

COMPARABILITY OF TRADITIONAL AND UNATTENDED MONITORING IN THE SOUTHERN GULF OF FINLAND – RESULTS FROM 1997-98

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Introduction

Estonian national monitoring grid consists of 36 stations (Fig. 1), among them only 6 are visited sufficiently frequently. It means that the great part of rapidly changing pelagic parameters can neither be used for recording short-term events nor for long-term trend analysis. The traditional research strategy has proved to be ineffective in giving statistically reliable results of the changes in the phytoplankton community, i. e. blooms. On the other hand, it is impossible to increase the temporal and spatial frequency of the traditional sampling to the level, at which the statistical trend analysis could be reliably performed.

However, some technical methods as satellite imagery and unattended recording systems on ships could enable cost-effective and target-oriented monitoring of the marine environment. The use of merchant ships is economic compared to research vessels, because the expense is the initial cost of the measuring equipment.

In 1997, the developed unattended flow-through system (Fig. 3) was installed on board passenger ferry 'Wasa Queen' running between Tallinn and Helsinki in the central Gulf of Finland. The system measures surface (~5 m depth) temperature, salinity and chlorophyll *a* fluorescence. Automatic water sampling makes possible to measure concentrations of nutrients and chlorophyll *a* content as well as to identify phytoplankton species composition and biomass. The water samples are collected at 11 sampling points along the ferry route (Fig. 2) once a week and the results of measurements are regularly presented at the project homepage (<http://meri.fimr.fi>) to provide operational information of the state of the Gulf of Finland. The aim of the present poster is to show the comparability of different sampling strategies on the ground of chlorophyll *a*.

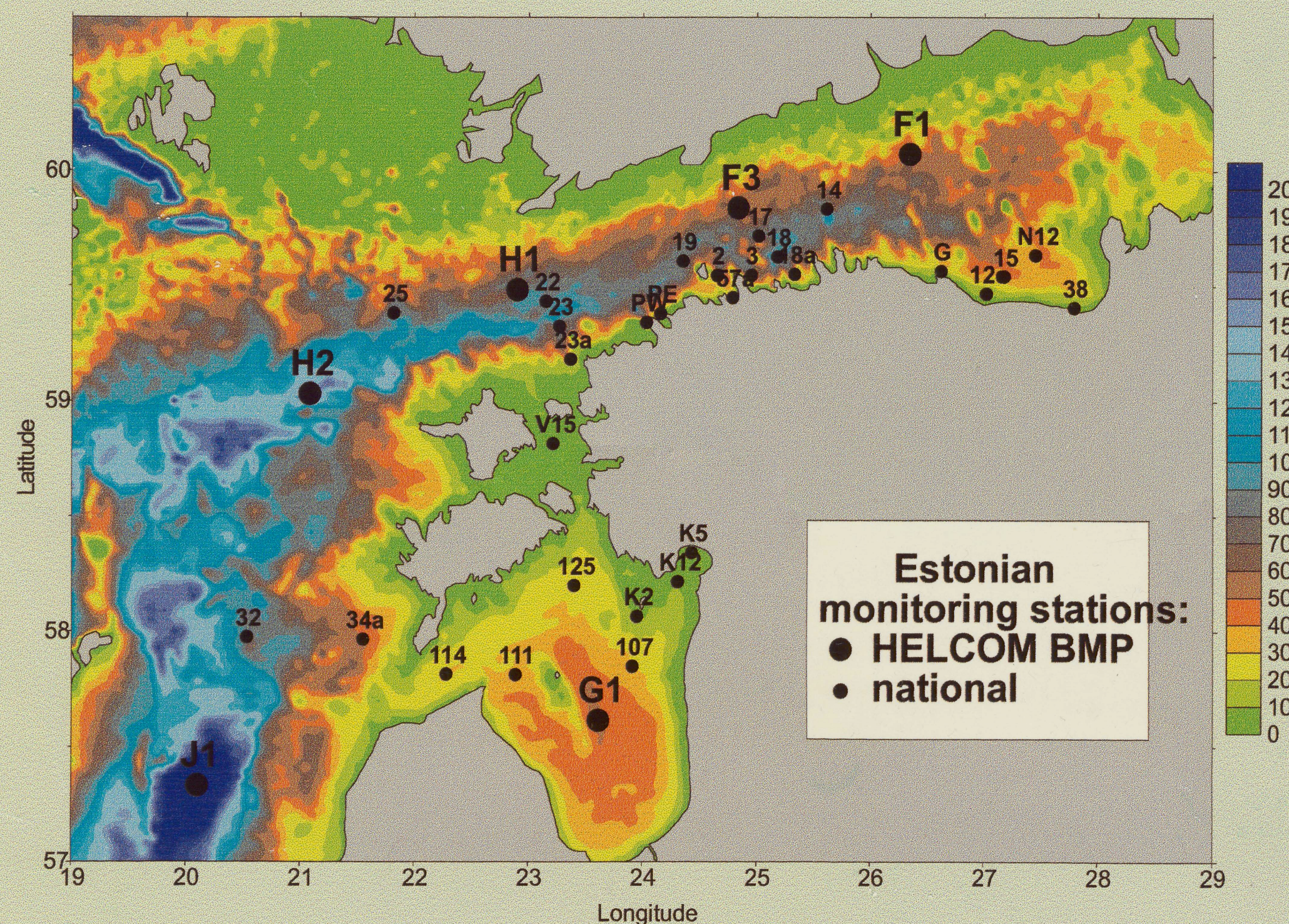


Figure 1. Scheme of the Estonian marine monitoring grid. Vertical scale-bar – depth in metres.

Finally, the comparative dynamics of chlorophyll *a* values obtained by the traditional monitoring (integrated samples from 0-10 m layer) and the results of laboratory analysis of unattendedly collected water samples in 1997-98 are presented in Fig. 7. The data collected by different strategies follow somewhat different patterns. In deeper stations (WQ 7, WQ 10, F3 and 2) the vernal chlorophyll *a* contents are higher using traditional sampling and respectively lower in the late summer period. It can be explained by vertical distribution of the phytoplankton biomass in the central Gulf of Finland discussed above. In the spring bloom period the most of phytoplankton biomass is concentrated in the uppermost 5 metres, while in the summer period the subsurface (5-10 m) maxima are common.

We give an account that the two-years data are incomplete to make far-reaching conclusions, but they are more informative than data obtained at much lower frequency, even when the vertical aspect is included. We confirm that the described unattended operational system is an effective tool both for monitoring the rapid changes in the marine environment and analysing the long-term trends in the state of the marine environment at least in the observed area – central Gulf of Finland. As taken separately, the alternative methods never pretend to explain whole ecosystem dynamics and the peculiarities for each sea area have to take into account by designing monitoring strategies. Still, there are only few of potential areas in the Baltic, where the new operative monitoring methods are proved to obtain complementary knowledge about the life-history of the sea.

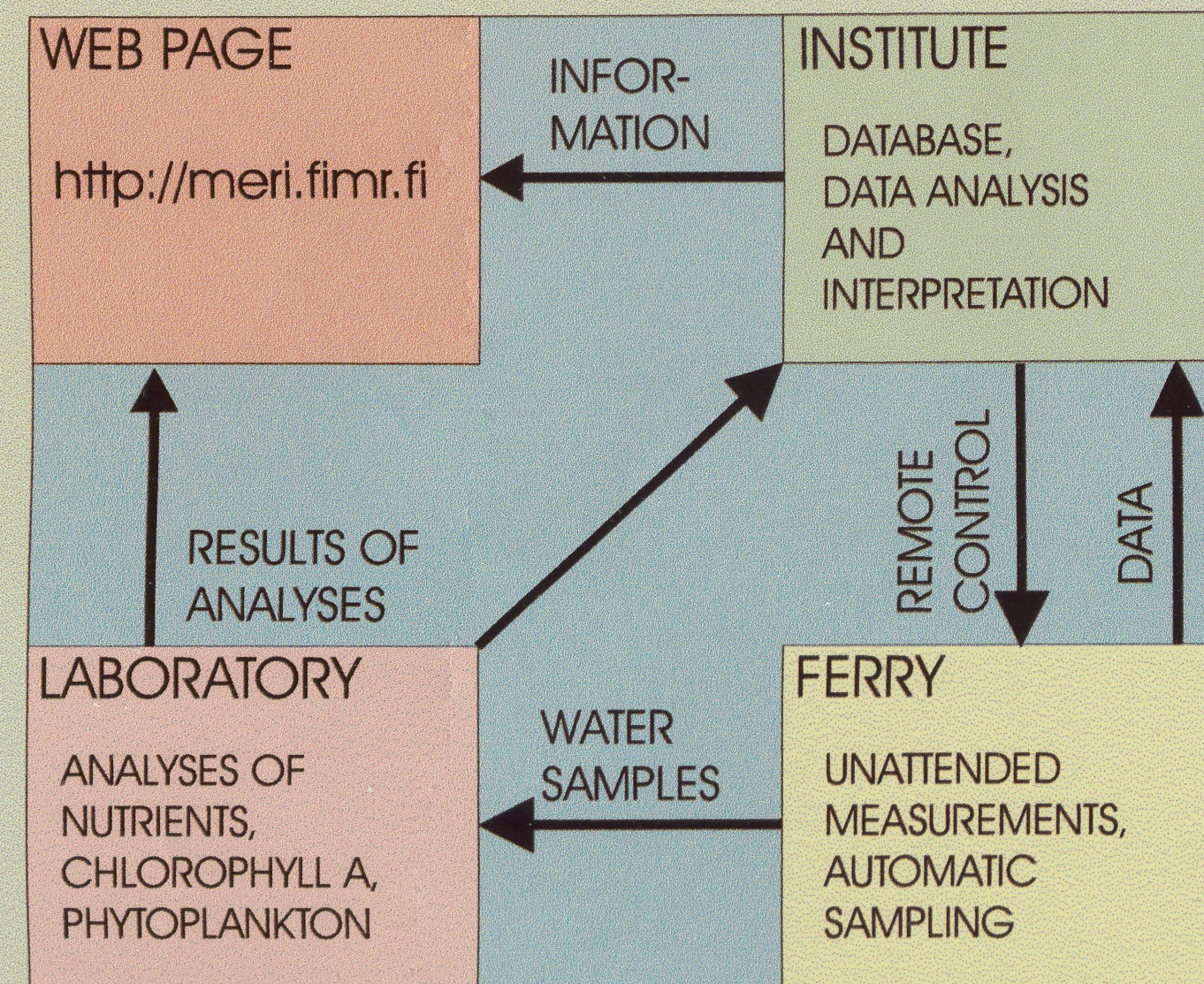


Figure 3. Schematic representation of the monitoring and information system based on the unattended measurements and sampling onboard commercial ferries.

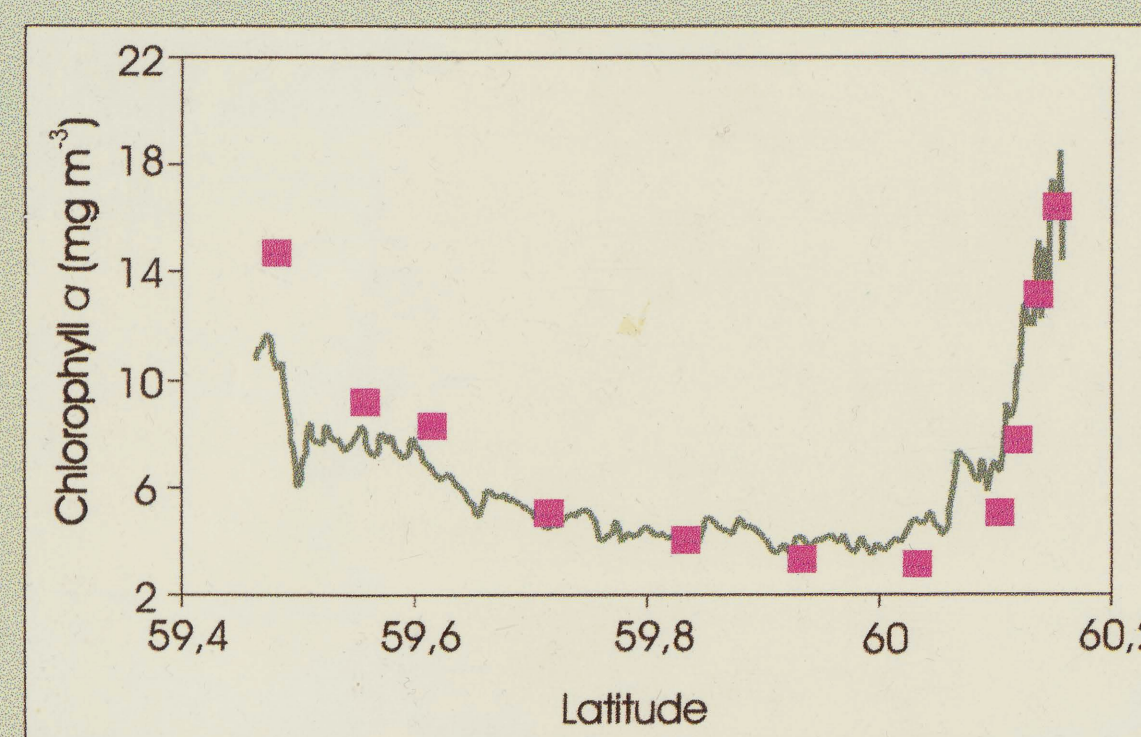


Figure 4. Chlorophyll *a* concentrations according to unattended fluorescence measurements vs. laboratory analysis of water samples (squares) along the ferry route between Tallinn and Helsinki on 27 July 1998.

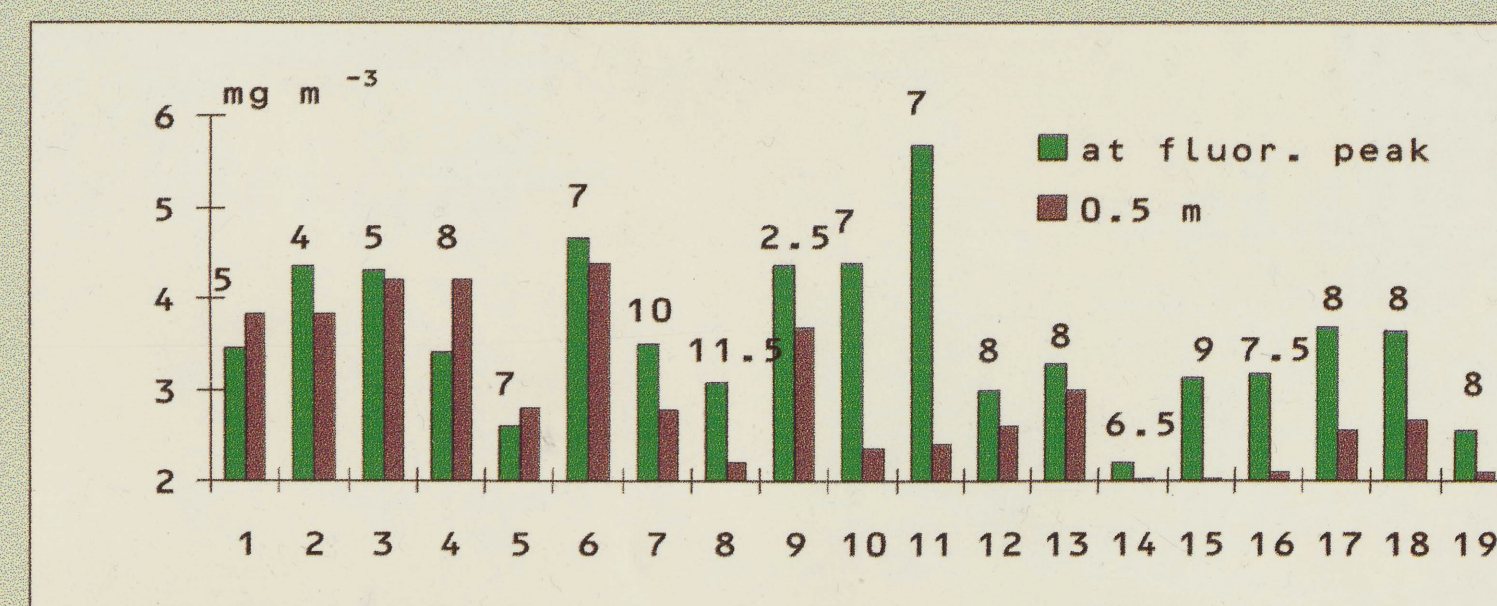


Figure 5. Comparison of chlorophyll *a* concentrations (mg m^{-3}) at surface (0.5 m) and *in vivo* fluorescence maximum depth in the southern Gulf of Finland on 16 and 19 August 1990. The numbers above the stakes indicate the depth of fluorescence maximum.

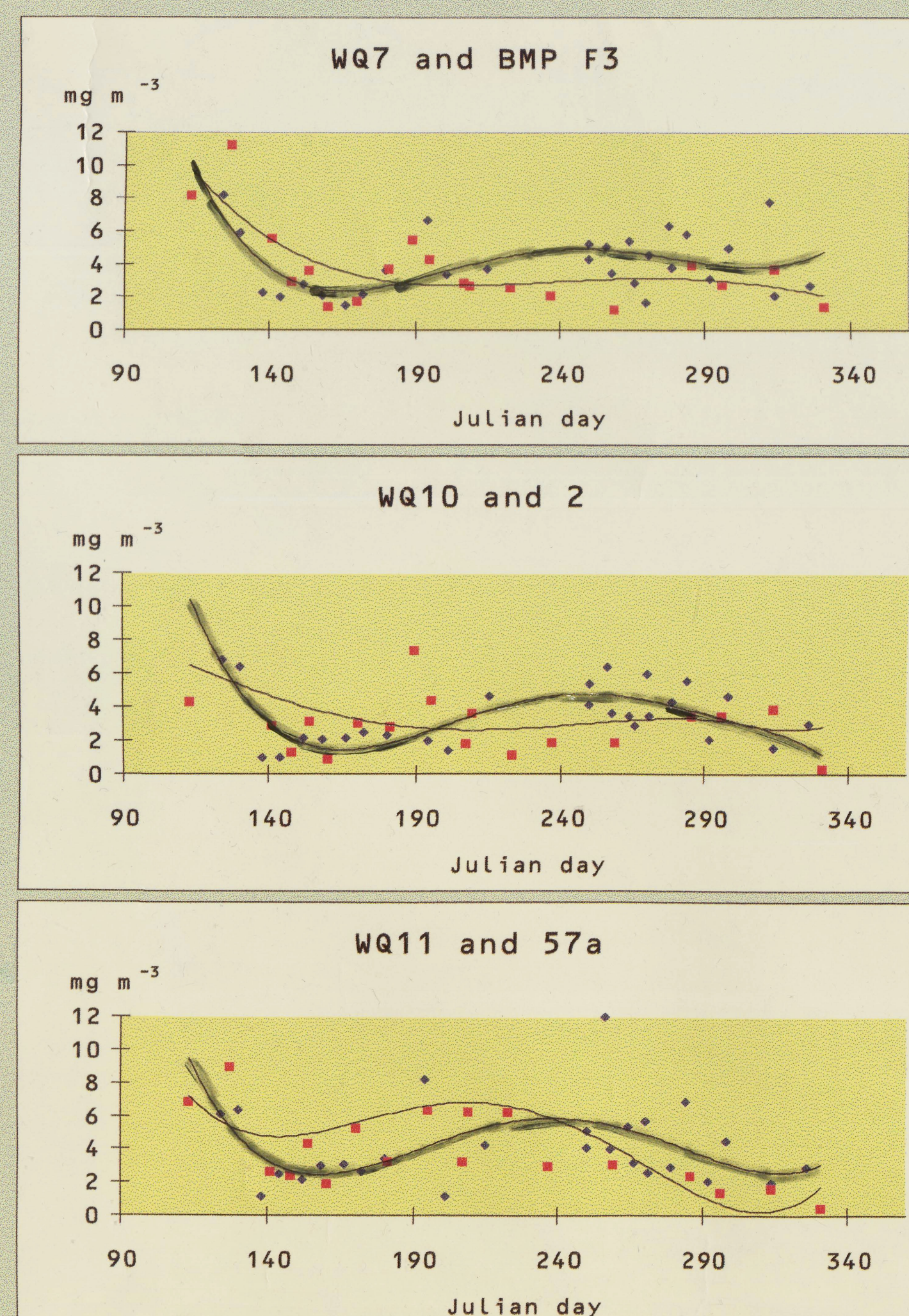


Figure 7. Single chlorophyll *a* measurements of unattended water samples (blue diamonds) and in traditional monitoring program (red squares) in 1997-98 and respective trendlines (thicker for WQ stations, thin for national monitoring stations). For the location of sampling sites see Fig. 2.

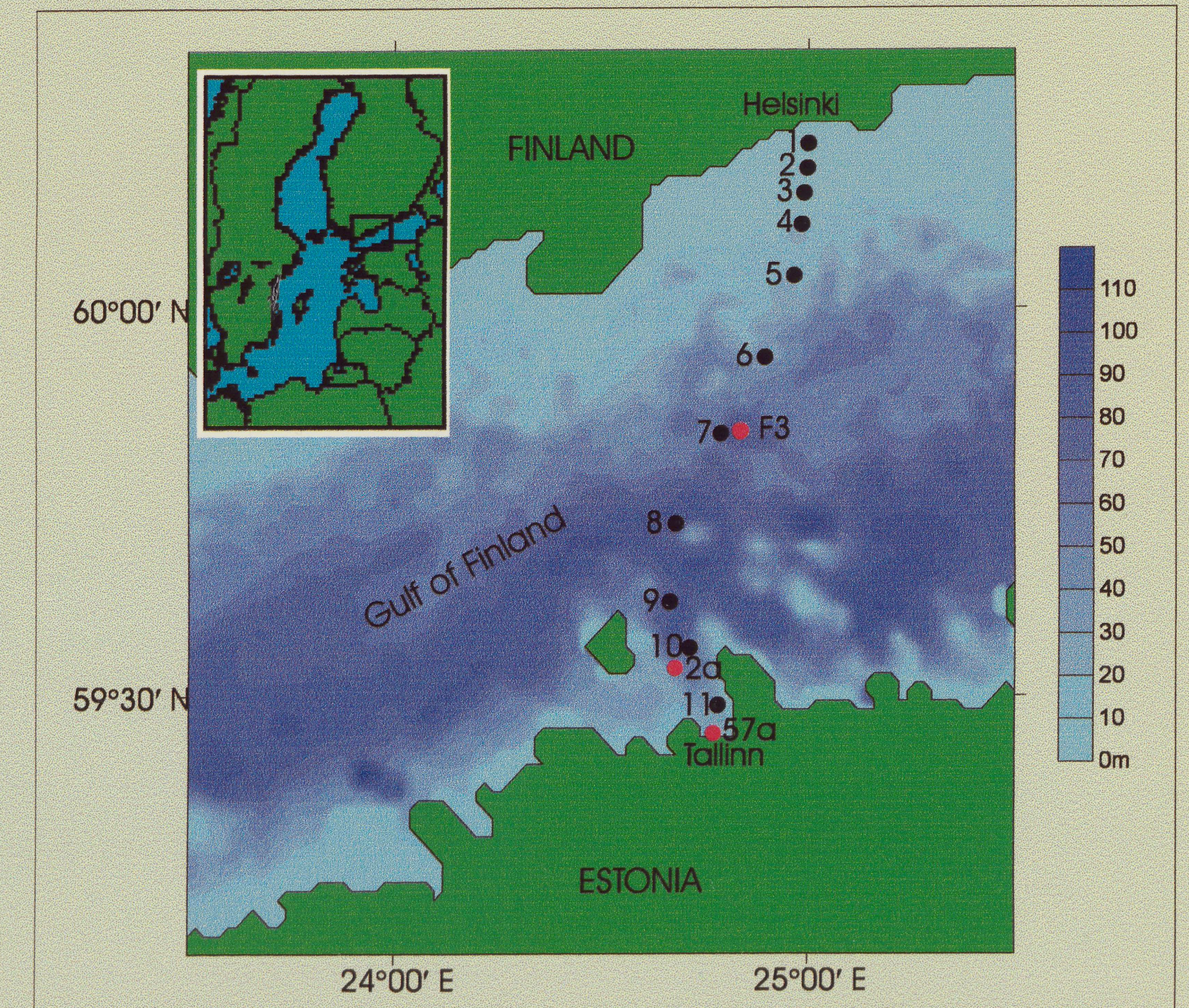


Figure 2. Location of sampling points along the ferry route between Tallinn and Helsinki (black circles) and stations belonging to the traditional monitoring program (red circles).

In vivo fluorescence of chlorophyll *a* is used as an indicator of the algal biomass. Depending on the algal species and the stage to their life cycle, a range of calibration factors are calculated, in respect to their chlorophyll *a* content. An example of the spectrophotometrically measured chlorophyll *a* concentration values obtained analysing water samples in the laboratory conditions vs. unattended fluorescence recordings is presented in Fig. 4.

Although the fluorescence measurements help to smooth out the mostly synoptic-scale spatial variability, a high-resolution vertical profiles are needed to estimate the total phytoplankton biomass, especially in highly stratified waters or on the occasion of sharp subsurface chlorophyll maxima. To clarify the vertical distribution of chlorophyll *a* fluorescence, the results of a series of measurements performed in the southern Gulf of Finland in August 1990 are presented in Fig. 5. It reveals that in most cases the fluorescence peaks and correspondingly the chlorophyll *a* maxima were located in subsurface layer (7.2 ± 2.1 m, $n = 19$). The given depth range coincides more or less with depth of the unattended recordings and makes the latter representative at least in the summer period, when the occurrence of potentially toxic phytoplankton blooms are most probable.

However, when analysing the vertical chlorophyll *a* distribution in different sea areas (Fig. 6), those do not follow the same pattern. It is clearly seen the difference between the Gulf of Finland (St. F1, F3 and H1) and the Baltic Proper (H2 and J1). When in the Gulf of Finland the most of chlorophyll *a* is concentrated in the upper 10 m layer, then in the open Baltic deeper maxima (10-20 m) are regular especially during the summer months. Several years, the sampling design has been an object of discussion within the expert group and the presented results give the reason for routine phytoplankton measurements in upper 20 metre layer instead of recommended 10 metre at least in some sub-basins of the Baltic Sea.

In spring and autumn periods the vertical distribution of chlorophyll *a* is more homogenous, although in the Gulf of Finland the spring maximum values are concentrated in the upper 10 m layer. It has also to take into consideration that in case of higher concentrations the light conditions under the surface layer may be unfavourable for phytoplankton development.

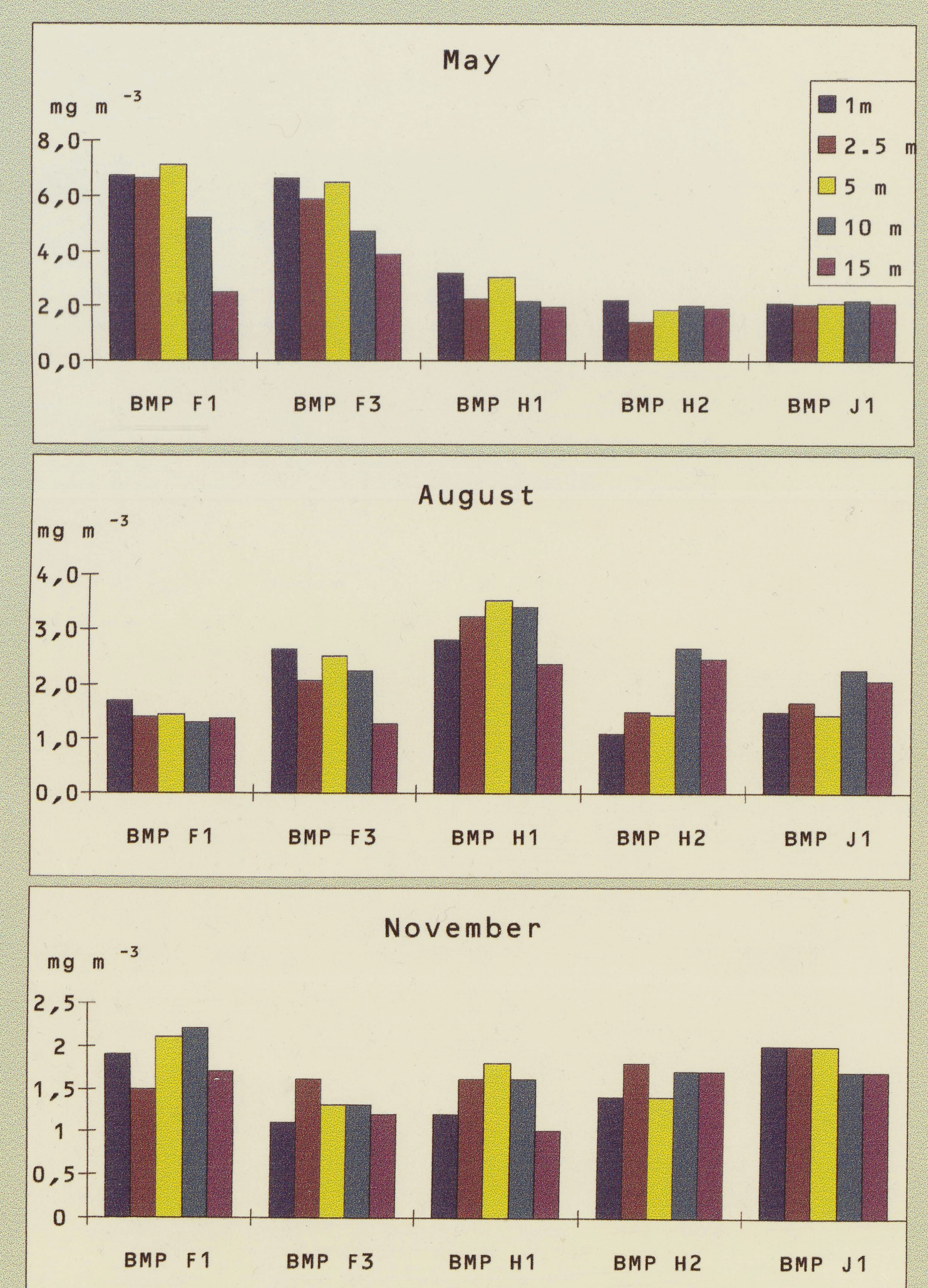


Figure 6. Averaged seasonal chlorophyll *a* (mg m^{-3}) values in HELCOM BMP stations at different depths. Data collected by the Estonian Marine Institute in 1994-96.