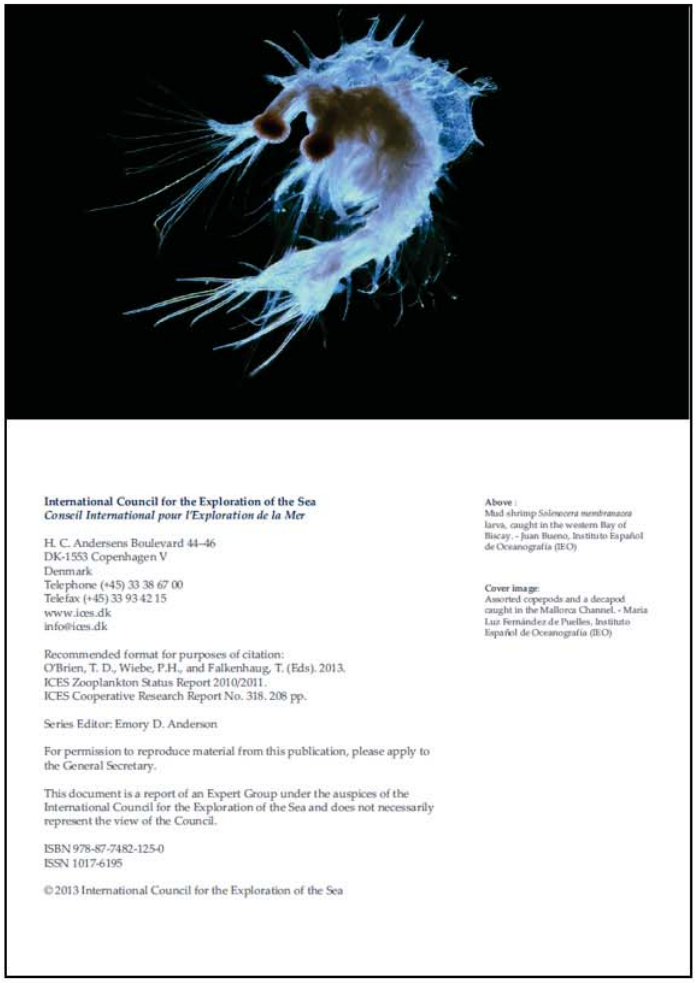

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Recommended format for purposes of citation:
O'Brien, T. D., Wiebe, P.H., and Falkenhaug, T. (Eds). 2013.
ICES Zooplankton Status Report 2010/2011.
ICES Cooperative Research Report No. 318. 208 pp.

Series Editor: Emory D. Anderson

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ISBN 978-87-7482-125-0
ISSN 1017-6195

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Above :
Mud shrimp *Solenocera membranacea* larva, caught in the western Bay of Biscay. - Juan Bueno, Instituto Español de Oceanografía (IEO)

Cover image:
Assorted copepods and a decapod caught in the Mallorca Channel. - María Luz Fernández de Puelles, Instituto Español de Oceanografía (IEO)

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6.1 Northern Baltic Sea (Sites 21–32)

Maiju Lehtiniemi

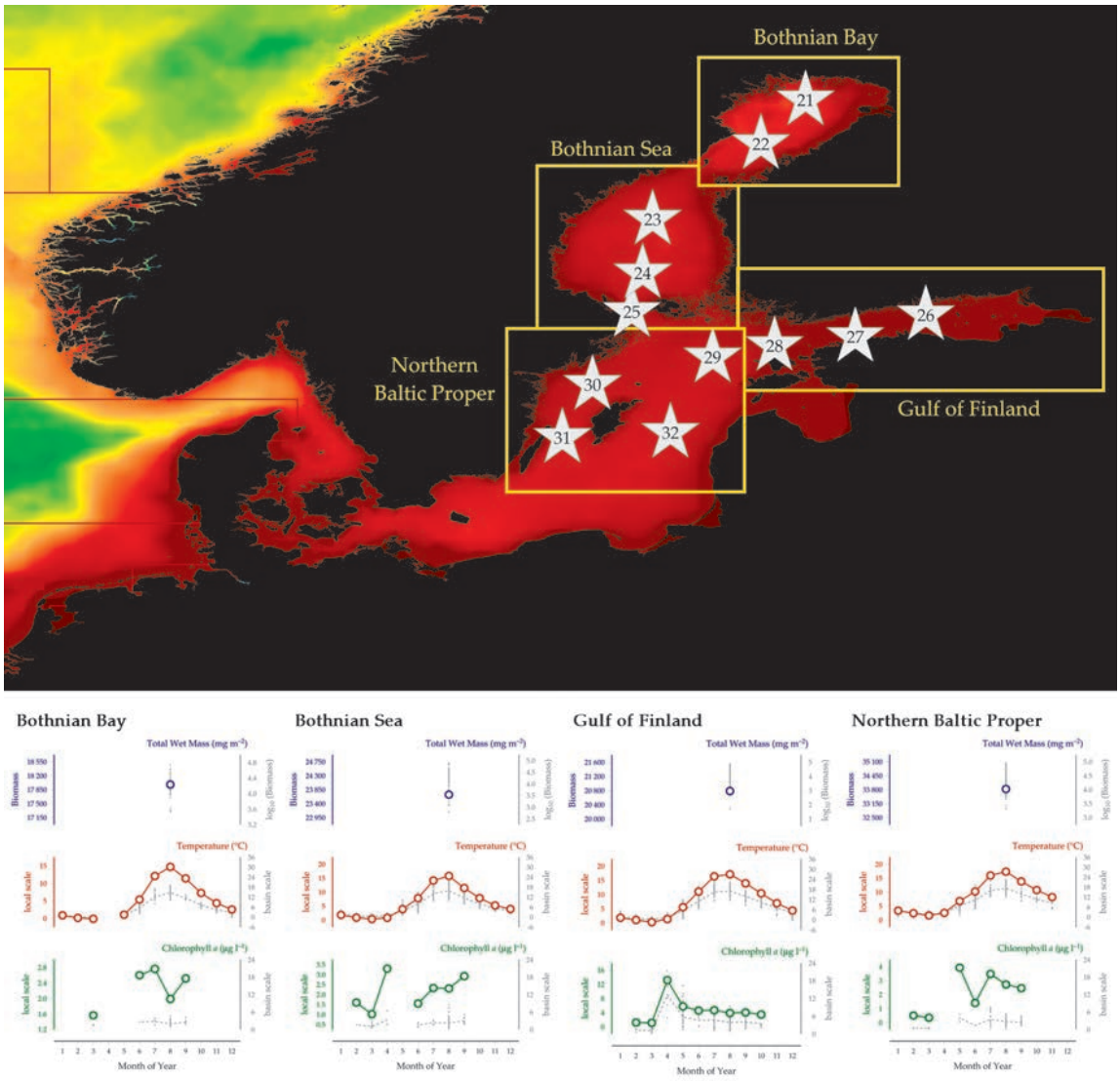


Figure 6.1.1
Location of Finnish Environment Institute (SYKE) monitoring stations in the northern Baltic Sea (Sites 21–32), and their corresponding seasonal summary plots (see Section 2.2.1). The yellow boxes and labels indicate the four subareas described in the report text.

Zooplankton monitoring by the Finnish Environment Institute SYKE [former Finnish Institute of Marine Research (FIMR)] began in 1979 after the Helsinki Commission (HELCOM) initiated cooperative environmental monitoring of the Baltic Sea. Monitoring is divided into four subareas (Figure 6.1.1), based on differing hydrographic environments: Bothnian Bay (sites 21–22), and Bothnian Sea (sites 23–25), Gulf of Finland (sites 26–28), and the Baltic Proper (sites 29–31). Zooplankton samples are collected in August, the peak abundance period, with a WP-2 net (56 cm diameter, 100 µm mesh).

The zooplankton samples are collected from two stations in the Bothnian Bay ("F2": site 21; "BO3", site 22), from three stations in the Bothnian Sea ("US5B", site 23; "SR5", site 24; "F64", site 25 located in the Åland Sea, but included in the Bothnian Sea analysis), from three stations in the Gulf of Finland ("LL3a", site 26; "LL7", site 27; "LL12", site 28), and from four stations in the Baltic Proper located within the eastern and northwestern Gotland Basin ("LL17", site 29; "LL23", site 30; "BY38", site 31; "BY15", site 32).

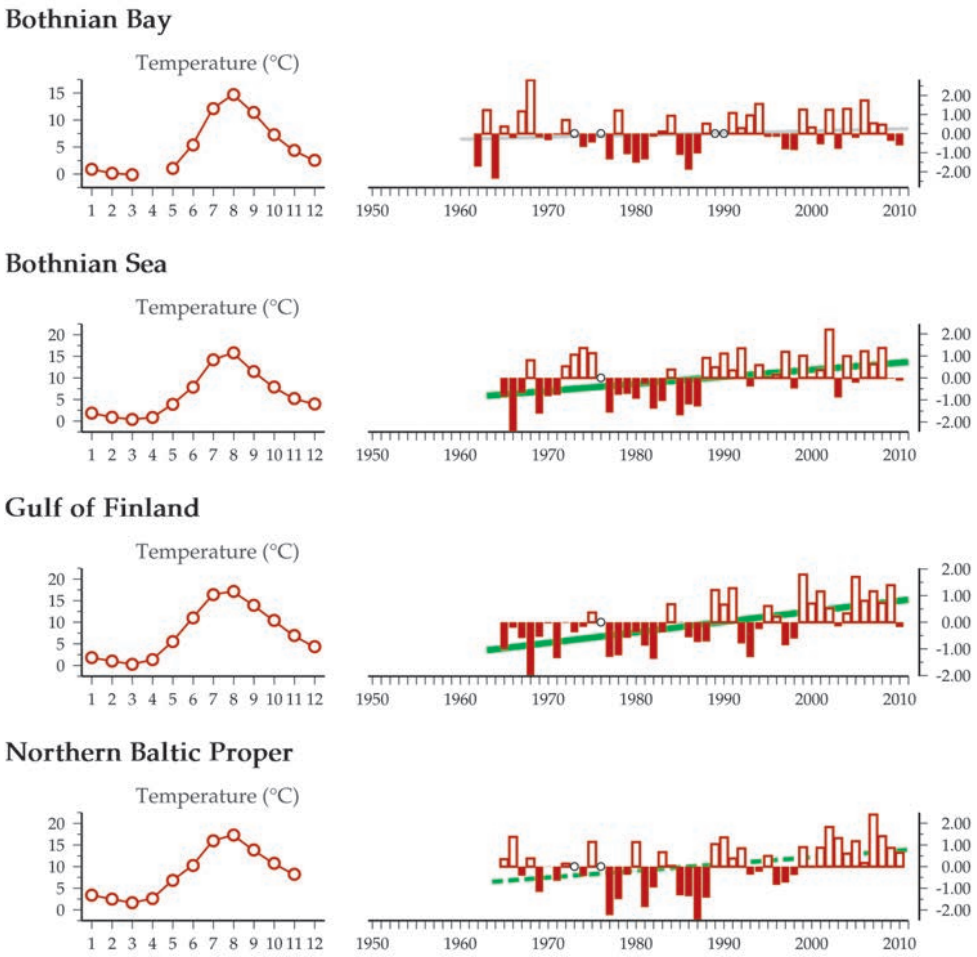


Figure 6.1.2
Multiple-variable comparison plot (see Section 2.2.2) showing the seasonal and interannual properties of surface temperatures within the four northern Baltic Sea monitoring regions.

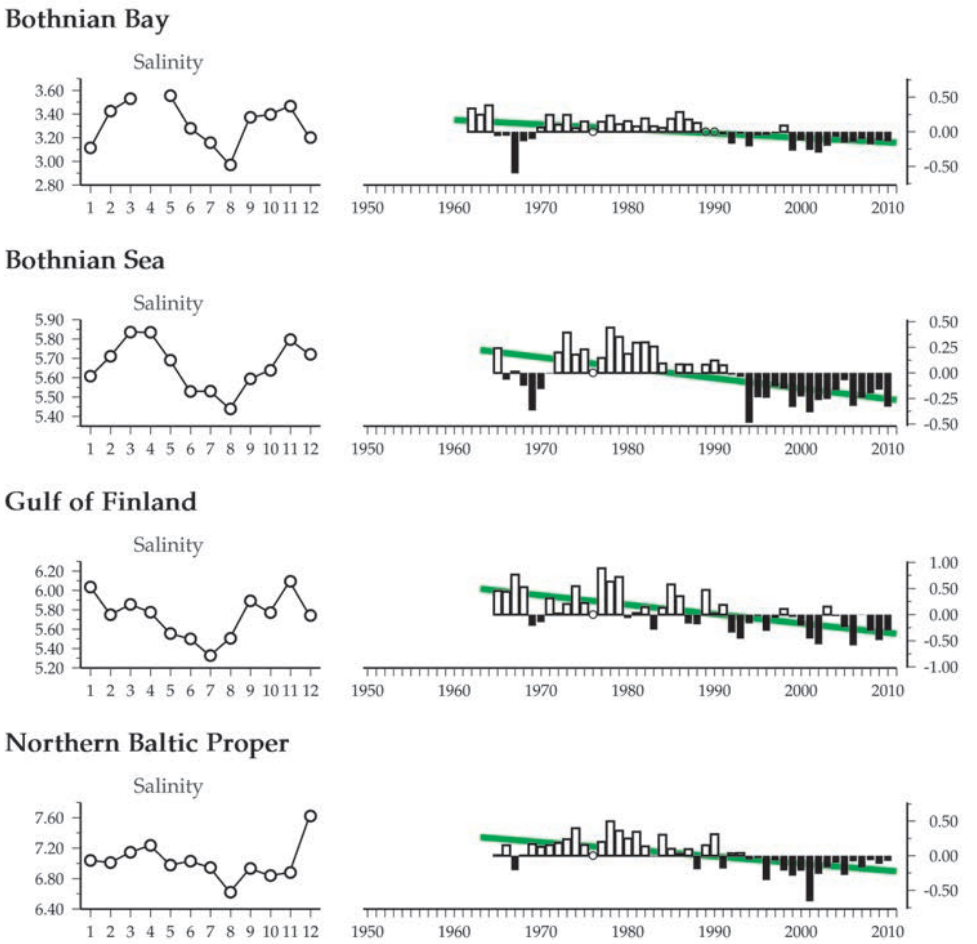


Figure 6.1.3
Multiple-variable comparison plot (see Section 2.2.2) showing the seasonal and interannual properties of surface salinities within the four northern Baltic Sea monitoring regions.

Seasonal and interannual trends in hydrography

Water temperatures are lowest in February–March and warmest in July–August (Figure 6.1.2) in all northern and eastern subbasins. Water temperatures in the Bothnian Bay are generally 1–2°C colder than those in the Bothnian Sea. Both regions have relatively low salinities, ranging from 2 to 4 in the Bothnian Bay (Leppäranta and Myrberg, 2009) and from 4 to 6 in the Bothnian Sea.

The hydrography of the Baltic Proper is characterized by strong stratification, which prevents mixing of the water column. A stabile halocline is formed at approximately 70 m depth. Water-column salinity varies from 6 to 8 at the surface to 9–13 in the deeper water (Leppäranta and Myrberg, 2009). Pronounced salinity stratification often leads to oxygen depletion in bottom waters. Only irregular saltwater intrusions from the North Sea ventilate the deep bottom waters of the central Baltic Sea. The hydrography of the Gulf of Finland is similar to the Baltic Proper owing to a direct connection between these basins.

The general Baltic-wide decrease in salinity since mid-1980s is seen in the northern and eastern subbasins (Figure 6.1.3), because of warmer temperatures and increased precipitation and river run-off in the Baltic. The surface salinity in the Gulf of Finland varies from almost freshwater in the eastern parts of the Gulf (LL3a), owing to freshwater discharge from the River Neva, to >6 in the west (LL12). A halocline is formed at 60–80 m depth, preventing mixing of the deeper saltier (5–9) waters with surface layers (Leppäranta and Myrberg, 2009).

Surface temperature has been increasing since the mid-1980s in the Bothnian Sea, Åland Sea, and Gulf of Finland. In the Baltic Proper, sea surface temperature has been higher during the last 10–15 years, but the increasing trend is not as clear as in the Bothnian Sea and Gulf of Finland (Figure 6.1.2). The 100-year HadISST sea surface temperatures (Figure 6.1.11) show the same trends, indicating increasing temperatures in all four regions.

Seasonal and interannual trends in zooplankton

The zooplankton community of the Baltic Sea is a mixture of freshwater, brackish, and marine species. The dominant species are the calanoid copepods *Eurytemora* spp., *Acartia* spp., *Temora longicornis*, *Limnocalanus macrurus*, and the cladocerans *Bosmina (Eubosmina) coregoni* and *Evadne nordmanni*. The differences in salinity between the subbasins influence the zooplankton community structure in each region, with taxa preferring higher salinities (e.g. *Pseudocalanus* spp.) being nearly absent in the relatively lower salinity Bothnian Bay waters, and taxa preferring fresher waters (e.g. *L. macrurus*) being nearly absent in the relatively higher salinity waters of the Baltic Proper (Figure 6.1.4). As a result of these preferences, the overall species composition is changing as both surface and bottom salinities have been decreasing in many regions since the beginning of the sampling programme in 1979.

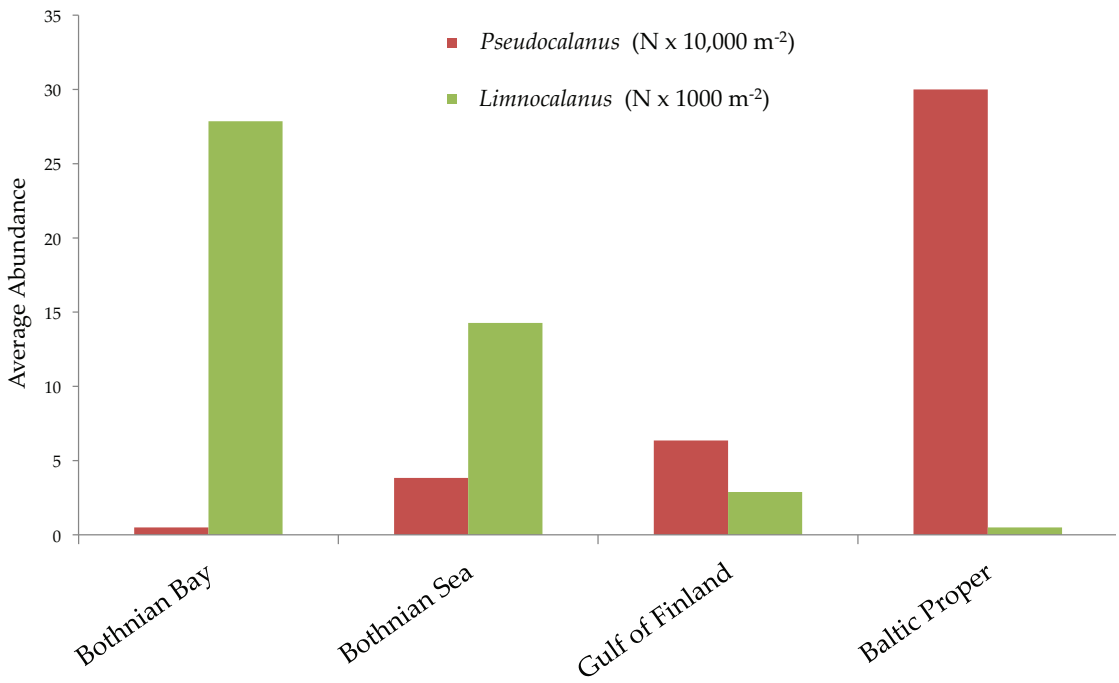


Figure 6.1.4
Average abundances of two copepods with opposite salinity preferences plotted by northern Baltic Sea regions ordered from relatively low (Bothnian Bay) to higher average salinities (Baltic Proper).

Bothnian Bay salinities average around 3, while Baltic Proper salinities are above 7.

The copepod Pseudocalanus *prefers higher salinity, while* Limnocalanus *prefers lower-salinity waters.*

No large shifts have occurred in the total zooplankton biomass except in the Bothnian Sea, where the biomass has significantly increased (Figure 6.1.5). However, significant changes have occurred in the species composition in many regions. Of the dominant copepods in the northern and eastern Baltic Sea, *Eurytemora* spp. has increased in the Bothnian Sea, Gulf of Finland, and Baltic Proper since the late 1980s, while in the northernmost Bothnian Bay, there has been a slight downward trend (Figure 6.1.6).

The other dominant copepod species, *Acartia* spp. (not shown) has increased in abundance in the Baltic Proper. *L. macrurus* is the largest species of copepods and an important species in the zooplankton communities of the less-saline environments such as the Bothnian Bay, Bothnian Sea, and Gulf of Finland. It is favoured by decreasing salinities and has significantly increased in abundance in the Bothnian Sea (Figure 6.1.7).

Pseudocalanus spp., a copepod genus of marine origin, has been decreasing in biomass over the monitoring period due to decreasing salinities (Flinkman *et al.*, 2007). Another marine copepod, *T. longicornis*, has decreased in the Bothnian Sea, but has strongly increased in the more-saline Baltic Proper (Figure 6.1.8).

The most abundant cladoceran species, *Bosmina* (*Eubosmina*) *coregoni*, has significantly increased from the beginning of the monitoring programme in the Bothnian Sea (Figure 6.1.9). A slight increase can also be seen in the Bothnian Bay. This species favours warm waters and is probably affected by the increasing surface water temperatures. No significant trends can be seen in the abundance of the two other common cladocerans, *E. nordmanni* and *Podon* spp., in any of the subbasins (not shown).

The moon jellyfish *Aurelia aurita* has been very abundant during late summer and early autumn during the last two years after many years of lower abundance. There are no ongoing monitoring programmes on gelatinous zooplankton in the northern and central Baltic Sea, but observations are collected by the public.

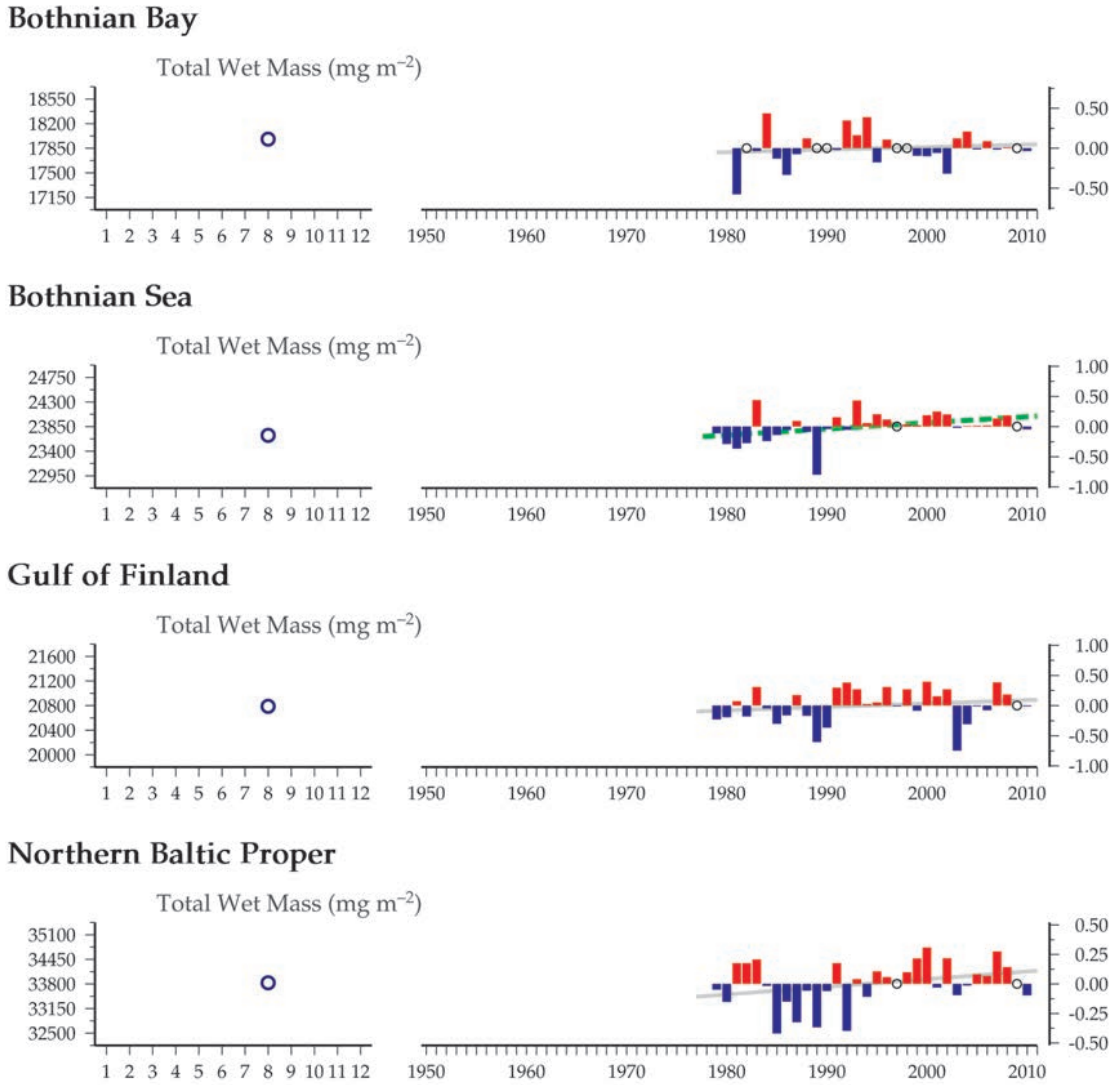


Figure 6.1.5
Multiple-variable comparison plot (see Section 2.2.2) showing the seasonal and interannual properties of total zooplankton wet mass values within the four northern Baltic Sea monitoring regions.

Figure 6.1.6
Multiple-variable comparison plot (see Section 2.2.2) showing the seasonal and interannual properties of Eurytemora *spp. abundance within the four northern Baltic Sea monitoring regions.*

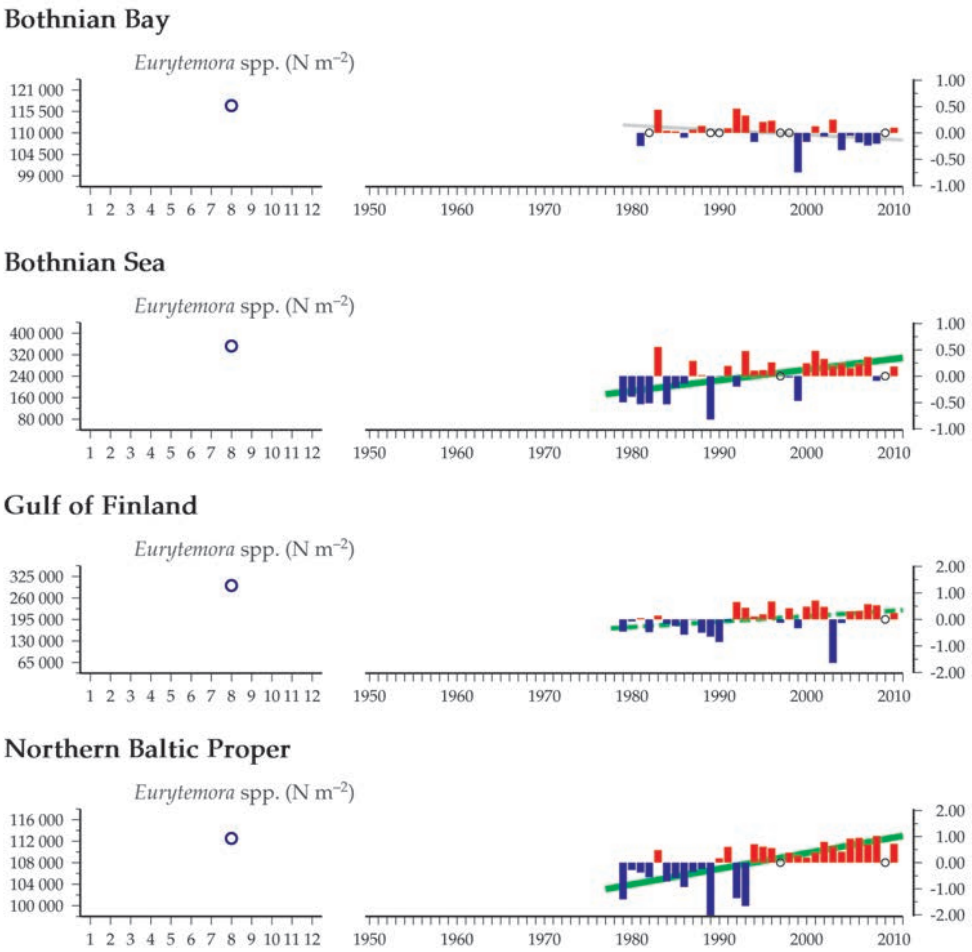
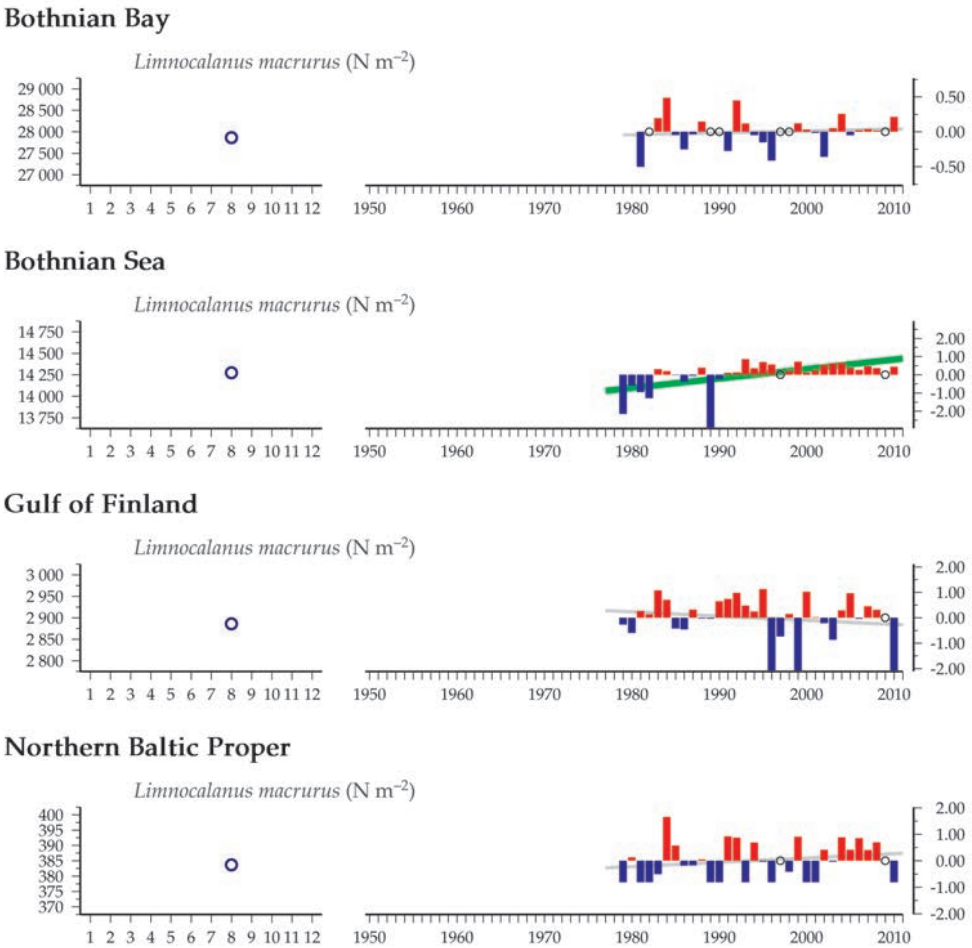


Figure 6.1.7
Multiple-variable comparison plot (see Section 2.2.2) showing the seasonal and interannual properties of Limnocalanus macrurus *abundance within the four northern Baltic Sea monitoring regions.*



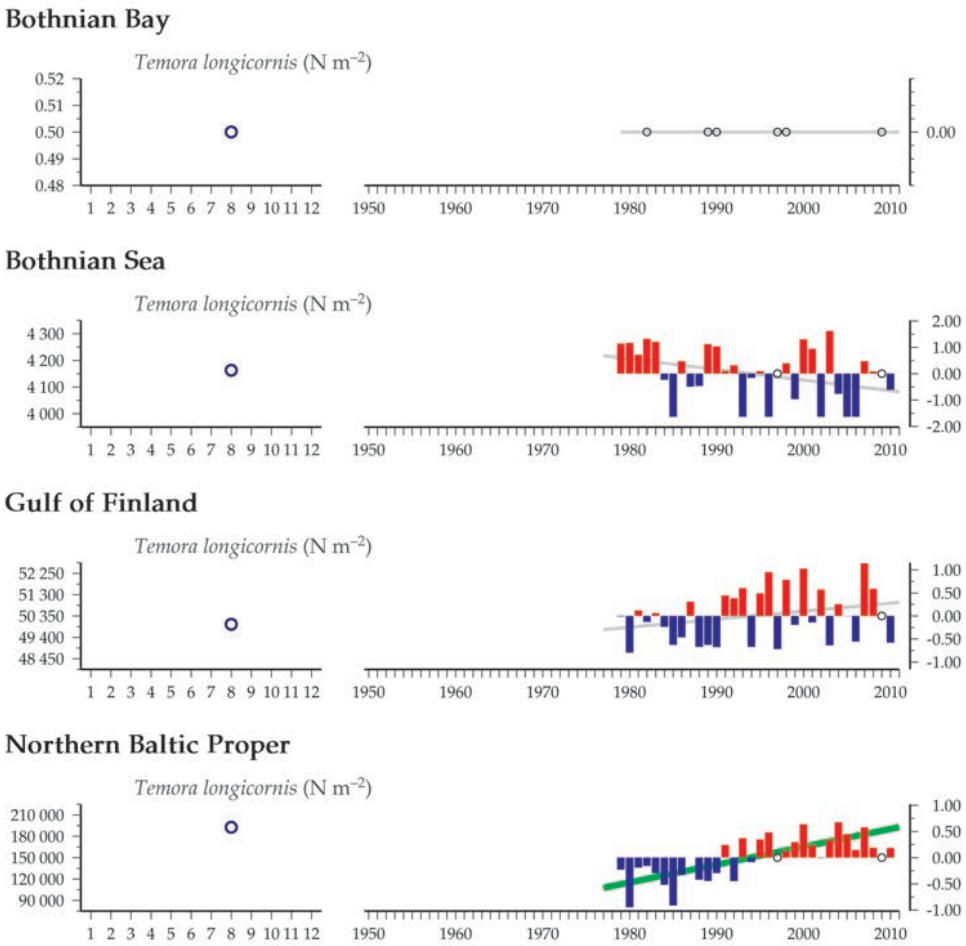


Figure 6.1.8
Multiple-variable comparison plot (see Section 2.2.2) showing the seasonal and interannual properties of Temora longicornis *abundance within the four northern Baltic Sea monitoring regions.*

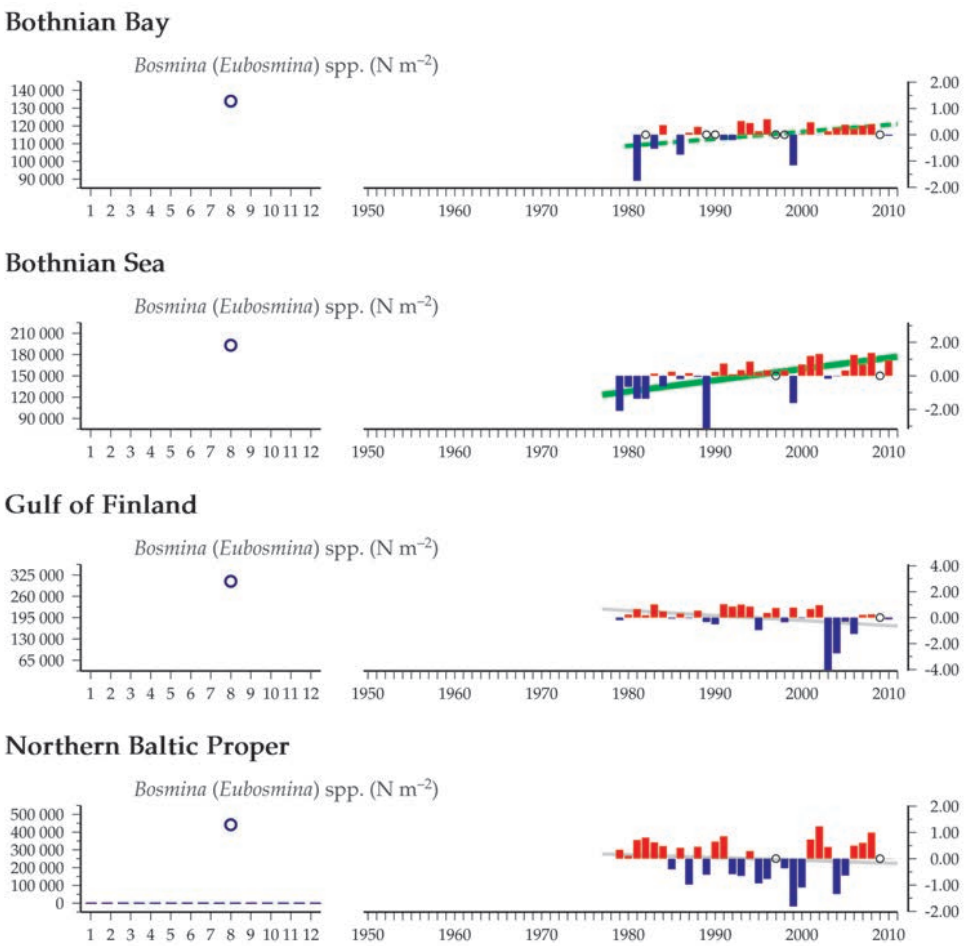
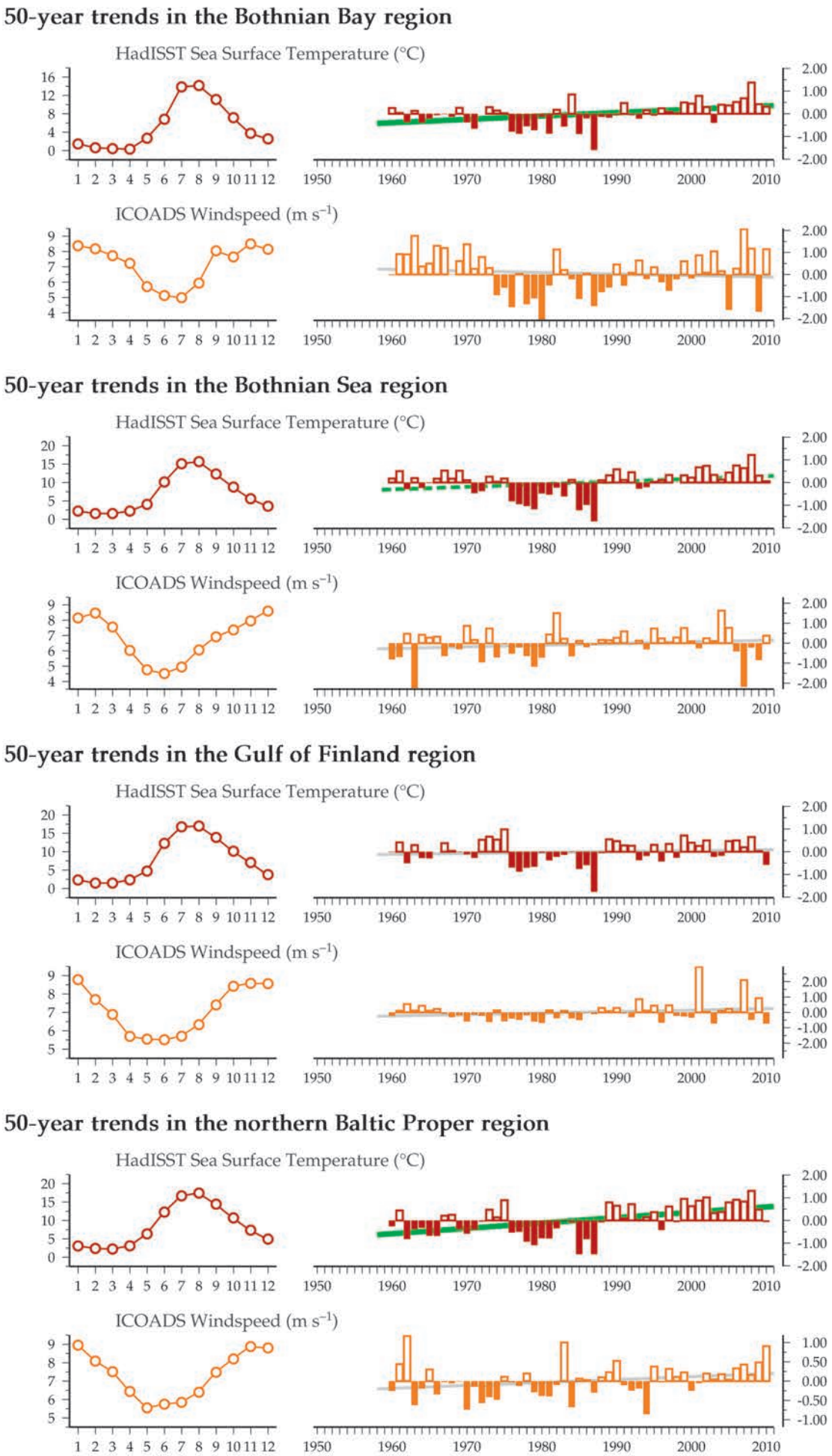


Figure 6.1.9
Multiple-variable comparison plot (see Section 2.2.2) showing the seasonal and interannual properties of Bosmina (Eubosmina) *spp. abundance within the four northern Baltic Sea monitoring regions.*

Figure 6.1.10
Regional overview plot (see Section 2.2.3) showing long-term sea surface temperatures and wind speeds in the general region surrounding the Northern Baltic Sea monitoring areas.



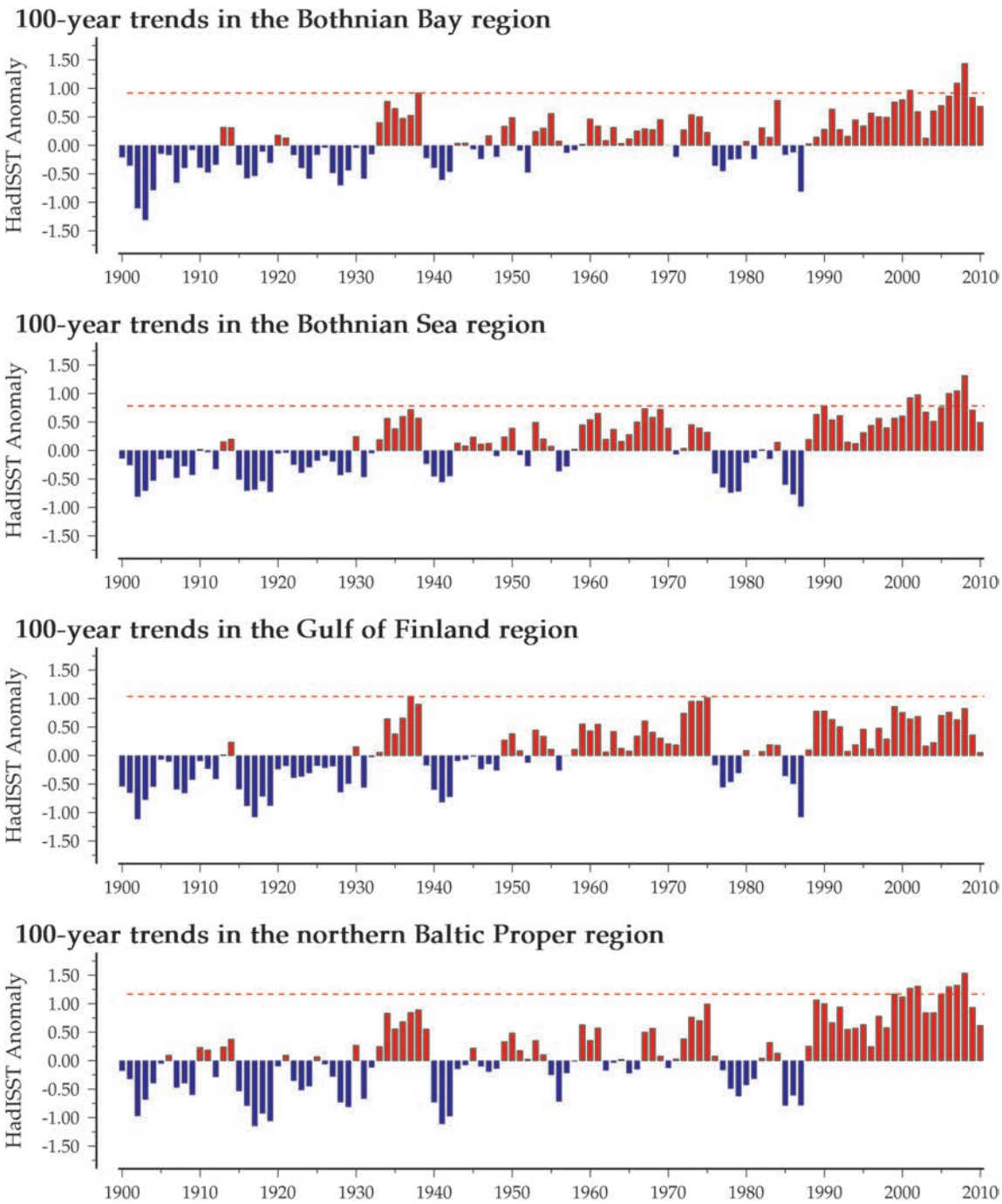


Figure 6.1.11
Regional overview plot (see Section 2.2.3) showing 100-year sea surface temperatures in the general region surrounding the Northern Baltic Sea monitoring areas.