiting otolith samples were taken for subsequent aging.
- Continuous* recording of hydroacoustic data with four different echosounder frequencies (38, 70, 120 and 200 kHz) for biomass estimations (*frequencies between 38kHz and 120kHz were partly muted during the cruises according to the restrictions given in the diplomatic permits by the Danish Ministry of Foreign Affairs and the Danish Environmental Agency concerning the planned sampling in designated harbour porpoise protected areas).

4 Narrative of the Cruise

RV ALKOR departed from GEOMAR pier in Kiel on January 24th at 08:30 heading to the first plankton grid station in the Kiel Bight (GS 6, Fig. 3.2), where the station work started, heading further towards the stations in the Fehmarn Belt and entering on Monday evening the Mecklenburg Bight. Until Wednesday evening all planned plankton stations within the Mecklenburg Bight were completed. Additionally, 6 angling stations were conducted in the Mecklenburg Bight and in the eastern part of the Fehmarn Belt (see Fig. 4.1E). From the Mecklenburg RV Alkor headed into the Little Belt, where station work was continued on Thursday morning. Due to strong westerly winds with 6 to 7 Beaufort, it was decided to conduct samplings at rather coastal stations on Thursday from the Little Belt on to the Bight of Eckernförde (i.e., GS 41, 40, 39, 38, 4, 3, and 1). Rod and reel fishery in the Little Belt were not carried out due to bad weather conditions, as the strong wind and resulting drift would not have allowed for controlled fishing. On Thursday evening RV headed to its homeport Kiel to ride out the stormy weather conditions. RV Alkor departed again from Kiel on Friday morning at 07:30 to continue station work in the Kiel Bight. Rather calm weather conditions enabled the completion of all remaining plankton stations in the Kiel Bight and Great Belt. Furthermore, an angling station was carried out on a wreck in the northern Bight of Hohwacht near to the Fehmarn Belt. On Friday evening RV Alkor headed once again to its homeport Kiel to ride out the stormy weather conditions on Saturday and Sunday with up to 10 Beaufort. It was decided to conduct additional angling samples on Monday to collect additional condition, maturity and length distribution data of WBC. For this purpose, RV Alkor departed on Monday morning at 7:30 from its homeport Kiel heading to a wreck in the south of the Stollergrund. During the day a total of 7 wreck sites as well as two spots at the Vejsnæs channel were sampled via rod and reel fishery. At Monday evening RV Alkor headed to the eastern shore of the habour in Kiel, where the cruise ended.

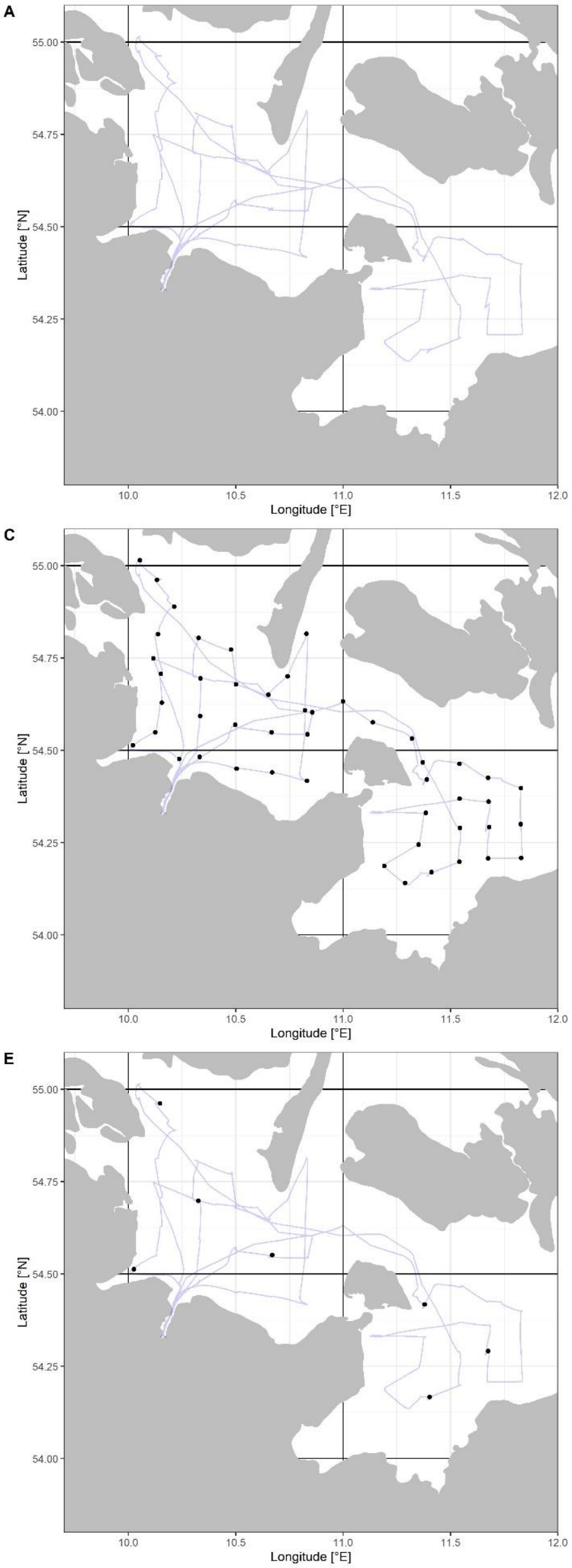

Figure 4.1. Cruise track (A) and sampling positions (B: BONGO net hauls, C: CTD hauls, D: Rod & reel fishery stations, E: MULTINET hauls) of AL568b. Blue lines indicate cruise track. Black dots indicate sampling positions. Vertical and horizontal black lines indicate borders of ICES statistical rectangles.

Table 4.1. Overview of gear deployment during AL 568b. Numbers indicate number of deployments per gear (CTD = CTD probe, TV3/520= bottom trawl net, MSN = MULTINET midi towed, BONGO = BONGO with 300, 500 and 150 µm nets, and RRF = rod & reel fishery) and sub-area (KB = Kiel Bight, FBelt, = Fehmarn Belt, LBelt = Little Belt, GBelt = Great Belt and MB = Mecklenburg Bight). Number in brackets indicate number of gear deployments per sub-area planned in advance of the cruise.

	KB	**FBelt**	**MB**	**LBelt**	**GBelt**	**Sum**
CTD	22(19)	3(3)	18(16)	3(3)	2(2)	43(48)
BONGO	19(19)	3(3)	16(16)	3(3)	2(2)	43(43)
MSN	3(5)*	0(1)*	3(5)*	1(1)*	0(1)*	7(13)*
TV3/520	0(5)**	0(1)**	0(5)**	0(1)**	0(1)**	0(13)**
RRF	11(0)***	4(0)***	2(0)***	0(0)	0(0)	17(0)

*It was decided to skip MSN hauls at some positions due to missing stratification
**Due to malfunction of the fishery winch, trawl fishery could not be carried out during the cruise
***Rod and reel fishery stations were carried out instead of bottom trawling to enable sampling of biological parameters of WBC

5 Preliminary Results

5.1 Hydrography

(Steffen Funk and Richard Klinger)

CTD profiles were obtained from a total of 48 sampling stations. In general, we observed a nearly completely vertically mixed water body throughout the working area (Fig. 5.1.1.). Highest salinities with > 22 PSU were observed in the bottom water layers at sampling positions of the Little Belt and from entrance to the Great Belt to central Kiel Bight (i.e., GS15 & GS16).
Surface salinities ranged between 12.93 PSU and 21.87 PSU from the western to the eastern parts of the sampling area. Bottom salinities ranged between 15.88 and 23.11 PSU, with lowest salinities observed in the eastern Mecklenburg Bight (GS 34) (Fig. 5.1.2).
In the literature, salinities between 18 to 33 PSU are given as range for neutral egg buoyancy of Western Baltic cod with an optimum of 20-22 PSU (von Westernhagen, 1970; Westerberg, 1994; Nissling and Westin, 1997). Based on this salinity range conditions for cod egg buoyancy and thus conditions for a successful spawning could be found in the northern and central Kiel Bight as well as in the Fehmarn Belt, Great Belt and Little Belt but only partly in the Mecklenburg Bight. Thus, as already mentioned in the last year's cruise report (see Funk and Möllmann, 2021) the question can be raised, if any spawning activity in the central and eastern Mecklenburg Bight (see Figure 5.1.1D) during the survey period would have resulted in successful reproduction if conditions were not optimal. However, as also already mentioned in the last year's winter cod cruise report (see Funk and Möllmann, 2021) most of the cod egg buoyancy experiments were conducted with cod samples from the north western Belt Sea only and information from the Mecklenburg Bight are extremely limited. In the Arkona Basin neutral cod egg buoyancy was already observed at a salinity of 13.7 PSU ± 1.3 PSU (Nissling and Westin, 1997). Hence, there is at least a potential for a lower salinity threshold for neutral egg buoyancy in Western Baltic cod. Further egg buoyancy experiments (for example in the framework of future winter cod cruises) may shed light on small

scale difference in cod egg buoyancy requirements within the Belt Sea, and thus may provide valuable information on how successful observed spawning activities potentially are.
Except on station GS15 and GS16 in the central Kiel Bight bottom temperatures (ranging between 4.06 and 5.66°C) at bottom layers were in the range of the optimal values (4-8.5 °C) for successful egg development of Western Baltic cod eggs at most sampling stations (von Westernhagen, 1970; Bleil, 1995) (Fig. 5.1.2).

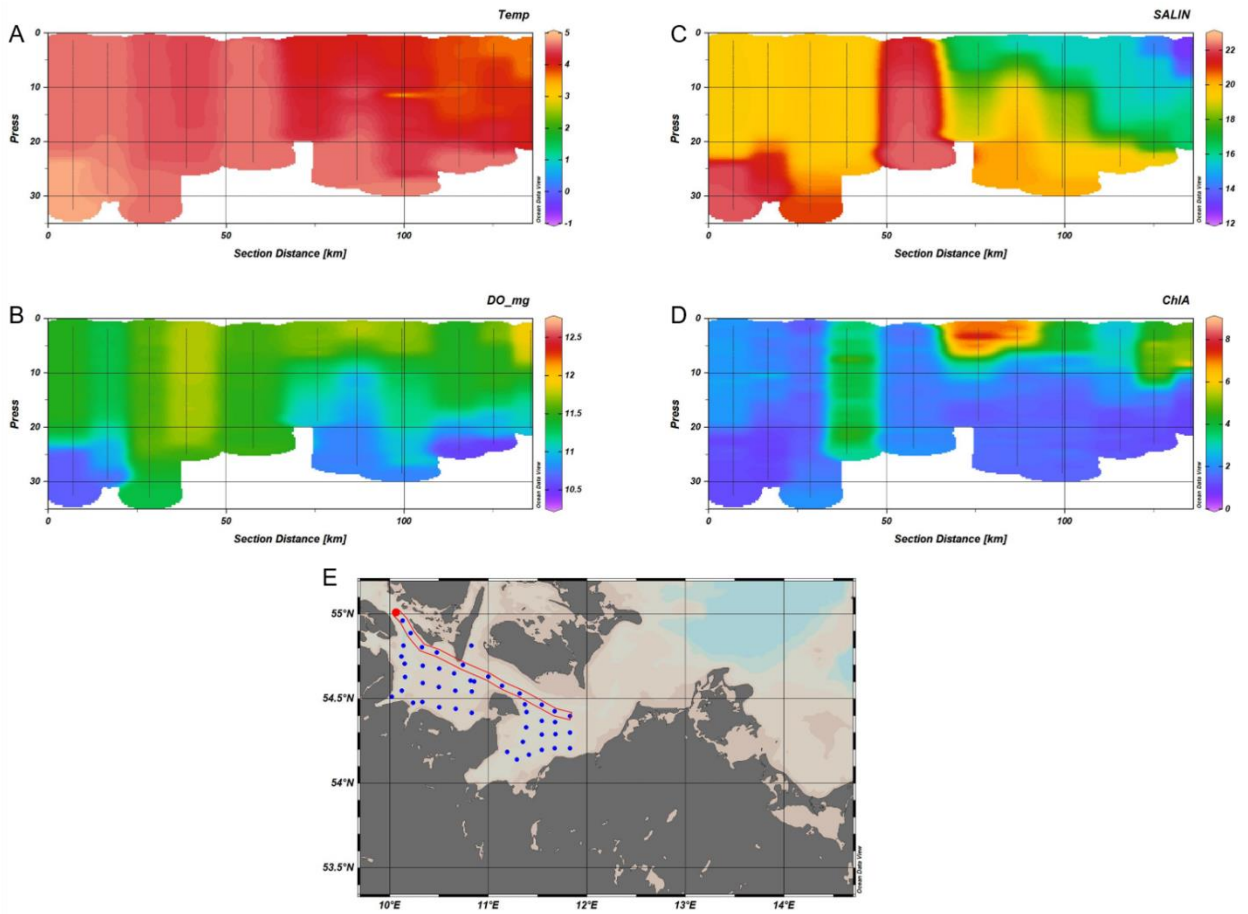

Figure 5.1.1. Interpolated hydrographic conditions in the Belt Sea in January 2022 (A: Temperature [°C], B: Dissolved oxygen [mg], C: Salinity [PSU], and D: Chlorophyll A concentration) obtained from CTD casts along a northwest-southeast gradient from the Little Belt to Mecklenburg Bight. Map (E) indicates chosen stations (red circled) for transect.

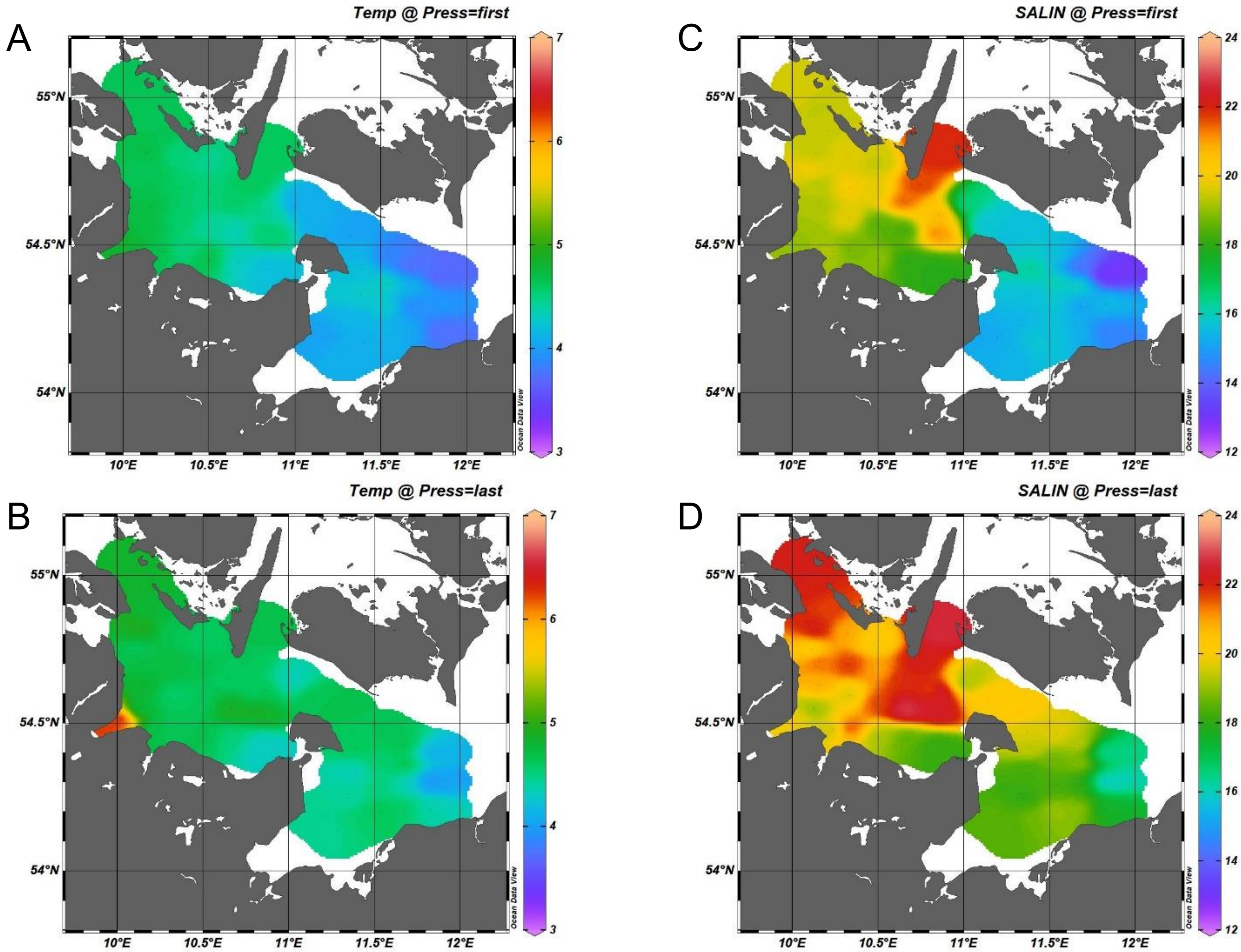

Figure 5.1.2. Interpolated hydrographic conditions in the Belt Sea in January 2022 (A: Temperature [°C] at surface, B: Temperature [°C] at bottom, C: Salinity [PSU] at surface, and D: Salinity at bottom [PSU]) obtained from CTD casts.

5.2 Fishery

(Steffen Funk, Richard Klinger, and Nicole Smialek)

A total of 17 rod and reel fishery hauls were conducted in Kiel Bight (n = 11), Fehmarn Belt (n = 4) and Mecklenburg Bight (n = 2) (see Tab. 4.1).

In total we caught 3 different fish species, a total of 70 fish individuals with a total weight of 50.828 kg (Tab. 5.2).

Our main target were adult cod for subsequent staging of the individuals as well as to collect further single fish data. Overall cod catches were relatively high, with a total catch of 65 cod individuals. Thus, we caught 30 individuals more than during trawling in the previous year (see Funk and Möllmann, 2021). However, due to lure bait-selection (i.e., lures for targeting cod were selected) we were not able to catch clupeids and we caught only single whiting and common dab as bycatch. Overall, our angling activities can be seen as highly cod selective fishing activities. During angling we mainly focussed on hard structured ground (i.e., mostly wreck sites) but also tested traditional spawning habitats as fishing spots such as the Vejsnæs channel. During fishing at these especially deep habitats characterised by soft bottom structures we were not able to catch a single cod individual. However, during trawling in the previous year these locations showed (among others) the highest cod abundancies. This inter-yearly catch differences can be due to several reasons: (i) cod spawning stock biomass (SSB) in the WBS is in constant decline and was lower in 2022 compared to 2021, hence catch potential during AL568b was simply lower than during AL549; (ii) overall abundance of cod on soft habitat might be driven by spill over effects since cod tend, even during spawning activity, to stay on rather hard-structured grounds. Thus, with lower overall WBC SSB overall spill over and thus cod abundancies on soft bottom areas might be lower in 2022 than in 2021. (iii) stormy weather may have driven cod to disperse rather than to aggregate. We fished at stations in the Vejsnæs channel on Monday 31st of January, two days after strong stormy weather. Fishers and charter vessel captains already reported that cod tend to aggregate on spawning grounds during calm weather situations, while they tend to disperse and move to their rather shallower feeding grounds during stormy weather (pers. comm. S. Funk with local gillnetters and charter vessel captains). Hence, we could not rule out that overall cod abundancies at their traditional spawning grounds were higher the day before the storm. However, during plankton sampling at the Vejsnæs channel on the Friday before, we also did not see strong fish signals near to the ground on the echo sounder which would have indicated higher cod abundances. (iv) in contrast to trawling even during drift fishing angling integrates cod catches from a much smaller area. Thus, especially when cod is extremely patchy and aggregated the chance of catching them with trawl might be much higher than during angling when not searching them via echosounder beforehand. (v) overall cod spawning activity in January 2022 might be lower than in 2021. This would also stand in line with lower numbers of cod larvae during AL568b compared to AL549 (see also section 5.3 Ichthyo- and Zooplankton Sampling).

Table 5.2. Catch composition in young fish trawl net hauls during AL568b with species composition, and total catch per species in numbers and weight [kg].

Species name	Common name	Total number	Total weight [kg]
Limanda limanda	common dab	2	0.106
Merlangius merlangus	whiting	3	0.214
Gadus morhua	cod	65	50.508

Cod catches

During the cruise AL568b a total of 65 cod individuals were caught during rod and reel fishery. All cod caught were processed individually and single fish data (i.e., total length, weight, gutted weight, sex maturity, liver weight, gonad weight and number of nematodes in the livers) as well as samples (i.e., otoliths, fin clips for genetics, female gonads, non-infested livers, and stomachs) were obtained.

The total catch numbers of cod were relatively high compared to trawl catches in the previous year (see above). In total 25 cod were caught at stations in the Fehmarn Belt area, 33 cod in the Kiel Bight area and seven cod in the Mecklenburg Bight area (Fig. 5.2.1A).

The highest total number of cod was caught at a wreck in the Fehmarn Belt with 20 cod. Highest catch per unit effort (CPUE) with 3.80 cod * angler^{-1} * hour^{-1} occurred at a wreck in the eastern Kiel Bight near to the Fehmarn Belt area (Fig. 5.2.1B). At five out of 12 wreck sites no cod was caught. Furthermore, no cod was caught on the three stations at the Vejsnæs channel. In the Mecklenburg Bight two locations characterised by hard ground (i.e., cobbles and boulders) have been sampled. On the first location, known as “Schwarzer Grund” a total of seven cod were caught. At the second deeper location (i.e., depth > 20 m), which was close to a known trawling ground which displayed relatively high cod catches during previous years, no cod was caught during rod and reel fishery.

Thus, best catches in terms of cod numbers during the whole cruise were obtained from wreck site sampling. However, our catches suggest that not every wreck site is productive in terms of cod abundancies and related cod catches. This stand in line with reports of local charter vessel captains who reported that cod display some kind of favouritism for some wrecks sites, while others were only rarely used as habitats (pers. comm with local charter vessel captains by S. Funk). However, they also reported that wreck habitat use of cod is weather and current related, with cod tending to aggregate at these areas during rather calm weather conditions but tend to disperse during storm (as stated above) (pers. comm with local charter vessel captains by S. Funk). Especially the latter, might be supported by our observation. Since we sampled one wreck sites in the eastern Kiel Bight twice at the beginning and the end of the cruise. While we caught seven cod on the first time of sampling, we caught only two during the second time of sampling. The second sampling period of the cruise started on Monday after the strong stormy weather on the weekend. Thus, the weather might have caused in general lower cod densities on the wrecks. However, in case of wrecks sampled twice during the cruise, we could, of course, not rule out that reduced catches during the second time of sampling might be also related to some kind of depletion effect in terms of removed cod caused by our first sampling and missing re-colonisation. Generally, wreck habitat-use by cod and later recolonisation is relatively poorly understood. However, as other studies from other ecosystems have shown that such artificial wreck sites are important refuges for cod (e.g., see Langkeek et al., 2013), more research should be done in the future, especially to find out what impact recreational fishers can have while focussing on targeted wreck site fishing (i.e., catch per unit effort values at wreck sites compared to unstructured areas etc.).

In general, it has to be noted that CPUE values have to be used with caution. On many wreck sites we fished only relatively short time and left quickly when the anglers had several minutes without a cod bite. On most wrecks, the first fishes were caught nearly immediately after starting fishing, while cod catches decreased sharply with increasing sampling time. An exception is for example station 30-1, a wreck east of Fehmarn at the Fehmarn Belt area, where we caught nearly constantly the whole time of fishing. On this wreck we caught the highest number of cod during the whole cruise AL568b. However, we also stayed longer on this wreck resulting in an overall lower CPUE value compared to some wrecks in the Kiel Bight. Nevertheless, the constant cod catches suggest an overall higher productivity in terms of cod catches and cod densities at the Fehmarn Belt wreck even though CPUE was lower.

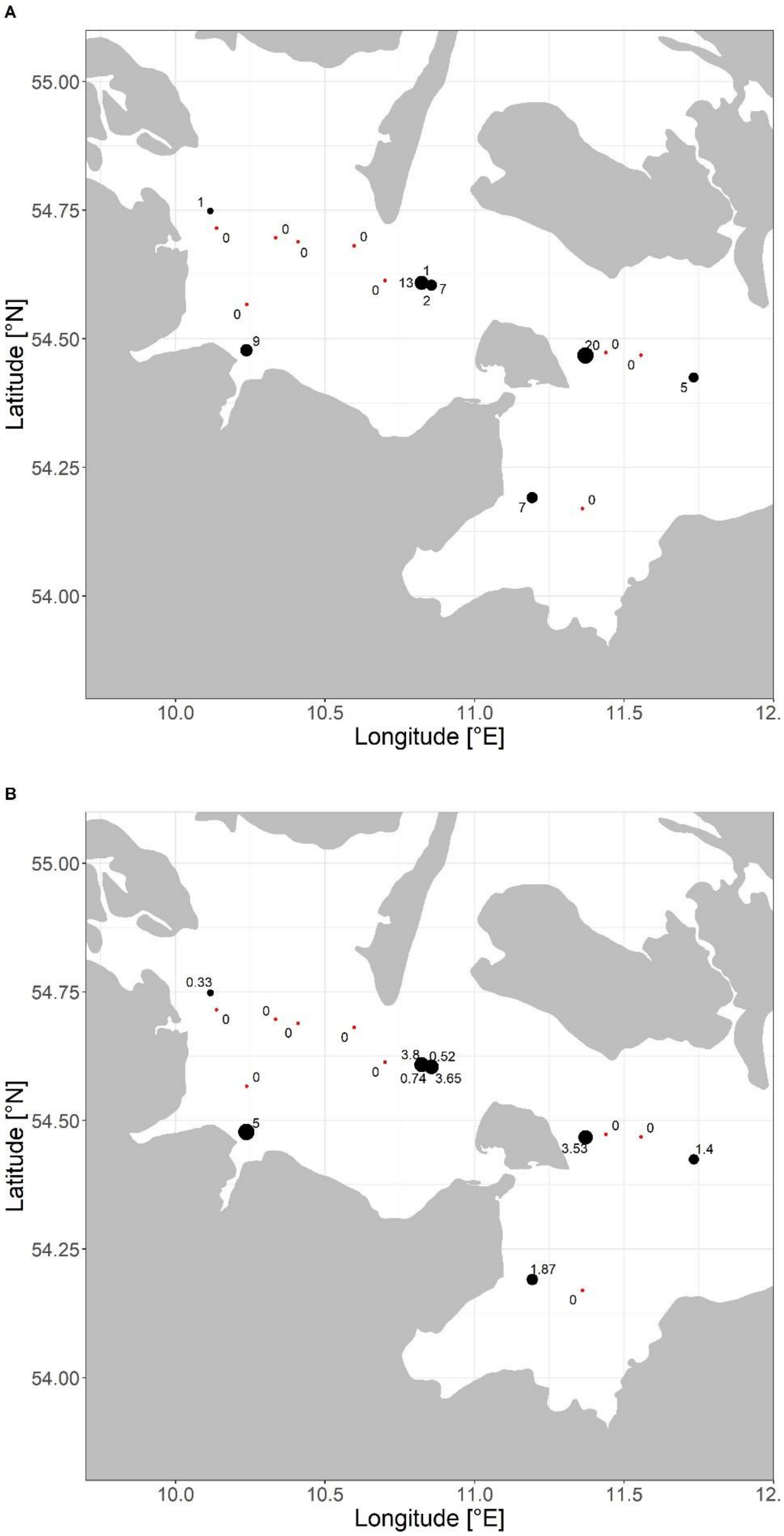

Figure 5.2.1. Cod catches during the cruise AL568b rod and reel fisheries. In A: Total numbers of cod caught per fishing station. In B: Catch per unit effort in numbers per cod caught per station * angler^{-1} * h^{-1}. Red dots denote stations where no cod were caught. Size of dots correspond with cod numbers (A) or CPUE values (B). Numbers give cod catches (A) or CPUE values (B).

Cod length distribution

Lengths of caught cod ranged between 27 cm and 70 cm. The smallest cod and the largest cod were both caught at wrecks in the eastern Kiel Bight area near to the Fehmarn Belt. In total we caught only four individuals larger than 60 cm, which is less than during the trawling activities in the previous year. All cod larger than 60 cm were caught at wreck sites in the eastern Kiel Bight. Interestingly mean length of caught cod was highest in the Fehmarn Belt area with 43.84 cm (± 6.32 cm), followed by the Kiel Bight with 41.79 cm (± 10.76 cm), and the Fehmarn Belt with 34.86 cm (± 6.59 cm).

While overall cod catches of large individuals were lower in 2022 compared to 2021, the catch of medium-size cod was significantly higher. In fact, in 2021 we did not catch a single individual in length class 21-30 cm and 31-40 cm, in 2021. However, these two length classes dominated the catch in these areas in 2022 (Fig. 5.2.2).

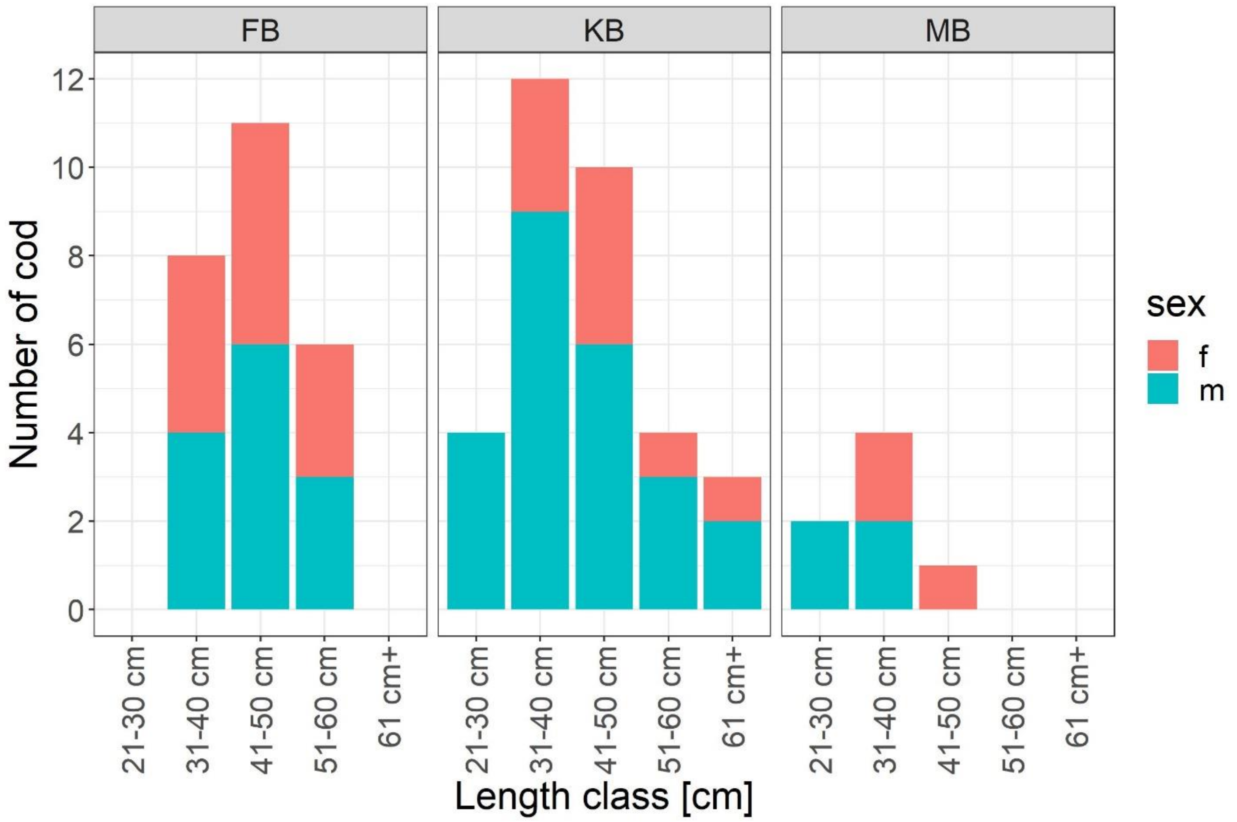

Figure 5.2.2. Length distribution of cod catches caught during AL568b per area (FB = Fehmarn Belt area, KB = Kiel Bight area, and MB = Mecklenburg Bight area). Colour indicates sexes of caught cod individuals (red = females [f]; blue = males [m]).

Cod condition

Hepatosomatic indices of WBC (calculated as HSI = liver weight [g] *gutted weight $[g]^{-1}$ *100) showed slightly differences between areas, with in median higher HSI values in Fehmarn Belt area. Observed HSI values ranged between 0.94 and 7.03 over all cod length and areas (Fig. 5.2.3A).

Fulton indices values (calculated as observed full weight * $length^{-3}$*100^{-1}) were in median higher in Kiel Bight than in Fehmarn Belt area. Samples from the Mecklenburg Bight displayed the lowest observed median Fulton indices. Observed Fulton indices ranged between 0.73 and 1.35 (Fig. 5.2.3B).

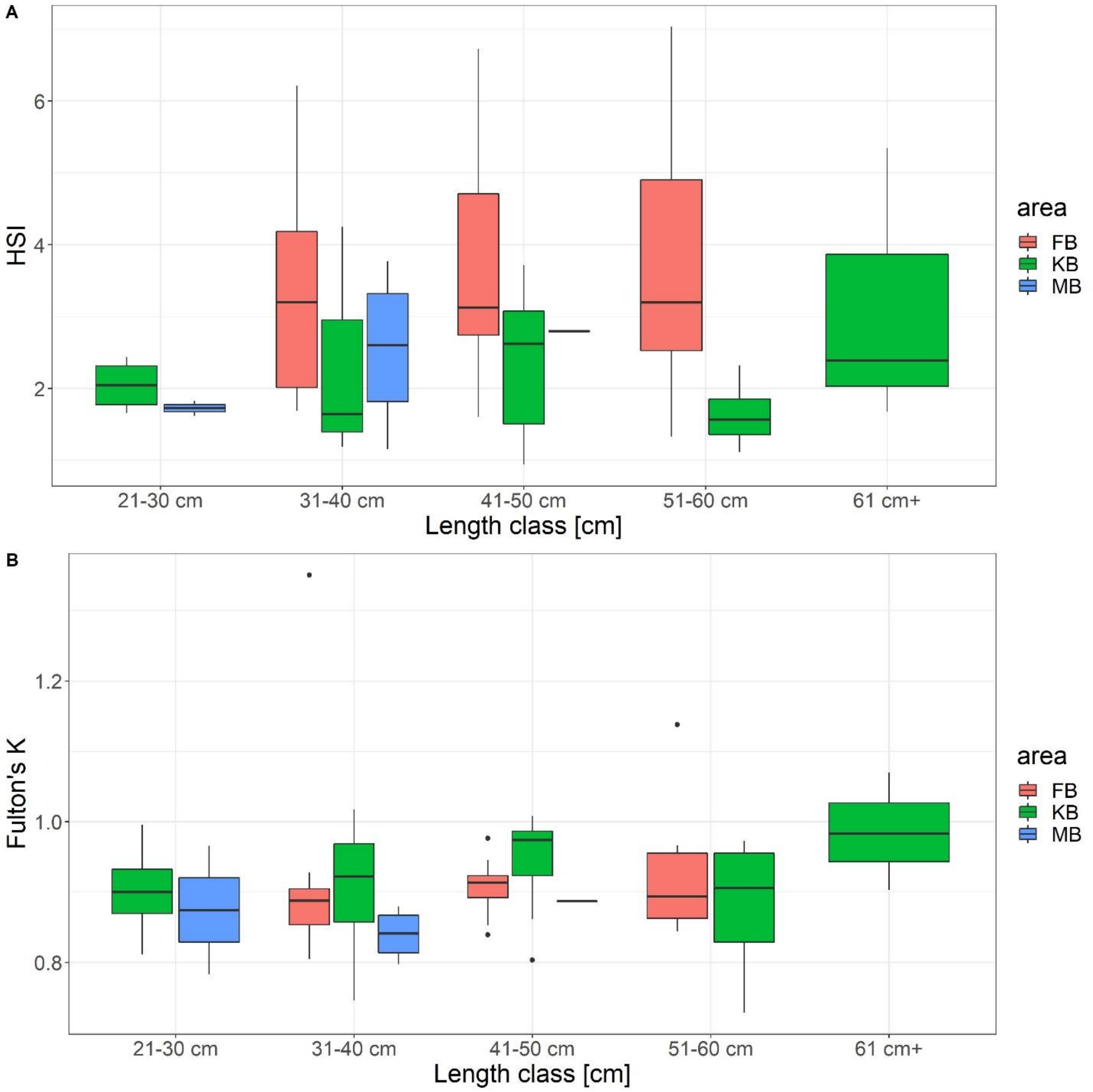

Figure 5.2.3. Condition indices (A: Hepatosomatic index, and B: Fulton's K) of cod sampled during AL568b per length class and area (FB = Fehmarn Belt, Kiel Bight, and MB = Mecklenburg Bight).

<u>Cod maturity stages</u>

In all three areas ripe cod individuals were found (Fig. 5.2.4), which means cod in maturity stages in five and six ("early spawning stage" and "main spawning stage"). All cod staging was determined following the guidelines of Tomkiewicz et al. (2002). Mature female individuals were mostly found in maturity stage three and four ("ripening stage" and "late ripening stage") while mature male individuals were found mostly in stages five and six ("early spawning stage" and "main spawning stage"). At one wreck at the Fehmarn Belt, we caught also a female individual in stage six (i.e., in “main spawning stage”). This female individual and the males in stages six gave evidence that spawning already started in the Fehmarn Belt area. However, since most of the females caught in the Fehmarn Belt area, but also in Mecklenburg and Kiel Bight area, were found in ripening stages indicated that main spawning of the length classes might occur later in February or March (i.e., the periods known as the traditional main spawning season of WBC). A surprising but not completely unsuspected result was the observation of some individuals larger 40 cm (males [n = 4 and females [n = 2]) which displayed maturity stages of two, which means “resting stages” (Fig. 5.2.4). These individuals will not take part spawning this year. Whether these individuals are skip-spawners or just immature individuals could not be clarified. However, their length < 50 cm suggested, that these individuals were immature. This observation was surprising, since during trawling on traditional spawning grounds in previous years immature individuals > 35 cm have been only recorded rarely. However, it was not completely unsuspected since we were fishing on hard structured grounds and artificial reef structures and thus potential feeding grounds of cod rather than at the soft-bottom-structured spawning habitats in the deeper channels and basins of the WBS. Funk et al. 2021a hypothesized that there might be a general issue with limited area coverage of traditional trawl surveys such as the BITS leading to a generally biased perception of WBC maturity distribution and related calculation of maturity ogive estimates. They hypothesized that immature cod and skip-spawners would tend to stay on their feeding grounds even during spawning period and that would be missed by traditional trawl surveys usually concentrating on deep soft bottom areas only (see Funk et al., 2020), i.e., on the areas known as traditional spawning grounds of WBC in the Belt Sea.

Our observation supports this hypothesis, but further sampling of potential cod feeding grounds would be needed to complement standardize trawl sampling of spawning grounds to find out more about the distribution of cod maturity distribution.

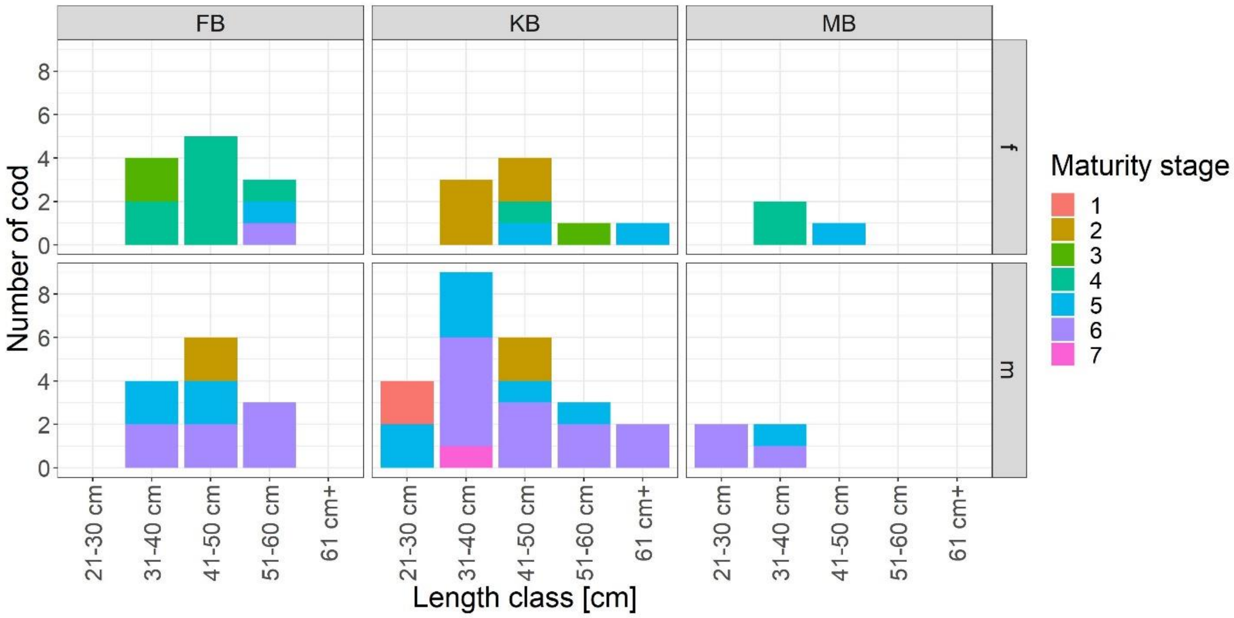

Figure 5.2.4. Maturity stage distribution of cod caught during AL568b. Colours denote maturity stages with 1 = juvenile, 2 = preparation stage/ resting stage & spawning omission, 3 = ripening stage, 4 = late ripening, 5 = early spawning stage, 6 = main spawning stage, 7 = late spawning

stage (i.e., “cessation of spawning”). Definition and subsequent terming of WBC maturity stages are based on the manual to determine gonadal maturity of Baltic cod (Tomkiewicz et al., 2002).

5.3 Ichthyo- and Zooplankton Sampling

(Steffen Funk, Richard Klinger, Margarethe Nowicki, and Nicole Smialek)

Zoo- and ichthyoplankton samples were obtained from a total of 43 BONGO and 7 MULTINET stations. BONGO net 500 µm samples were also checked directly on board for occurrence of cod larvae by trained scientists (Margarethe Nowicki, Richard Klinger, Anton Höper, and Dr. Nicole Smialek). Cod larvae were picked out of the samples and deep frozen for later condition analysis. The rest of the plankton samples were conserved in formalin for later species- and size-composition analysis in the laboratory.

<u>Cod larvae</u>

In total we found a number of 3 cod larvae in the BONGO net 500 µm samples, clearly indicating a spawning activity and a successful hatch of cod in January 2022 (Fig. 5.3.1). While in the previous year during AL498 cod larvae were found in the Kiel Bight and Mecklenburg Bight area, this year observation of cod larvae was limited to the Kiel Bight only, which may indicate that main cod spawning at the eastern Belt Sea area starts later this year. However, it could not be ruled out that the decrease in WBC SSB from 2021 to 2022 also affected recruitment strength and related abundance of cod larvae. However, preliminary results from BONGO sampling at the same station grid (GS1 to GS 35) at the following cruise AL568c (chief scientist: Richard Klinger) already revealed the presence of cod larvae in the Mecklenburg Bight area. Considering the egg development time of cod eggs at the prevailing temperature conditions of around 4 °C with 20-24 days (von Westernhagen, 1970; Geffen et al., 2006), eggs of these larvae had to be spawned already during January, which give further strong evidence for the hypothesized shift in spawning phenology of Belt Sea cod in the Mecklenburg Bight area. However, considering the development time and potential larval drift the observation of cod larvae does not necessarily mean, that the area of observation equals the area where the corresponding cod eggs have been spawned. In fact, location of cod larvae gives only limited information on the importance of individual WBC spawning sites. Therefore, we hope that later analysis of BONGO net 300µm samples and potential observations and counts of cod eggs will shed light on spatial patterns in WBC spawning activity within the Belt Sea subareas.

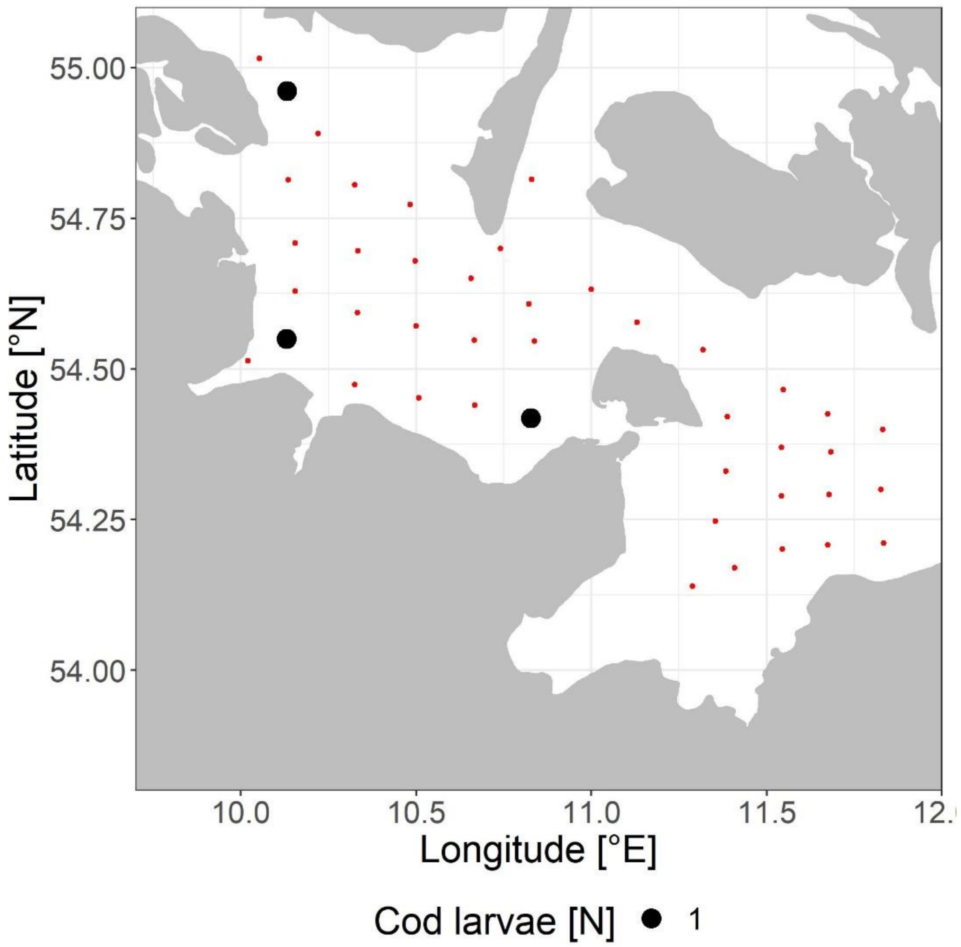

Figure 5.3.1. Number of cod larvae observed in BONGO 500 µm net samples during AL568b. Red dots denote BONGO stations where no larvae were caught.

<u>Other fish larvae</u>

Despite larvae of cod, we also found flatfish larvae (most likely plaice [*Pleuronectes platessa*] and flounder [*Platichthys flesus*]) larvae of hooknose (*Agonus cataphractus*), bull-rout (*Myoxocephalus scorpius*), sandlance (Ammodytidae) and clupeids (e.g., *Sprattus sprattus*), and pipefish (*Sygnathidae*). Furthermore, we found a number of other fish larvae which were not identified during the cruise. One of these larvae showed characteristics of a whiting (*Merlangius merlangus*) larvae. In case of unknown larvae, subsamples (including potential whiting larvae) were deep-frozen on -80°C given to Dr. Felix Mittermayer (GEOMAR) for subsequent DNA species-identification.

Observation of flatfish larvae in BONGO 500 µm net samples indicated a clear spatial pattern in distribution, with higher abundances in north-western parts of the Belt Sea area (Fig. 5.3.2A). Flatfish larvae occurred on each sampled station. Recorded number of individuals per 500 µm net sample varied between 1 and 31.

Sandlance larvae were found in values between 0 and 68 individuals*BONGO 500 µm net sample^{-1}. Highest number of sandlance was observed in BONGO net hauls at the entrance of the Great Belt (GS42). Overall, observation from BONGO net hauls indicated slightly higher abundances of sandlance in the Fehmarn Belt region compared and northern Kiel Bight, and lesser abundancies in the Mecklenburg Bight (Fig. 5.3.2B).

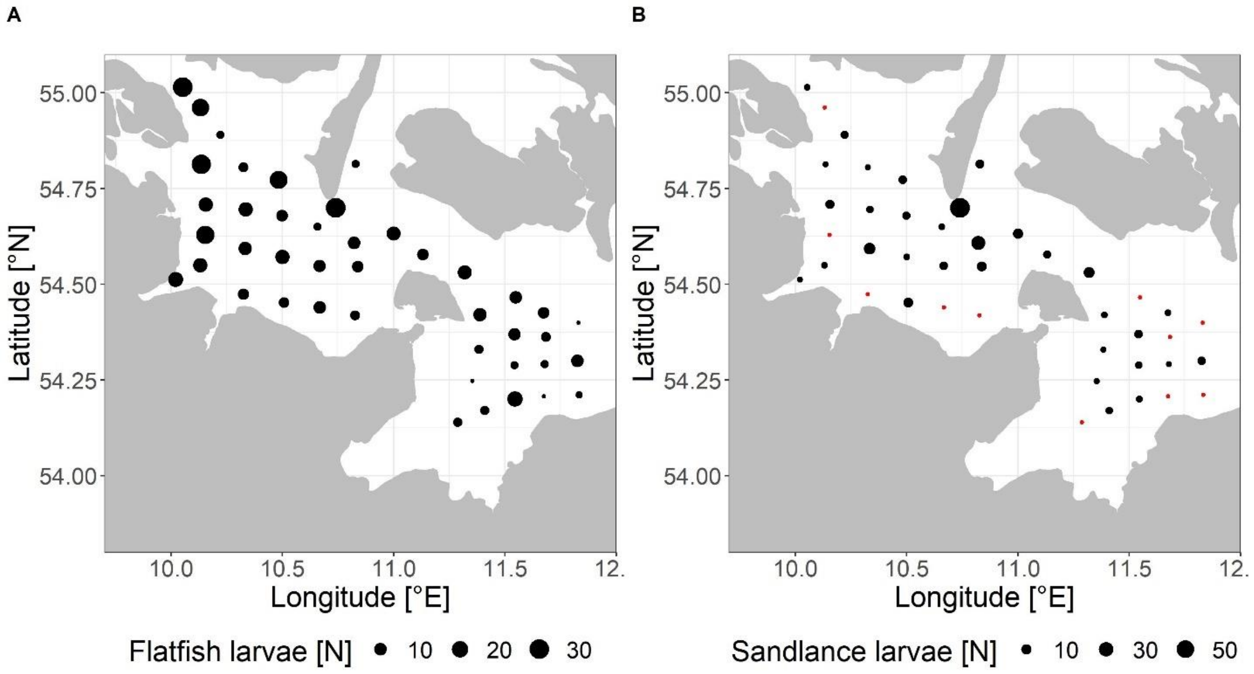

Figure 5.3.2. Distribution of flatfish (A) and sandlance (B) larvae observed in the study area during AL568 in January 2022. Point sizes are related to numbers of larvae observed in BONGO 500 µm net hauls. Red dots denote BONGO stations where no larvae were caught.

<u>Fish eggs</u>

Number of Fish eggs counted in subsamples and then extrapolated to the total sample of BONGO 500 µm net hauls. Estimated number of observed fish eggs varied between 35 and 2700. Highest number of fish eggs was observed in central Kiel Bight at station GS 12. Overall, no spatial pattern in fish egg abundancies was observed (Fig. 5.3.3).

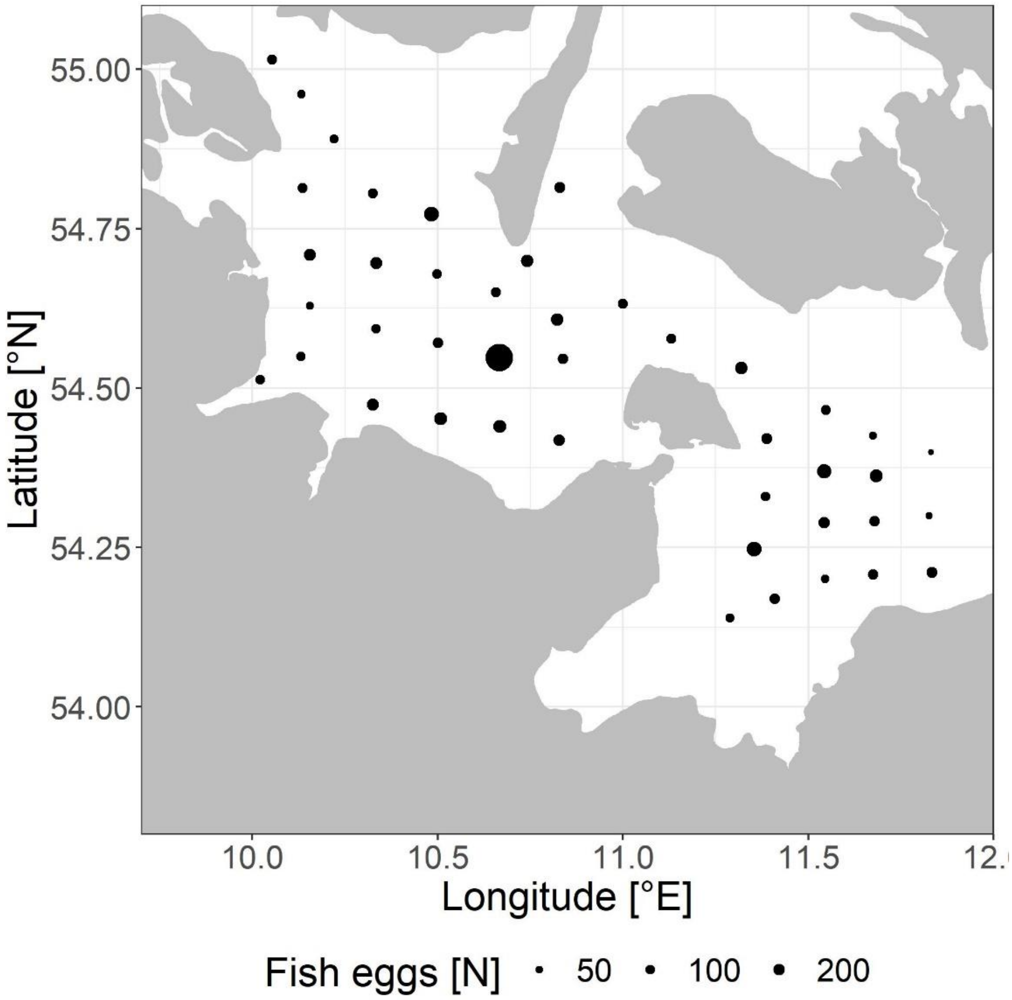

Figure 5.3.3. Distribution of fish eggs observed in the study area during AL568 in January 2022. Point sizes are related to numbers of fish eggs observed in BONGO 500 µm net hauls.

<u>Gelatinous plankton</u>

In the 500 µm BONGO nets, which were sorted immediately after the haul, we observed Ctenophora species and *Cyanea capillata*. Number of *Cyanea capillata* per BONGO net varied between 0 and 42. No *Cyanea capillata* were observed at two stations in the central Kiel Bight. Highest number of *Cyanea capillata* with 42 individuals was counted at GS33 in the south-eastern Mecklenburg Bight (Fig. 5.3.4A). Overall, we were not able to identify a clear spatial pattern in *Cyanea capillata* distribution.

In contrast to *Cyanea capillata* we found Ctenophora individuals in each BONGO 500 µm net sample. Observed numbers of Ctenophora individuals ranged between 1 and 111. Lowest number of Ctenophora with only 1 individual was observed at the stations GS3 in the Kiel Bight and GS42, and GS43 in the entrance of the Great Belt. Highest number of 111 individuals was observed at station GS34 in the south-eastern Mecklenburg Bight (Fig. 5.3.4B). The observations of Ctenophora in the BONGO net hauls pointed towards a spatial pattern in distribution, with higher abundance in Mecklenburg Bight and Fehmarn Belt area and lower abundance in Kiel Bight.

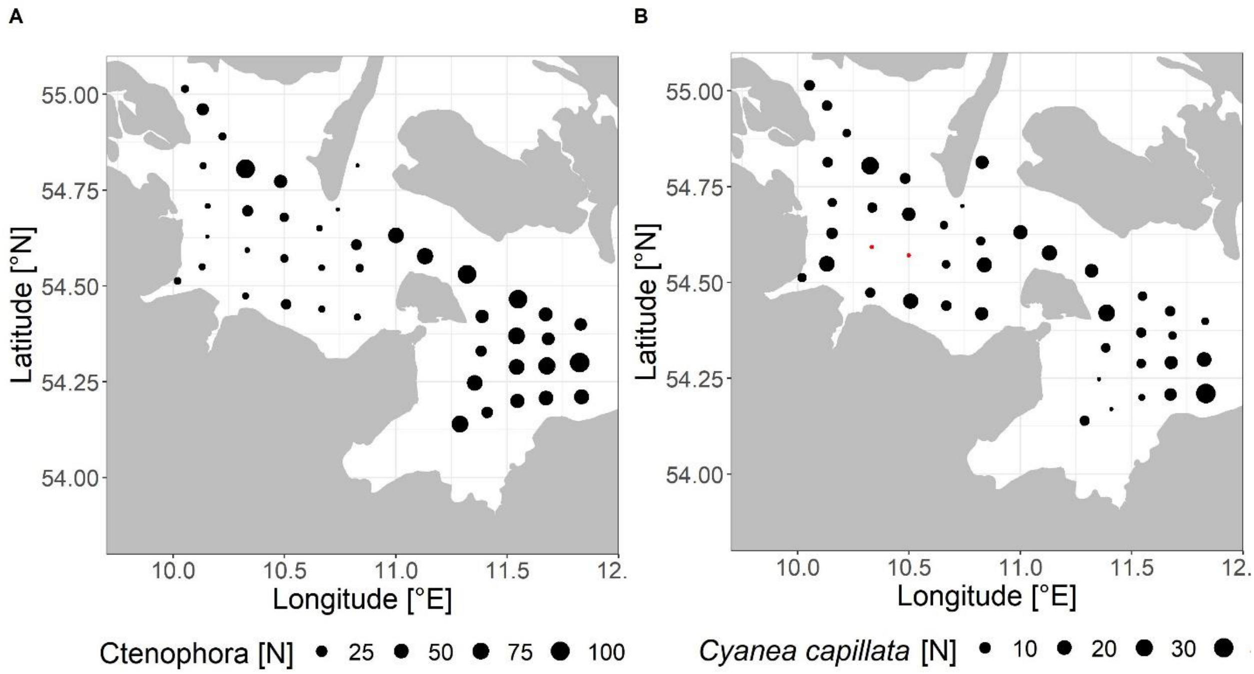

Figure 5.3.4. Distribution of gelatinous plankton (A = Ctenophora, B = *Cyanea capillata*) observed in the study area during AL568 in January 2022. Point sizes are related to numbers of gelatinous plankton observed in 500µm BONGO net hauls.

6 Station List

In total 115 gear deployments were conducted during the cruise AL568b (see Tab. 4.1 for an overview per subarea and Tab. 6.1 for the full station list). The electronic version of the station list as well as additional cruise data are permanently stored at the field data server of the Institute of Marine Ecosystem and Fisheries Science (IMF) of the University of Hamburg and are available on request. Furthermore, it is planned to make additional cruise data of AL568b (including for example station data, catch data and individual fish data of whiting and cod, as well as cod stomach content data) publicly available via the public data repository PANGEA (for further details see also section 7 "Data, Sample Storage and Availability" and Tab. 7.1).

Table 6.1. Station List with all gear deployments during AL568b with CTD = CTD probe, BONGO = BONGO net with 150, 300 and 500 µm nets, RF = rod and reel fishery, MN_S5 = MULTINET midi, Stat. = Station number, Stat. Id. = internal station name (see also section 3.2. Aims of the Cruise), and SD = ICES subdivision.

Gear	AL568b Stat.	Stat. ID	SD	Lat h	Lon h	Lat min	Lon min	Date 2022	Depth [m]	Duration [m]
CTD	1-1	GS7	22	54	010	28	19	24.1	19	0:02
BONGO	1-2	GS7	22	54	010	28	19	24.1	19	0:03
BONGO	2-1	GS9	22	54	010	34	30	24.1	19	0:03
CTD	2-2	GS9	22	54	010	34	29	24.1	19	0:03
CTD	3-1	GS12	22	54	010	32	40	24.1	21	0:02
BONGO	3-2	GS12	22	54	010	32	40	24.1	20	0:04
MN_S5	3-3	GS12	22	54	010	33	40	24.1	21	0:19
BONGO	4-1	GS15	22	54	010	32	50	24.1	22	0:04
CTD	4-2	GS15	22	54	010	32	50	24.1	21	0:02
FR	5-1	NONE	22	54	010	36	51	24.1	20	0:23
CTD	6-1	GS17	22	54	010	37	59	24.1	20	0:02
BONGO	6-2	GS17	22	54	010	37	59	24.1	20	0:03
BONGO	7-1	GS18	22	54	011	34	07	24.1	28	0:03
CTD	7-2	GS18	22	54	011	34	08	24.1	28	0:02
CTD	8-1	GS19	22	54	011	31	19	24.1	30	0:02
BONGO	8-2	GS19	22	54	011	31	19	24.1	30	0:04
CTD	9-1	GS20	22	54	011	25	23	25.1	22	0:02
BONGO	9-2	GS20	22	54	011	25	23	25.1	22	0:02
MN_S5	9-3	GS20	22	54	011	25	22	25.1	21	0:13
FR	10-1	NONE	22	54	011	28	26	25.1	28	0:16
BONGO	11-1	GS28	22	54	011	27	32	25.1	26	0:04
CTD	11-2	GS28	22	54	011	27	32	25.1	26	0:03
FR	12-1	NONE	22	54	011	28	33	25.1	25	0:12
CTD	13-1	GS29	22	54	011	25	40	25.1	25	0:02
BONGO	13-2	GS29	22	54	011	25	40	25.1	25	0:04
FR	14-1	NOE	22	54	011	25	43	25.1	25	0:43
BONGO	15-1	GS35	22	54	011	23	49	25.1	22	0:03
CTD	15-2	GS35	22	54	011	23	49	25.1	22	0:02
CTD	16-1	GS34	22	54	011	18	49	25.1	23	0:02
BONGO	16-2	GS34	22	54	011	17	49	25.1	23	0:04
BONGO	17-1	GS33	22	54	011	12	50	25.1	21	0:04
CTD	17-2	GS33	22	54	011	12	49	25.1	21	0:02
CTD	18-1	GS32	22	54	011	12	40	25.1	26	0:02
BONGO	18-2	GS32	22	54	011	12	40	25.1	25	0:04
CTD	19-1	GS31	22	54	011	17	40	25.1	26	0:02
BONGO	19-2	GS31	22	54	011	17	40	25.1	26	0:03
MN_S5	19-3	GS31	22	54	011	17	40	25.1	26	0:16
BONGO	20-1	GS30	22	54	011	21	41	25.1	26	0:04
CTD	20-2	GS30	22	54	011	21	40	25.1	26	0:02
CTD	21-1	GS27	22	54	011	22	32	25.1	25	0:02
BONGO	21-2	GS27	22	54	011	22	32	25.1	25	0:03
CTD	22-1	GS21	22	54	011	19	23	26.1	22	0:02
BONGO	22-2	GS21	22	54	011	19	23	26.1	22	0:03
BONGO	23-1	GS22	22	54	011	14	21	26.1	21	0:02
CTD	23-2	GS22	22	54	011	14	21	26.1	21	0:02
FR	24-1	NONE	22	54	011	11	11	26.1	18	0:44
CTD	24-2	NONE	22	54	011	11	11	26.1	20	0:02

CTD	25-1	GS23	22	54	011	08	17	26.1	26	0:02
BONGO	25-2	GS23	22	54	011	08	17	26.1	26	0:04
FR	26-1	NONE	22	54	011	10	21	26.1	23	0:18
CTD	27-1	GS24	22	54	011	10	24	26.1	24	0:02
BONGO	27-2	GS24	22	54	011	10	24	26.1	23	0:02
MN_S5	27-3	GS24	22	54	011	10	24	26.1	24	0:16
BONGO	28-1	GS25	22	54	011	12	32	26.1	25	0:02
CTD	28-2	GS25	22	54	011	11	32	26.1	24	0:02
CTD	29-1	GS26	22	54	011	17	32	26.1	25	0:02
BONGO	29-2	GS26	22	54	011	17	32	26.1	24	0:03
FR	30-1	NONE	22	54	011	28	22	26.1	23	1:08
CTD	30-2	NONE	22	54	011	28	22	26.1	23	0:02
CTD	31-1	GS41	22	55	010	00	03	27.1	34	0:03
BONGO	31-2	GS41	22	55	010	00	03	27.1	34	0:04
CTD	32-1	GS40	22	54	010	57	07	27.1	34	0:03
BONGO	32-2	GS40	22	54	010	57	07	27.1	34	0:05
MN_S5	32-3	GS40	22	54	010	57	08	27.1	35	0:15
BONGO	33-1	GS39	22	54	010	53	13	27.1	86	0:04
CTD	33-2	GS39	22	54	010	53	12	27.1	31	0:02
CTD	34-1	GS38	22	54	010	48	08	27.1	27	0:02
BONGO	34-2	GS38	22	54	010	48	08	27.1	28	0:03
BONGO	35-1	GS4	22	54	010	42	09	27.1	25	0:03
CTD	35-2	GS4	22	54	010	42	09	27.1	26	0:02
CTD	36-1	GS3	22	54	010	37	09	27.1	22	0:02
BONGO	36-2	GS3	22	54	010	37	09	27.1	22	0:02
BONGO	37-1	GS2	22	54	010	32	07	27.1	21	0:03
CTD	37-2	GS2	22	54	010	32	07	27.1	22	0:02
CTD	38-1	GS1	22	54	010	30	01	27.1	27	0:03
BONGO	38-2	GS1	22	54	010	30	01	27.1	27	0:03
MN_S5	39-1	GS1	22	54	010	30	01	27.1	27	0:12
CTD	40-1	GS6	22	54	010	35	20	28.1	16	0:04
BONGO	40-2	GS6	22	54	010	35	19	28.1	16	0:02
CTD	41-1	GS5	22	54	010	41	20	28.1	32	0:03
BONGO	41-2	GS5	22	54	010	41	20	28.1	32	0:03
MN_S5	41-3	GS5	22	54	010	41	19	28.1	31	0:15
CTD	42-1	GS37	22	54	010	48	19	28.1	34	0:03
BONGO	42-2	GS37	22	54	010	48	19	28.1	34	0:16
BONGO	43-1	GS36	22	54	010	46	28	28.1	25	0:02
CTD	43-2	GS36	22	54	010	46	28	28.1	26	0:02
CTD	44-1	GS10	22	54	010	40	30	28.1	25	0:02
BONGO	44-2	GS10	22	54	010	40	29	28.1	25	0:02
BONGO	45-1	GS11	22	54	010	39	39	28.1	34	0:03
CTD	45-2	GS11	22	54	010	39	39	28.1	30	0:03
CTD	46-1	GS42	22	54	010	42	44	28.1	24	0:02
BONGO	46-2	GS42	22	54	010	41	44	28.1	24	0:04
CTD	47-1	GS43	22	54	010	48	49	28.1	44	0:03
BONGO	47-2	GS43	22	54	010	48	49	28.1	36	0:05
FR	48-1	GS16	22	54	010	36	49	28.1	22	0:41
CTD	48-2	GS16	22	54	010	36	49	28.1	22	0:02

BONGO	48-3	GS16	22	54	010	36	49	28.1	22	0:03
BONGO	49-1	GS14	22	54	010	25	49	28.1	13	0:01
CTD	49-2	GS14	22	54	010	25	49	28.1	13	0:01
CTD	50-1	GS13	22	54	010	26	40	28.1	19	0:02
BONGO	50-2	GS13	22	54	010	26	40	28.1	19	0:02
BONGO	51-1	GS8	22	54	010	27	30	28.1	18	0:02
CTD	51-2	GS8	22	54	010	26	30	28.1	18	0:01
FR	54-1	NONE	22	54	010	28	14	31.1	20	0:18
CTD	54-2	NONE	22	54	010	28	14	31.1	19	0:03
FR	55-1	NONE	22	54	010	33	14	31.1	20	0:11
FR	56-1	NONE	22	54	010	42	08	31.1	24	0:13
FR	57-1	NONE	22	54	010	44	07	31.1	21	0:29
CTD	57-2	NONE	22	54	010	44	07	31.1	24	0:02
FR	58-1	NONE	22	54	010	41	20	31.1	32	0:24
FR	59-1	NONE	22	54	010	41	24	31.1	32	0:12
FR	60-1	NONE	22	54	010	40	35	31.1	19	0:12
FR	61-1	NONE	22	54	010	36	42	31.1	24	0:21
FR	62-1	NONE	22	54	010	36	51	31.1	20	0:27
CTD	62-2	NONE	22	54	010	36	51	31.1	20	0:01

7 Data, Sample Storage and Availability

All data obtained during the cruise have been backed up on the field data server of the IMF of the University of Hamburg. In addition, data have been backed up and stored on different hard drives at different locations. Paper protocols filled out during the cruise were entered electronically and thus already felt under the back-up scheme, applied for the rest of the cruise data (including all cruise meta data such as the output of the onboard DSHIP-System). In addition, paper protocols were also conserved as hard copy at the IMF.

Furthermore, we aim to make all data obtained during the cruise AL568b publicly available. Hydrographic data (CTD) will be submitted to the ICES Oceanographic database within one year from the cruise. Furthermore, it is planned to upload fishery data (including cod and whiting single fish data) in the public data repository PANGEA.

Depending on the data set, some of the data (especially including all zooplankton & ichthyoplankton data) are intended for specific publications. In the context of publication these data will be made publicly available. Right after analysing the taken cod stomach samples, stomach data will be added to the cod stomach data base of the IMF and Thuenen-OF. It is planned to make the whole Belt Sea cod stomach data publicly available in near future.

All plankton as well as sprat and herring samples obtained during the cruise AL568b and preserved in formalin were labelled directly on board using a barcoding scheme, and were achieved at the IMF. Please contact the responsible persons for a corresponding data set (see Tab. 5) if earlier access to the data is desired.

Table 7.1. Overview of data, data availability and corresponding contact persons (responsible for the specific data sets).

Data	Database	Available	Free Access	Contact
Hydrography (CTD data)	ICES database	Publicly by January 2023, earlier on request	By January 2023	steffen.funk@uni-hamburg.de

Fishery data	PANGEA	Publicly at time of publishing of the underlying peer-reviewed publication; earlier upon request (see contact)		steffen.funk@uni-hamburg.de
Cod stomach content data	PANGEA	Publicly at time of publishing of the underlying peer-reviewed publication; earlier upon request (see contact)		steffen.funk@uni-hamburg.de
Ichthyoplankton	PANGEA	Publicly at time of publishing of the underlying peer-reviewed publication; earlier upon request (see contact)		christian.moellmann@uni-hamburg.de
Zooplankton	PANGEA	Publicly at time of publishing of the underlying peer-reviewed publication; earlier upon request (see contact)		christian.moellmann@uni-hamburg.de
Hydroacoustic data	PANGEA	Publicly at time of publishing of the underlying peer-reviewed publication; earlier upon request (see contact)		christian.moellmann@uni-hamburg.de

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10 Abbreviations

BITS – Baltic international trawl survey
DTU – Danish Technical University
ICES – International Council for the Exploration of the Sea
IMF – Institute of Marine Ecosystem and Fisheries Science
UHAM – University of Hamburg
Thuenen-OF – Thuenen Institute of Baltic Sea Fisheries Rostock