SMHI

REPORT OCEANOGRAPHY No. 82, 2026

Oxygen Survey in the Baltic Sea 2025

- Extent of Anoxia and Hypoxia, 1960-2025



Front: The CTD-hangar door opens for another sampling onboard R/V Svea. During the fishing surveys, organized by SLU-Aqua, before or after each trawl, a CTD-profile and water samples are collected for analysis. Dissolved oxygen and concentration of hydrogen sulphide are examples of parameters that are collected. Data from the ICES co-ordinated trawl surveys are well suited for concurrent oxygen surveys because of randomized sampling and since surveys are performed by different countries almost simultaneously, a vast sea area can be monitored. Photo by Martin Hansson.

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Oxygen Survey in the Baltic Sea 2025
- Extent of Anoxia and Hypoxia, 1960-2025

Martin Hansson & Lena Viktorsson

Swedish Meteorological and Hydrological Institute - SMHI
Oceanographic Unit, Göteborg, Sweden

Summary

In 2011, SMHI published *Report Oceanography No. 42*, a climatological atlas detailing the oxygen status in the deep waters of the Baltic Sea. Since then, annual updates have been released as new data are reported to the International Council for the Exploration of the Sea (ICES) data center. This report provides an update for 2024 and presents the preliminary results for 2025. The oxygen data for 2025 were collected from various sources, including ICES coordinated trawl surveys, national monitoring programmes, and research projects involving Poland, Estonia, Latvia, Denmark, Sweden, and Finland.

For the autumn period, each profile in the dataset was analyzed for the occurrence of hypoxia (oxygen deficiency) and anoxia (total absence of oxygen). The depths of onset of hypoxia and anoxia were then interpolated between sampling stations to produce two surfaces that represent the depths at which hypoxic and anoxic conditions are present, respectively. The volume and area of hypoxia and anoxia were then calculated and the results transferred to maps and diagrams to visualize the annual autumn oxygen situation during the analyzed period.

The updated results for 2024 and the preliminary results for 2025 show that the severe oxygen conditions in the Baltic Proper after the regime shift in 1999 continues. In 2024 anoxia was found at one fifth (~19%) of the bottom areas in the Baltic Proper and one third (~34%) suffered from hypoxia including anoxic areas. Preliminary results for 2025 show that anoxia affected ~21% of the bottom areas and ~34% suffered from hypoxia (including anoxic areas). The concentration of hydrogen sulphide is still on record high levels in all the basins around Gotland. The inflows that occurred during 2024 had a short-term positive effect that could be seen in the Southern Baltic Proper but not further into the Baltic Proper than the Eastern Gotland basin at intermediate depths and in the southernmost part of the Western Gotland Basin. Unfortunately, these pulses of oxygenated water are too small to have any major positive impact on the overall oxygen situation.

Sammanfattning

År 2011 publicerade SMHI *Report Oceanography No. 42*, en klimatologisk atlas som beskriver syreförhållandena i djupvattnet i Östersjön. Sedan dess har årliga uppdateringar publicerats i takt med att nya data rapporteras till Internationella havsforskningsrådets (ICES) datacenter. Denna rapport utgör en uppdatering för 2024 och presenterar preliminära resultat för 2025. Syredata för 2025 har samlats in från flera olika källor, inklusive trålundersökningar samordnade av ICES, nationella övervakningsprogram och forskningsprojekt i samarbete mellan Polen, Estland, Lettland, Danmark, Sverige och Finland.

För höstperioden analyserades varje profil i datasetet med avseende på förekomst av hypoxi (syrebrist) och anoxi (helt syrefritt). De djup där hypoxi och anoxi inträffar interpolerades mellan provtagningsstationer för att generera två ytor som representerar de nivåer där respektive tillstånd förekommer. Därefter beräknades volym och utbredning av hypoxi och anoxi, och resultaten visualiserades i kartor och diagram för att illustrera syresituationen under hösten för den analyserade perioden.

De uppdaterade resultaten för 2024 och de preliminära resultaten för 2025 visar att de allvarliga syreförhållandena i Egentliga Östersjön efter regimskiftet 1999 kvarstår. Under 2024 förekom anoxi på omkring en femtedel (~19 %) av bottenarealen i Egentliga Östersjön, medan omkring en tredjedel (~34 %) var påverkad av hypoxi, inklusive anoxiska områden. De preliminära resultaten för 2025 visar att anoxi påverkade ~21 % av bottenarealen och att ~34 % var påverkad av hypoxi (inklusive anoxiska områden).

Koncentrationerna av svavelväte ligger fortfarande på rekordhöga nivåer i samtliga bassänger runt Gotland. De inflöden som inträffade under 2024 hade en kortvarig positiv effekt som kunde observeras i södra Egentliga Östersjön. Längre in i Egentliga Östersjön kunde effekten endast ses på intermediära djup (ca 100-130 m) i Östra Gotlandsbassängen samt i den sydligaste delen av Västra Gotlandsbassängen. Tyvärr är dessa pulser av syrerikt vatten alltför små för att ha någon större positiv inverkan på den övergripande syresituationen.

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1 Background

The deep central basins of the Baltic Proper are characterized by persistently low oxygen concentrations, largely as a consequence of the Baltic Sea's geography and restricted water exchange. Its semi-enclosed, fjord-like shape limits the renewal of deep-water oxygen, as exchange with the North Sea is restricted by the narrow straits and shallow sills of the Belt Sea and the Sound.

The large freshwater input from the extensive Baltic Sea catchment drives a predominantly outward surface flow through the Sound and Belt Sea towards the Kattegat and North Sea. During certain combinations of wind, atmospheric pressure, and sea-level conditions, however, the circulation can temporarily reverse. These events may allow saline, oxygen-rich North Sea water to enter the Baltic Sea and, when sufficiently strong, contribute to the ventilation of its deeper basins.

These inflows, though beneficial, do not always reach all deep-water layers due to the strong stratification caused by differences in salinity and density. As a result, oxygenation of deeper waters remains limited, while the continuous decomposition of large amounts of organic matter depletes existing oxygen supplies. This process leads to critically low oxygen levels, endangering marine life and promoting the expansion of oxygen-depleted zones.
However, large inflow events, or series of smaller inflows, can supply the deep water of the Baltic Proper with oxygen, as the inflowing water is usually well oxygenated. The inflowing water either forms a layer that follows the seafloor or is interleaved at intermediate depths, depending on its density. Inflows can only reach the deep basins of the central Baltic Proper if the volume is large enough to pass over the sills between the different basins and the density is high enough for the inflowing water to settle along the bottom. Major Baltic Inflows (MBIs) are rare, with the latest large MBI occurring as a series of large inflows during 2014–2016 [Mohrholz et al., 2015].

The oxygen situation in the Baltic Proper has become increasingly problematic because large inflows do not occur every year and because of large nutrient inputs over time, mainly between the 1950s and the late 1980s, resulting in escalating eutrophication with increasingly severe effects on the Baltic Sea ecosystem [HELCOM, 2018]. The more organic matter that is supplied to the deep water, the more oxygen is consumed, resulting in oxygen deficiency, and if the bottom water is not renewed this can eventually lead to anoxia. Increasing bottom-water temperatures further contribute to oxygen depletion, as higher temperatures increase respiration and the rate of microbial decomposition of organic matter, thereby increasing oxygen consumption. In the Baltic Sea, increasing bottom-water temperatures have been shown to contribute to worsening oxygen conditions through increased respiration [Carstensen et al., 2014].

Anoxia is the condition when all oxygen has been consumed by microbial processes and no oxygen is left in the water. If the water stays anoxic for an extended period, hydrogen sulphide (H_2S) is formed, which is toxic to higher marine life. Only bacteria and fungi can survive in a water environment with a total absence of oxygen.

The pool of hydrogen sulphide found in the deep parts of the Baltic Proper must be oxidized by oxygen-rich inflowing water or pushed above the permanent stratification, where oxygen is available, before a new inflow can have any effect on oxygen concentrations. During anoxic conditions, sediments release nutrients such as phosphate and silicate to the water column, which, due to vertical mixing or upwelling events, can reach the surface layer and the photic zone. High concentrations of nutrients in surface waters favour phytoplankton growth, especially cyanobacteria during summer, which can further enhance oxygen depletion as the bloom sinks to the bottom and consumes oxygen when it is decomposed – a vicious circle is formed [Vahtera et al., 2007].

These natural factors, combined with external human pressures on the Baltic Sea, form the basis for the increasingly problematic low-oxygen conditions and the "dead zones" or oxygen minimum zones (OMZs) found in the Baltic Sea. Total absence of oxygen and oxygen deficiency in deep water or at intermediate depths throughout the year are mainly found in the central deep basins of the Baltic Proper and the Gulf of Finland. Seasonal lack of oxygen is generally found in the southern parts of the Baltic Proper and Kattegat.

Oxygen depletion, or hypoxia, occurs when dissolved oxygen falls below the level needed to sustain most animal life. The concentration at which animals are affected varies broadly. Literature studies [Vaquer-Sunyer & Duarte, 2008] show that sublethal oxygen concentrations range from 0.06 ml/l to 7.1 ml/l. The mean for all experimental assessments was 1.8 ± 0.12 ml/l. The same study also suggests that the commonly used threshold for acute hypoxia of around 2.0 mg/l (1.4 ml/l) is below the empirical sublethal and lethal oxygen concentrations for half of the species tested. The dominant demersal fish population in the Baltic Sea, the Baltic cod (*Gadus morhua*), has been shown to avoid oxygen concentrations below 1 ml/l [Schaber et al., 2012]. However, already at 4.3 ml/l the condition and growth of cod starts to be affected [Chabot and Dutil,1999]. It has also been shown that Baltic Sea cod eggs need at least 2 ml/l oxygen for successful development [MacKenzie et al., 2000; Nissling, 1994; Plikshs et al., 1993; U.S. EPA, 2003; U.S. EPA, 2000,]. With this background the limit of acute hypoxia, in this report, is set to 2.0 ml/l.

This report presents a time series of the areal extent and water volume of anoxic and hypoxic autumn conditions of the Baltic Proper, including the Gulf of Finland and the Gulf of Riga, for the period 1960 to 2025. The time series was first published in 2011 and the results have been updated annually as new additional data have become available at the International Council for the Exploration of the Sea (ICES) [ICES, 2009]. In the report from 2011 and in a newly published article a distinct regime shift in the oxygen situation in the Baltic Proper was found to occur around 1999 [Hansson et al, 2011; Almroth et al., 2021]. During the first regime, 1960-1999, hypoxia affected large areas while anoxic conditions were found only in minor deep areas. After the regime shift in 1999, both areal extent and volume of anoxia have been constantly elevated to levels that only occasionally have been observed before 1999.

In this report results from 2024 and 2025, in form of maps and diagram of bottom areas affected by oxygen deficiencies, has been added to the time series starting in 1960. The complete and updated time series can be found as figures in this report and as maps in Appendix 2, which can be used as a climatological atlas describing the historical development and the present oxygen situation in the Baltic Proper.

2 Data

2.1 Oxygen data

The oxygen data for the analysis of 2025 are based on oxygen data collected during the annual trawl surveys coordinated by the ICES in the Baltic Sea and North Sea; The Baltic International Acoustic Survey (BIAS), International Bottom Trawl Survey (IBTS) and Polish Multiannual Fisheries Data Collection Programme complemented by data from national and regional marine monitoring programmes and mapping projects with contributions from Finland, Estonia, Latvia, Poland, Denmark, Germany and Sweden. See all data contributors in the Acknowledgement below.

Oxygen data have not been fully quality controlled; only preliminary checks have been performed. The time series and the results presented for 2025 will be updated when additional data are reported to ICES in 2026/2027. In this report the results for 2024 has been updated with all available bottle and CTD data retrieved from the dataset on ocean hydrography at ICES (http://www.ices.dk, last access: 2026-09-23).

Trawl survey data, oxygen CTD and bottle, are particularly well suited for concurrent oxygen assessments due to the randomized sampling approach and the near-simultaneous execution of cruises by multiple countries. As a result, almost the entire offshore Baltic Proper is covered with extensive spatial distribution, offering a comprehensive snapshot of the oxygen conditions. These surveys are conducted during late summer and autumn, from August to October, a period when oxygen depletion is typically at its peak. Thus, they provide a crucial contribution of oxygen data, complementing the routine national and regional monitoring carried out monthly at fixed stations.

2.2 Inflow data

The inflow through the Belt Sea and the Sound to the Baltic Sea is an important factor influencing the oxygen development in the deep water in the southern and central basins of the Baltic Proper.

SMHI calculates the flow through the Sound from the sea level difference between two sea level gauges situated in the northern part (Viken) and the southern part (Klagshamn) of the Sound [Håkansson et. al. 1993, Håkansson 2022]. The results, as accumulated inflow, from 1977 to present are presented in Swedish at the SMHI website under the title “Vattenåret”. To improve the yearly summary of inflow/outflow events the calculations has been revised. Inflow/outflow events are added together but small inflows/outflows, < 0.5 days and <1 km^3, that would interrupt and ongoing inflow/outflow, has been added or removed from inflow/outflow events to get at better overview of the size and duration of inflow and outflow events. For the years 2024 and 2025 see Figure 5 and 6 for accumulated inflow and inflow/outflow events [SMHI, 2026].

Another estimate of the flow through the Sound and the Belt Sea has been presented by [Mohrholz, 2018] and is continuously updated. Simplified, the calculations are based on the mean sea level at Landsort and river discharge to the Baltic Sea. In Figure 1, the two estimates of the flow through the Sound are compared. The results from the two calculations are generally similar and in the same range. The results by [Mohrholz, 2018] is usually higher but the SMHI inflows are often divided into several inflow events. Larger inflows seem to correlate better. However, there are some inflows in both time series that do not correlate at all. For example, during late 1980s and 1990s in [Mohrholz, 2018] and in early 1990s in the SMHI timeseries. The difference could be explained by the local [SMHI, 2026] and regional [Mohrholz, 2018] perspectives of the two methods.

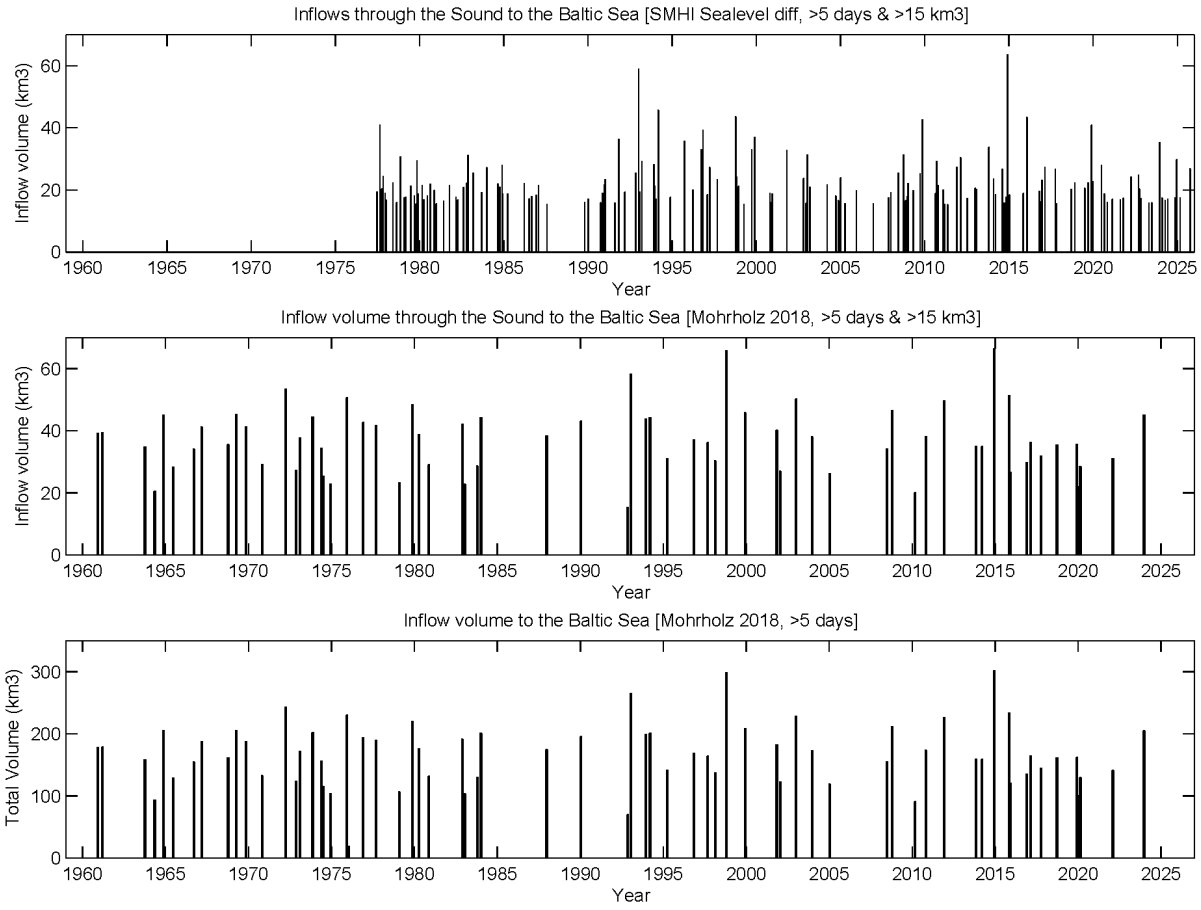


Figure 1. Two different estimations of inflow to the Baltic Sea through the Sound (Öresund). Top: Inflow through the Sound estimated from 1977-2025 by SMHI. [Revised summary of inflow events, SMHI, 2026]. Middle: Inflow through the Sound 1960-2024 estimated by [Mohrholz, 2018]. Bottom: Total volume transport through the Sound and the Danish Straits to the Baltic Sea for inflows, 1960-2024 [Mohrholz 2018, updated 2026-09-23]. Note that the SMHI results are only available from 1977 and that by the time for publication Mohrholz had not updated the time series with data for all 2024 or 2025.

3 Method

For the late summer and autumn period, August to October, each vertical profile including at least three data points, was examined for the occurrence of hypoxia (< 2 ml/l) and anoxia (< 0 ml/l). To find the depth of the onset of hypoxia and anoxia in each vertical profile, interpolation between discrete measurements in the profile was used. If hypoxia or anoxia was not found in the profile, the two deepest measurements in the profile were used to linearly extrapolate the oxygen concentration down towards the bottom. If two or more profiles were found at the same position an average profile was calculated for that position. To process the dataset a few profiles had to be filtered out: for example, when data was missing in the deep water, when correct data from a shallow area obviously negatively affects the interpolation results in nearby deep areas or when questionable data were found.

The depths of the onset of hypoxia and anoxia were gridded with linear interpolation (Delaunay triangulation) between sampling stations, producing a surface representing the depth at which hypoxic and anoxic conditions are found. The surface was compared with bathymetry data,

[Seifert, 2001] see Figure 2, to exclude profiles where the hypoxic and anoxic depths were greater than the actual water depth. After filtering the results, the affected area and volume of hypoxia and anoxia was calculated for each year.

The calculations do not account for the existence of oxygenated water below an anoxic or hypoxic layer. Hence, during inflow situations when an intermediate layer with low oxygen concentrations or hydrogen sulphide can be found above oxygenated water, the method overestimates the area and volume. However, these oxygenated zones are still problematic for most benthic animals and fish since they are trapped below an anoxic or hypoxic layer that also prevents migration and recolonization. On the other hand, the oxygenated zones below the intermediary layer, does influence the sediment to water nutrient exchange [Hall et al., 2017 and Sommer et al., 2017].

Areal extent and volumes are presented in relation to the area and volume of the Baltic Proper, including the Gulf of Finland and the Gulf of Riga, see Figure 2 [Fonselius, 1995].

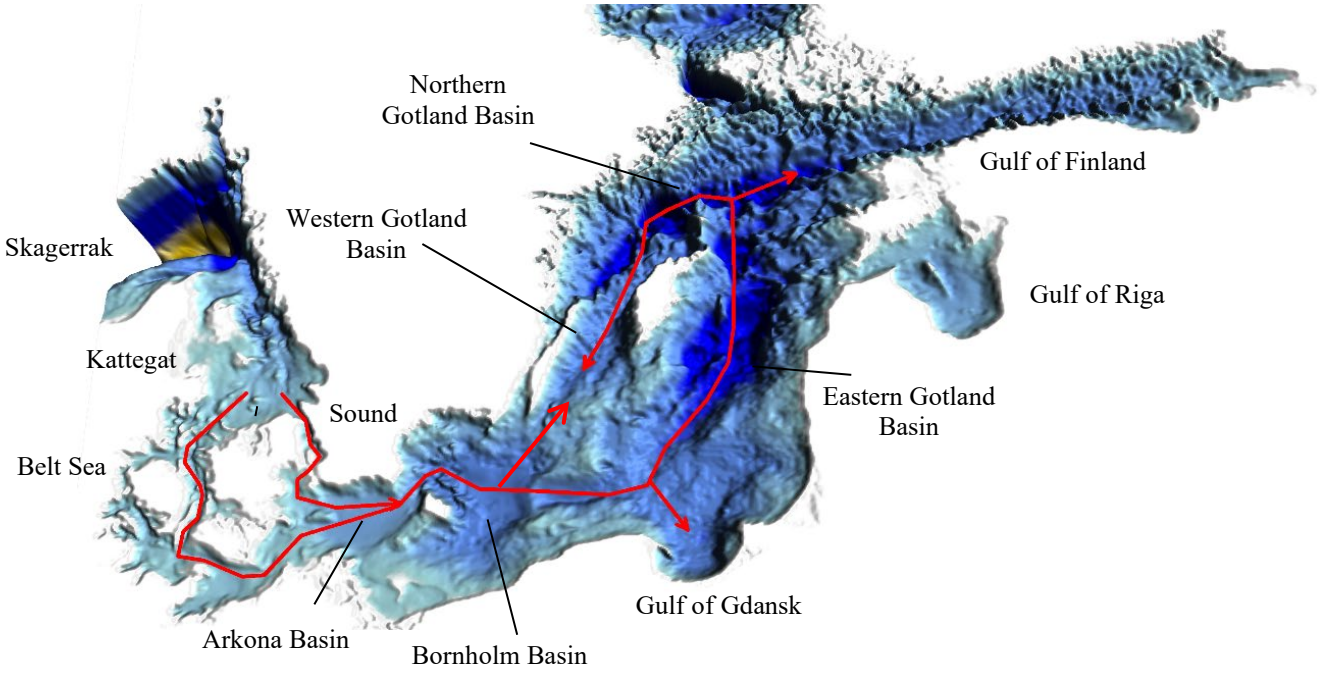


Figure 2. Bathymetry [Seifert, 2001] of the south Baltic Sea and pathways of inflowing deep-water during inflows. The Baltic Proper includes the Arkona Basin, the Bornholm Basin, the Gulf of Gdansk, the Gulf of Riga and the Eastern-, Western- and Northern Gotland Basin [Fonselius, 1995].

4 Result

Extent and volume affected by hypoxia and anoxia during the period 1960 - 2025 are presented in Figures 3 and 4, respectively. Maps presenting bottom areas affected by hypoxia and anoxia during the autumn period 2024 and 2025 can be found in Appendix 2. The mean, maximum and minimum areal extent and volume affected by hypoxia and anoxia before and after the regime shift in 1999 [Hansson et. al, 2011]) and the preliminary results for 2025 are presented in Table 1. Note that the hypoxic area and volumes are defined as all area/volume with oxygen concentration below the limit for acute hypoxia, thus it includes both hypoxic and anoxic areas/volumes.

The preliminary results for 2025 are all above mean for the period 1999-2024.

Table 1. Mean, max and min areal extent and volume of anoxia and hypoxia before and after the regime shift. Results are given as part (%) of the area and volume of the Baltic Proper, including the Gulf of Finland and the Gulf of Riga. Updated table from Hansson et. al., 2011.

in %	1960 – 1998		1999 – 2024		2025 (Preliminary)	
	Hypoxia	Anoxia	Hypoxia	Anoxia	Hypoxia	Anoxia
Mean Areal extent	22	5	30	17	34	21
Max Areal extent (Year)	27 (1970)	14 (1969)	35 (2022)	24 (2018)	-	-
Min Areal extent (Year)	9 (1993)	1 (1994)	25 (1999)	10 (2000)	-	-
Mean Volume	13	2	19	10	22	14
Max Volume (Year)	19 (1965)	8 (1969)	22 (2019)	15 (2018)	-	-
Min Volume (Year)	5 (1993)	0.1 (1994)	15 (2000)	4 (1999)	-	-

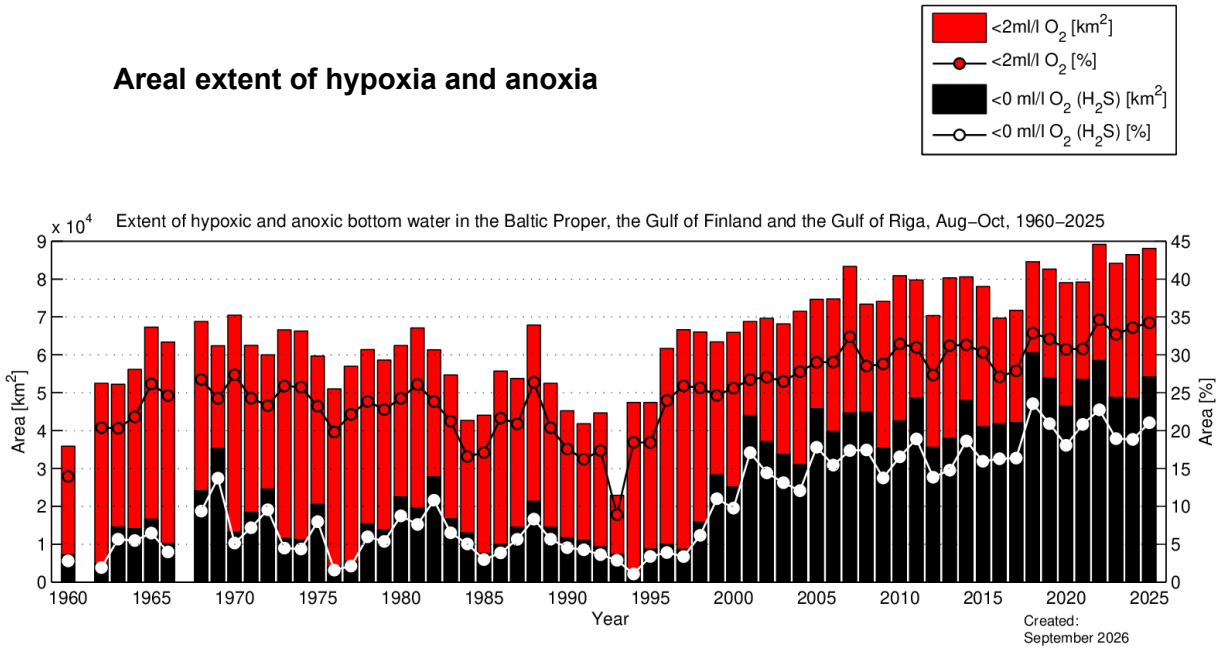


Figure 3. Areal extent of anoxic and hypoxic conditions in the Baltic Proper, Gulf of Finland and Gulf of Riga. Results from 1961 and 1967 have been removed due to lack of data from the deep basins. Note that the hypoxic area is defined as all area with oxygen concentration below the limit for acute hypoxia, thus it includes both hypoxic and anoxic areas.

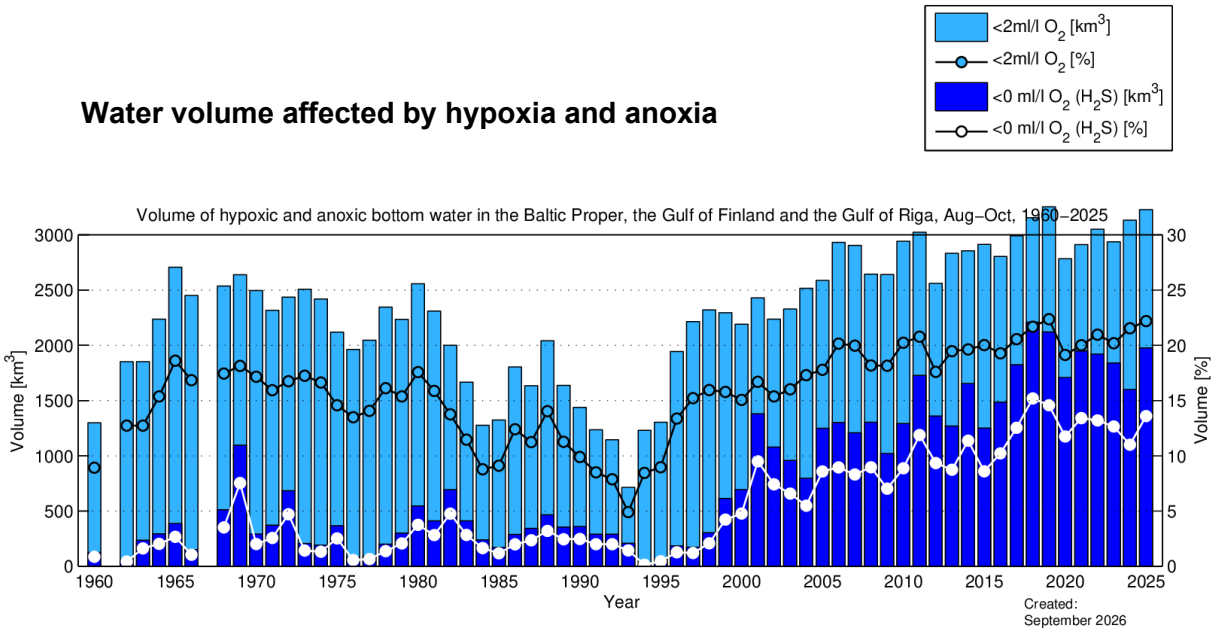


Figure 4. Volume of anoxic and hypoxic deep water in the Baltic Proper, Gulf of Finland and Gulf of Riga. Results from 1961 and 1967 have been removed due to lack of data from the deep basins. Note that the hypoxic volumes are defined as all volume with oxygen concentration below the limit for acute hypoxia, thus it includes both hypoxic and anoxic volumes.

4.1 Updated results for 2024

The result for 2024 has been updated as additional hydrographic data has been reported to ICES. Overall the update resulted in minor increase of the total areas and volumes of both anoxia and hypoxia. After the update the anoxic and hypoxic area increased somewhat in the Gulf of Gdansk, while anoxic areas in the southern parts of eastern Gotland basin decreased.

After the update the proportion of areas affected by anoxia increased from 18% to 19% and hypoxic areas was unaffected at 34%. The proportion of volume affected by anoxia and hypoxia was unchanged at 11% and 22% respectively.

The results for 2024 are all above the mean for the period after the regime shift in 1999, see Table 1. The areal extent and volume of anoxia and hypoxia continues to be elevated and the oxygen development in the Baltic Proper that has prevailed since the regime shift in 1999 continues, see Figure 3-4.

In 2024, five inflow events occurred through the Sound, each with a volume of approximately just below 20 to ~30 km^3. The latest in December 2024, was the largest, ~30 km^3. See Figure 5.

The total inflow to the Baltic Sea through the Sound during 2024 was 336 km^3 which is above the mean for the time period 1977-2023; 318 km^3. The outflow was 621 km^3, which is similar to the mean for the same period as above, 623 km^3. The accumulated inflow through the Sound (Öresund) during 2023, compared to the mean inflow 1977-2023 can be seen in Figure 5.

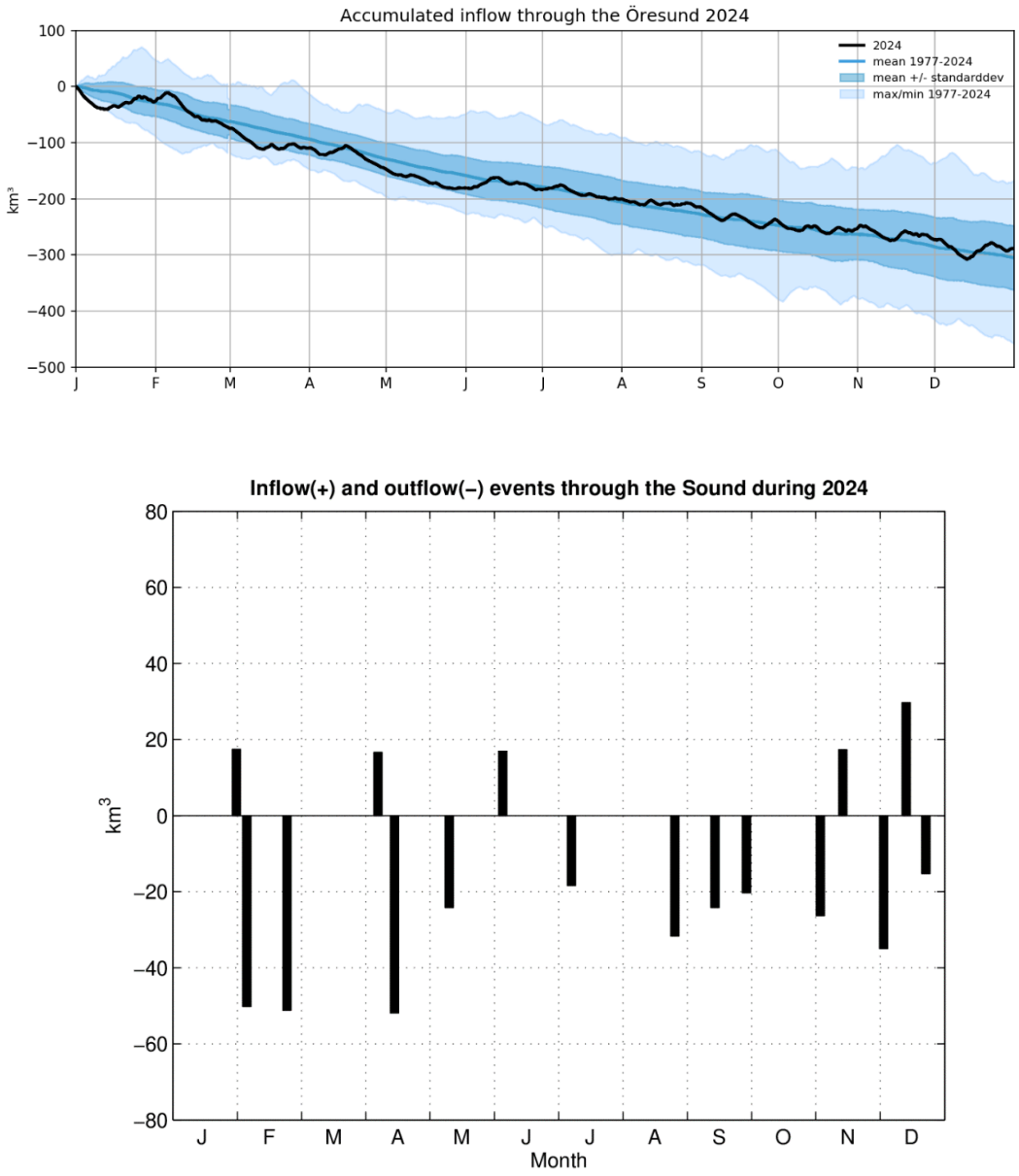


Figure 5. Top: Accumulated inflow (volume transport) through the Sound (Öresund) during 2024 in comparison to mean inflow/outflow 1977-2024. Below: Inflow (+) and outflow (-) events during 2024 that was longer than 5 days and larger than 15 km^3. [Revised summary of inflow events, SMHI, 2026].

4.2 Preliminary results for 2025

The latest major inflow to the Baltic Sea occurred in late 2014. After that a series of inflows occurred during the period 2015-2016, but during 2017-2018 only minor inflows was observed. In late 2019, one somewhat larger inflow (~40 km^3) was noted. During 2020-2025 the frequency of inflows ranged from 3-5 per year and the majority was small inflows. An inflow in December 2023, was somewhat larger, just below 40 km^3 and another in December 2024 (~30 km^2). In 2025 only two inflows were above 15 km^3 and longer than 5 days; one in late February of just below 20 km^3 and a ~30 km^3 inflow in early October. See Figure 6.

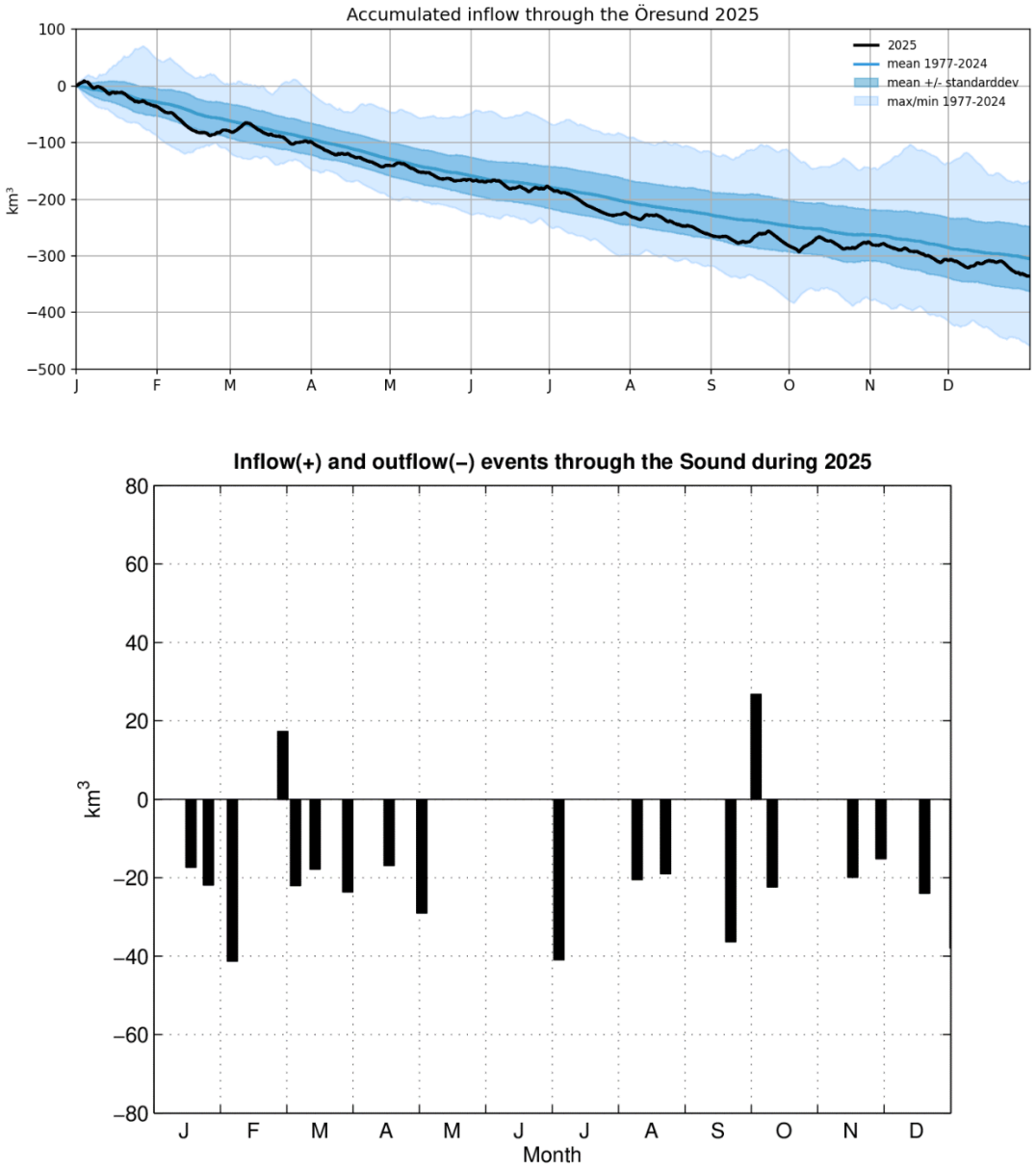


Figure 6. Top: Accumulated inflow (volume transport) through the Sound (Öresund) during 2025 in comparison to mean inflow/outflow 1977-2024. Right: Inflow (+) and outflow (-) events during 2025 that was longer than 5 days and larger than 15 km^3. [Revised summary of inflow events, SMHI, 2026].

The deep water oxygen conditions in the Arkona Basin normally follow the regular annual cycle with well oxygenated conditions during winter and spring, followed by decreased oxygen concentrations during summer and recovery during late autumn and winter. In 2025 the oxygen situation followed the same pattern. Low oxygen levels prevailed between May to September. At sampling station BY1 acute hypoxia, around 2ml/l oxygen, was observed in May, August and December, which is rare at this site in the Arkona basin. At station BY2, further east in the basin, acute hypoxia was first seen in May and then in August and September. No near anoxic conditions were noted. See station locations in Figure 7. [SMHI, 2025]

In the Hanö Bight at station Hanöbukten the deep-water oxygen was near-anoxic, with oxygen concentrations close to 0 ml/l, in February and during a longer period between September and

December. Throughout the remaining months, hypoxic conditions, below 2 ml/l prevailed. In the Bornholm Basin, at station BY4 and BY5, the positive effects of the inflow in November and December 2024 were also observed from January-May as oxygen concentrations in the deep water remained around 2 ml/l. But during the following months the oxygen concentration decreased to acute hypoxia and from July near anoxic conditions prevailed throughout the year. See station locations in Figure 7. [SMHI, 2025]

Further into the southeastern Baltic Proper at station BCSIII-10 the oxygen conditions near the bottom were more or less anoxic or just above 0 ml/l throughout the year. The pulses of inflows in November/December 2024 had only minor effects on the oxygen conditions and could be seen as an increase of the oxygen concentration in April to about ~1 ml/l, in May the oxygen concentration was back to just above 0 ml/l.

In the Eastern Gotland Basin, at the Gotland Deep - station BY15, anoxia starts at 70-80 meters depth where both oxygen and hydrogen sulphide often are below detection limit or just above. From 100-125 meters depth hydrogen sulphide is present and the concentration of hydrogen sulphide increases with depth. These conditions prevail through the year. The concentrations of hydrogen sulphide remained on high levels during 2025. From depths exceeding 225 meters the concentrations of hydrogen sulphide varied between 154 - 198 µmol/l over the year.

In September, 2023 the measured concentration of hydrogen sulphide at 239 meters depth was 213 µmol/l. This was the highest concentration noted in the Eastern Gotland Basin during the analyzed period 1960-2023. However, in November 2024 another record was noted when 244 µmol/l hydrogen sulphide was measured at 225 meters, surpassing the previous record. The maximum concentration 2025, (198 µmol/l) was found at 240 meters depth in July. See Figure 7, Appendix 1 and SMHI cruise reports from 2023-2026 [SMHI, 2023-2026].

The oxygen conditions further up in the water column, below the permanent halocline, is affected by sporadic intermediate inflows. The inflow in late 2024 and early 2025 reached the Gotland deep station in August and could be found as an intermediate layer at around 110 m depth, where oxygen increased slightly up to ~0.8 ml/l in water that were previously sulphidic. Already in September this oxygen was more or less consumed and near anoxic conditions prevailed at this depth throughout the year. Acute hypoxic conditions, below 2 ml/l, was found at approximately 60-70 meters depth. From 80-125 meters depth near anoxic conditions prevailed with oxygen concentrations near zero or low concentrations of hydrogen sulphide.

The oxygen situation in the deep water in the Northern Gotland Basin shows similar development as in the Eastern Gotland Basin. The concentration of hydrogen sulphide in the bottom water also continues to increase, but concentrations are lower than in the Eastern Gotland Basin. At depths exceeding 150 meters the concentration ranged from 32-54 µmol/l compared to 31-58 µmol/l in 2024. See Figure 7.

Also, in the Western Gotland Basin the severe stagnation continues. The concentrations of hydrogen sulphide are higher than normal and are at a record high level for this basin, see appendix 1. At station Landsort Deep, BY31, the hydrogen sulphide concentration in the deep water exceeding 400 meters depth ranged from 37-61 µmol/l compared to from 43-64 µmol/l during 2024. Similar values were found in the deep water at Norrköping Deep, station BY32, further south in the Western Gotland Basin, 51-64 µmol/l. Acute hypoxia was found from 60-80 meters depth and anoxic conditions from 70-90 meters depth.

Further south in the Western Gotland Basin, at the station BY38 the hydrogen sulphide at depth exceeding 100 meters depth remains high but also show large variations. In January no hydrogen sulphide was found and bottom water oxygen levels were just below 2 ml/l. A possible cause to this increase in oxygen could be the inflows that occurred in November/December 2024. When these inflows reached the Bornholm Basin a pulse of oxygen rich bottom water found its way through the small, narrow channel that connects Bornholm and the Western Gotland Basin. However, the pulse was too small to change the overall oxygen

situation since anoxica was present already in February and during the rest of the year the hydrogen sulphide concentrations ranged from 30-68 µmol/l compared to 15-62 µmol/l in 2023 and 34-84 µmol/l in 2024. [SMHI, 2026]

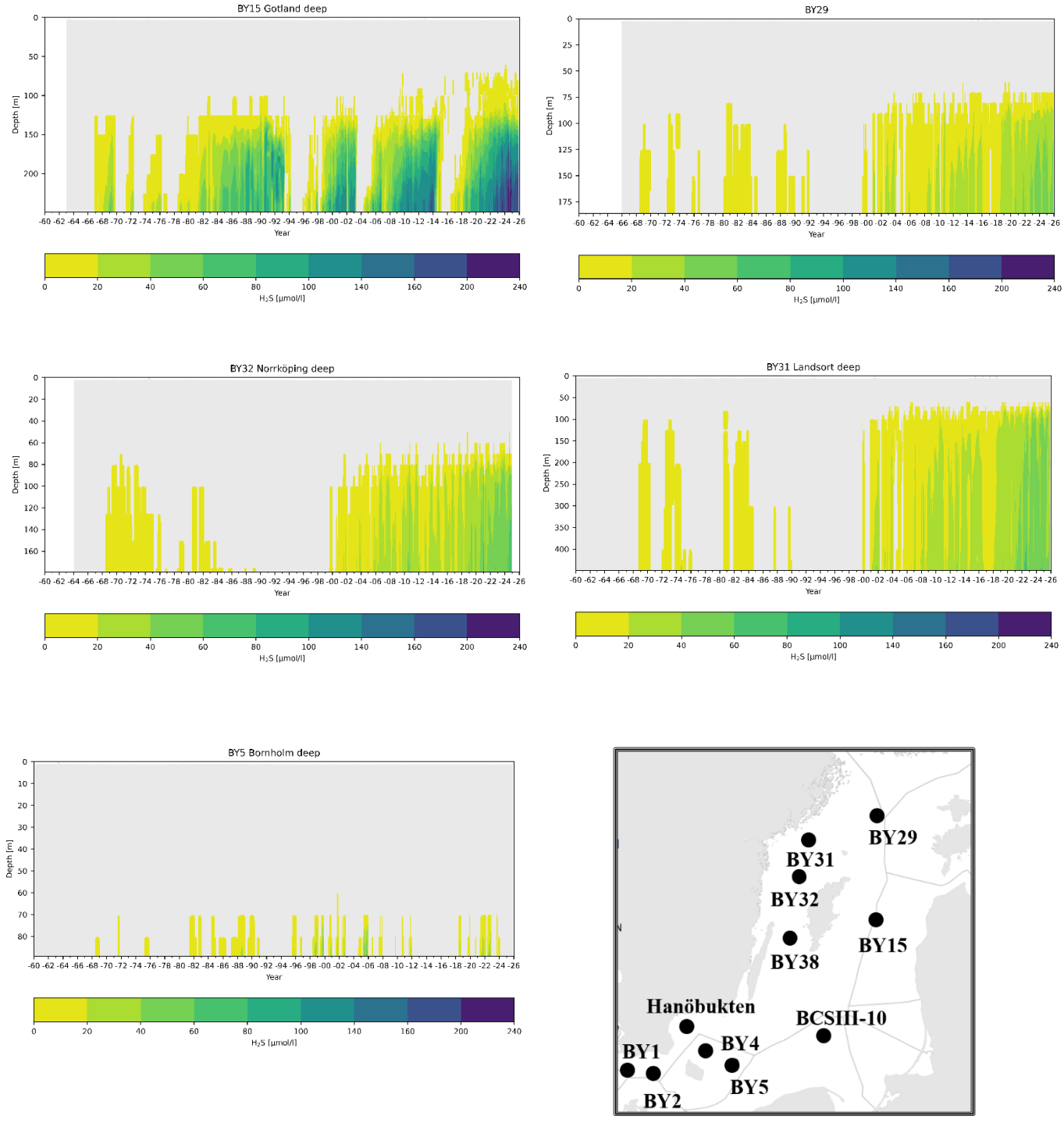


Figure 7. Concentration of hydrogen sulphide (H2S) in the Baltic Proper, 1960-2025. Grey color signifies no hydrogen sulphide present and white indicate that data is missing.
Top left: Gotland Deep (BY15) in Eastern Gotland Basin. Top right: Northern Baltic Proper (BY29). Middle left: Norrköping Deep (BY32). Middle right: Ladsort Deep (BY31), in the Western Gotland Basin. Lower left: Bornholm Deep (BY5) in the Bornholm Basin. Lower right: Map of monitoring stations in the Baltic Proper.

In October 2025 a somewhat bigger inflow occurred (~30 km^2). However, this inflow was warm (13-14 degree C) relatively saline (~19 psu) but not well oxygenated (~5 ml/l) and will only have minor positive effects on the oxygen situation in the southern Baltic Proper.

Note that the 2025 results are preliminary; however, the results are based on extensive data sets with essential data contributions from almost all countries around the Baltic Proper.

The updated results for 2024 and the preliminary results for 2025 show that the severe oxygen conditions in the Baltic Proper after the regime shift in 1999 continues. The areal extent of anoxia and hypoxia is more or less similar to previous years only with small differences. The situation in both the Eastern and Western Gotland Basin continues to deteriorate as the concentration of hydrogen sulphide continues to increase with new record high concentrations. The positive effect of the inflow that do occur can be seen in the Southern Baltic Proper but these pulses of oxygenated water are too small to have any major impact on the overall oxygen situation. A major inflow or a series of medium inflows are needed to have a real positive impact on the oxygen situation in Baltic area.

5 Conclusions

- The severe oxygen conditions in the Baltic Proper continues. The areal extent and volume of anoxia are still elevated and follow the development that have prevailed since the regime shift in 1999.

- In 2024 anoxia was found at ~19% of the bottom areas and ~34% suffered from hypoxia during the autumn period.

- Preliminary results for 2025 shows similar results as 2024. About ~21% of the bottom areas suffer from anoxia and approximate ~34% suffered from hypoxia.

- The concentration of hydrogen sulphide is above normal in all the basins around Gotland. In the Eastern and Western Gotland Basin hydrogen sulphide in the bottom water has remains on an elevated record high level.

- The inflows that occurred in November/December 2024 did have an effect on the oxygen situation in southern parts of the Baltic Proper and the southern parts of the Western Gotland Basin. The inflow reached intermediate depth in the Eastern Gotland Basin in August. However, no inflows reached the Western or Northern Gotland Basins.

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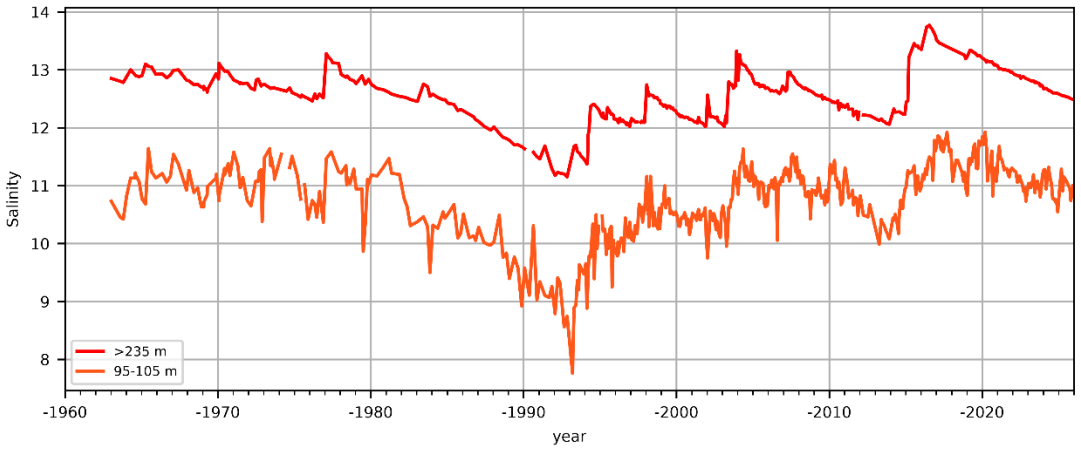
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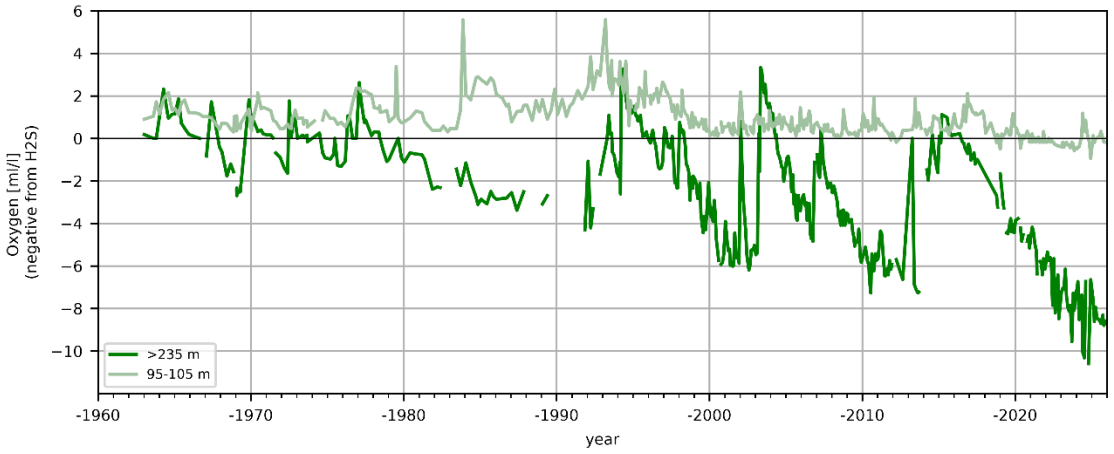
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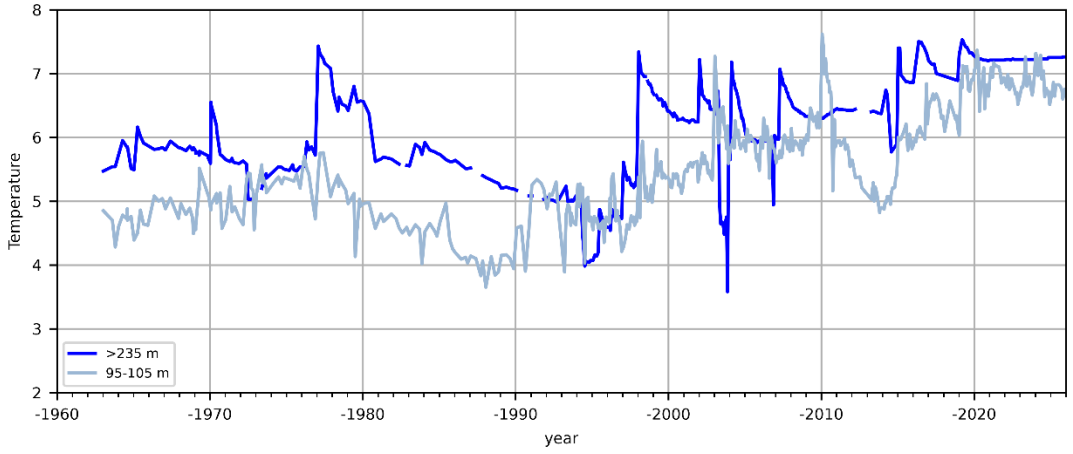
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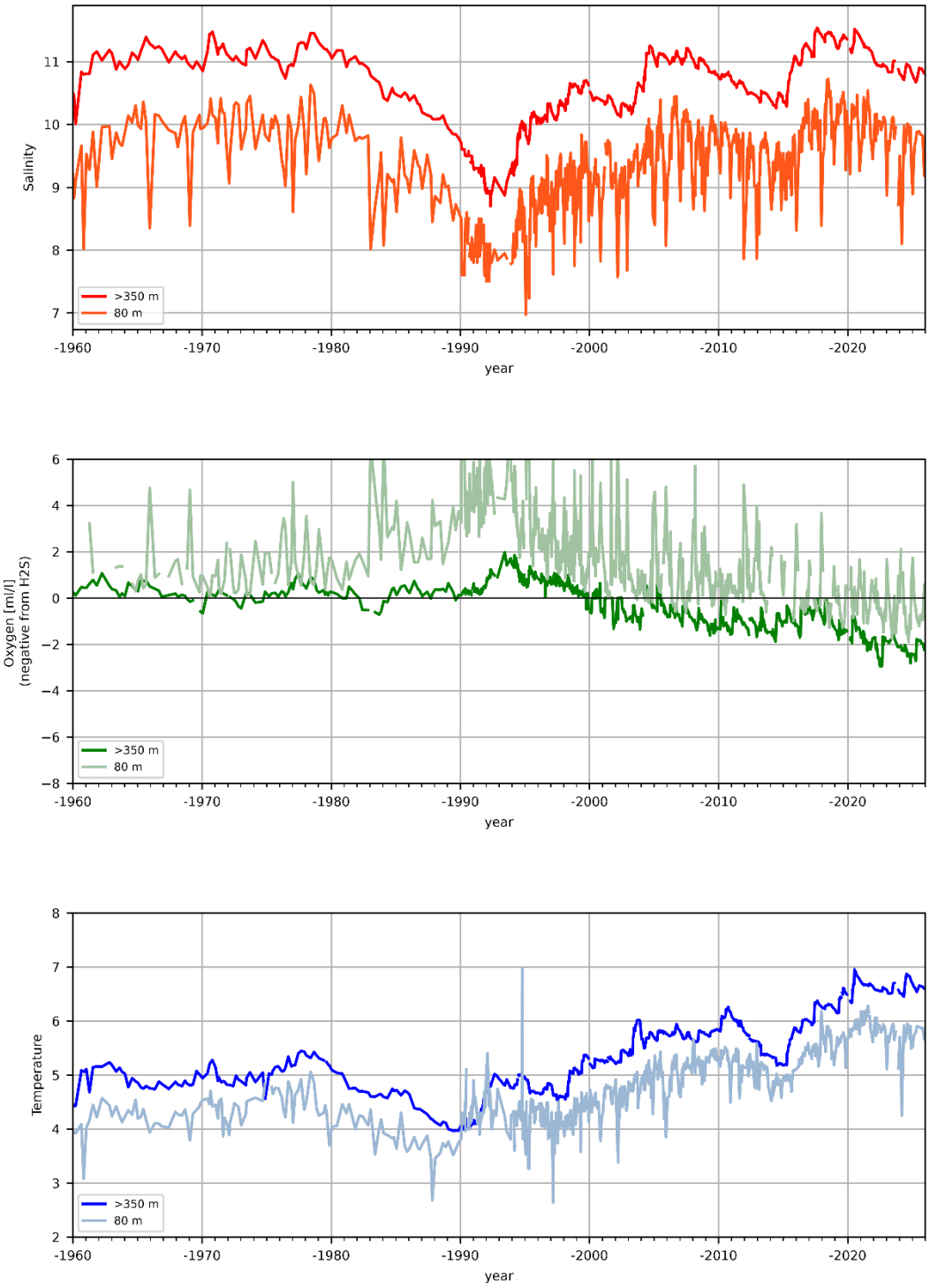
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Swedish Meteorological and Hydrological Institute
SE 601 76 NORRKÖPING
Phone +46 11-495 80 00 Telefax +46 11-495 80 01

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