

*GEF BALTIC SEA REGIONAL PROJECT
PHASE 1: 2003 – 2005*

TECHNICAL REPORT ON ZOOPLANKTON INDICATORS

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1. Introduction

Zooplankton plays a key role in the pelagic food web by controlling phytoplankton production and shaping pelagic ecosystems. In addition, because of their critical role as a food source for larval and juvenile fish, the dynamics of zooplankton populations, their reproductive cycles, growth, reproduction, and survival rates are all important factors influencing recruitment to fish stocks (Harris *at al.* 2000).

Zooplankton data provide fundamental information on the dynamics and functioning of the Baltic Sea ecosystem. In this respect the Baltic Sea Regional Project offers a unique cooperation between traditional productivity monitoring specialists and fishery scientists.

A technical report will describe datasets useable for assessing the role of zooplankton dynamics for ecosystem based management and propose possible zooplankton indicators of productivity and eutrophication in selected subsystems of the Baltic Sea.

The final report of the group will identify reliable zooplankton indicators for the Baltic Sea. The draft of the final report will be presented at a workshop to monitoring experts.

This task is difficult and demanding what might be confirmed by the ICES Working Group on Zooplankton Ecology report (WGZE 2004): “there is evidence that plankton dynamics are linked to recruitment in some fish stocks, but there is considerable scepticism in the WGZE about the derivation and use of indices and indicators. The WGZE realises that it is tasked with the development of indices that are relevant and useful for fisheries management. Also, WGZE realises that generating indices requires exploring multiple factors and associations, so requires multivariate techniques or multi-parameter models to produce simple, repeatable indices. It is very possible however, that such results may be wrongly interpreted or applied, when all the known and unknown variability is reduced to single figure indices”.

Therefore, results provided by LL ZOO might be preliminary and further effort will be needed during the second phase of the BSRP.

2. Possible zooplankton indicators of productivity and eutrophication in selected subsystems of the Baltic Sea

2.1. Current status of ‘zooplankton indicators’

Zooplankton is not included among relevant quality elements to be used for the assessment of ecological status (Water Framework Directive, Annex V 1.1.). It is also not listed as HELCOM Indicators 2004, which were proposed to describe the state of the Baltic Sea environment:

- Hydrography and Oxygen in the Deep Basins,
- Water exchange and conditions in deep basins,
- Temporal trend in Baltic Sea Runoff,
- Water transparency,
- Development of Sea surface temperature in the Baltic Sea,
- Spatial Distribution of the Winter Nutrient Pool,
- Chlorophyll-a concentrations,
- Spring bloom estimates,

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- Phytoplankton biomass and species succession,
- Cyanobacterial blooms in the Baltic Sea,
- Cyanobacteria bloom index,
- Atmospheric emissions of heavy metals in the Baltic Sea region,
- Atmospheric depositions of heavy metals over the Baltic Sea,
- Heavy metals in water,
- Temporal Trends in Contaminants in Herrin,
- Lead concentrations in fish liver,
- PCB concentrations in fish muscle,
- Caesium-137 in Baltic Sea sediments,
- Cs-137 concentrations in fish and surface waters,
- Illegal discharges of oil.

Similar list of OSPAR indicators contains no zooplankton elements, as well.

ICES Working Group on Zooplankton Ecology (WGZE 2004) noted that OSPAR and EU WFD have not included zooplankton status measures in their recommendations for monitoring. The ecosystem role of zooplankton, mediating phytoplankton and fish production, and modulating nutrient fluxes makes this decision a short-sighted to say the least, especially given that these and many other policy drivers are calling loudly for ecosystem approaches. There is growing recognition of the essential role that zooplankton play in regional and global biogeochemical fluxes and cycles, mediating the transport and the balance of particulate and dissolved matter in the system. It was expressed during the 3rd International Zooplankton Production Symposium on: “The role of zooplankton in global ecosystem dynamics: Comparative studies from the world oceans” that zooplankton monitoring would do much to reveal the quality status of the ecosystem, natural large-scale variability and regime shifts, and therefore, it was strongly suggested to include zooplankton monitoring in the EU water directive at the same level as phytoplankton and benthic monitoring.

2.2. MANTRA-East Project perspective

Project MANTRA-East (Integrated Strategies for the *Management of Transboundary Waters* on the Eastern European fringe – The pilot study of Lake Peipsi and its drainage basin) provided evidence that zooplankton might be among useful biological quality elements used for the assessment of water body ecological status. The set of zooplankton indicators used in the case of Lake Peipsi included: total zooplankton number (increasing with lake trophy), total zooplankton biomass (increasing with lake trophy), mean zooplankton weight (decreasing during eutrophication), number of rotifers (increasing with lake trophy), biomass of rotifers (increasing with lake trophy), percentage of rotifers in total zooplankton number (increasing with lake trophy), percentage of rotifers in total zooplankton biomass (increasing with lake trophy), biomass of copepods (decreasing with lake trophy), percentage of *Daphnia* in crustacean biomass (decreasing with lake trophy), and zooplankton/phytoplankton ratio (Nõges T. *et al.* 2003). The last ratio has been considered as a highly informative index of eutrophication process. It reflects adequately the trophic state of a water body, decreasing with increasing trophy. Very similar parameters were effectively used in the case of the other pilot study area: Vistula Lagoon (Margoński *et al.* 2003). However, there were another indicators used as well. *Brachionus angularis* abundance was among the most successful indicators of an increasing lagoon trophy (Figure 2.2.1). Despite the fact that MANTRA-East indicators were used for ecological status assessment rather than for productivity measures, it proved that it is possible to identify valuable and useful zooplankton indicators.

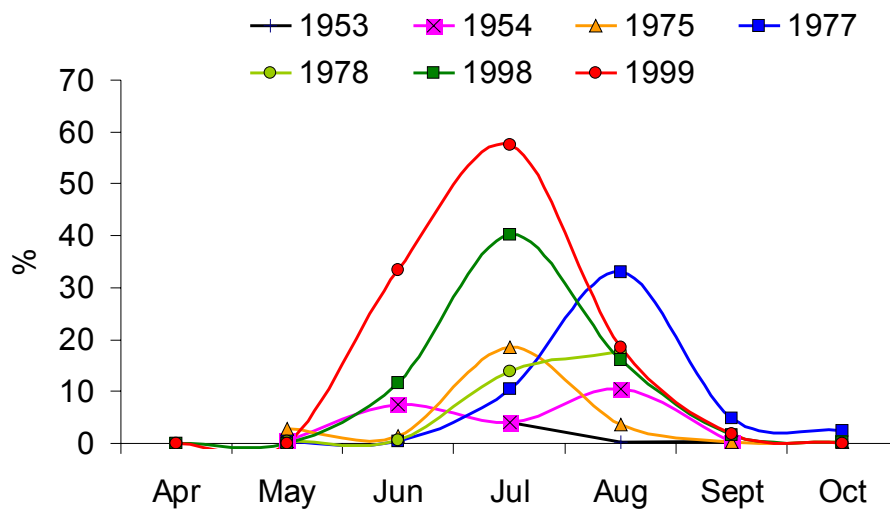


Figure 2.2.1. Percentage of *Brachionus angularis* in total zooplankton abundance in 1950s, 1970s and 1990s in the Polish part of the Vistula Lagoon (Margonski et al. 2003)

2.3. GLOBEC-Germany Project perspective

There are many examples that zooplankton organisms, and especially copepods, may have a strong impact on fish growth, survival and condition and therefore they might be useful productivity indicators. Jürgen Alheit stated that a substantial decrease of individual weight of herrings and sprats at high biomass documented in the Baltic Sea is assumed to be caused by food (mainly copepods) limitation in the Baltic Sea (GLOBEC-Germany project description). Copepods of the genus *Pseudocalanus* serve as a major food organism for larval fish, determining their growth and survival (Hinrichsen *et al.* 2002, Möllmann *et al.* 2003b), but also for adult pelagic planktivorous fish such as sprat and herring (Möllmann and Köster 1999 and 2002). Recent analyses of the feeding habits of Baltic sprat demonstrate a strong preference for nauplii and copepodites of *Acartia* spp., particularly by their larvae. These copepod species thus form an important link between phytoplankton production and fish recruitment in the food web of the Baltic Sea (Voss *et al.* 2003). Results from simulations with a coupled hydrodynamical/trophodynamical individual-based model (IBM) on survival and growth of cod larvae revealed the occurrence of non-optimal feeding conditions for first-feeding larval stages in the Baltic Sea. For this larval stage, exclusively feeding on nauplii stages of calanoid copepods, pronounced differences in nutritional condition and survival were observed due to variability in ambient temperature and the encountered feeding environment. Especially the biomass of *Pseudocalanus elongatus* was found to be critical for cod larvae (Hinrichsen *et al.* 2002).

Numerous GLOBEC-Germany publications describing the zooplankton impact on fish larvae and juveniles' growth and survival need to be analyzed. Summary will be provided in the Final Report.

2.4. SG PROD Meeting, 2-4 December 2004

The meeting refined the definition of productivity indicators. As the most important criteria, productivity indicators should have a measurable impact on the next trophic level, i.e. changes in indicator value cause significant measurable change of quantitative parameters on the next trophic level. Key species within trophic networks should be used as indicators. The group further reviewed the list of parameters currently monitored in the Baltic Sea with respect to their suitability as productivity indicators, and also discussed a few additional variables (SGRPOD 2005).

For the lower trophic levels, systematic data collection in the Baltic Sea is driven by the HELCOM COMBINE monitoring program and the requirements of the EU Water Framework Directive (WFD). Both programs do not aim to describe productivity, but are focused on the assessment of eutrophication (HELCOM COMBINE part C) or, more general, the evaluation of ecological status (WFD). Working Group reached a consensus, that productivity indicators should make maximum use of parameters already included into Baltic Sea monitoring. The group also agreed that eutrophication and productivity indicators partially overlap.

Discussion on the criteria for productivity indicator selection led to formulating four basic criteria. Indicators that specifically describe marine lower trophic level productivity should:

- Respond to productivity conditions, i.e., changes in productivity conditions (e.g., nutrient conditions) cause significant change in the indicator value.
- Have a measurable impact on the next trophic level, i.e., changes in indicator value cause significant measurable change of quantitative parameters on the next trophic level.
- Be indicative of specific conditions, i.e., it should be possible to infer what changes in biotic and/or abiotic factors have caused the indicator response.
- Involve key species within a community, i.e., characterize changes in productivity conditions for most dominant or ecologically important taxa in the community.

To evaluate the suitability of indicators used in different ongoing monitoring and measurement schemes for usability in productivity monitoring it was decided to evaluate these indicators against the agreed productivity indicator selection criteria. The result of this exercise for zooplankton parameters are presented in Table 2.4.1.

Table 2.4.1. Potential zooplankton productivity indicators.

Variable/Substance	BSRP productivity indicators		
	Productivity suitability	Purpose	Comments
Zooplankton			
<i>abundance</i>	+	food quantity for the next trophic level	population structure and mean weight of an individual are among useful measures; it needs to be combined with info on taxonomic composition; zooplankton abundance and biomass in spring may be useful indicator of potential productivity
<i>biomass</i>	+		
<i>taxonomic composition and population structure</i>	+	food quality for the next trophic level	particular copepodite stages should be treated separately to enable cohort analysis
<i>direct secondary production</i>	+	in-situ growth assessment and food availability for the next level	bio-chemical markers; allometric methods

Lutz Postel (HELCOM MONAS Zooplankton Expert Network) provided a working paper regarding zooplankton parameters as useful indicators of productivity (SGPROD 2005, Annex 2). Abundance and biomass might be an indicator of long term eutrophication processes. For example the Baltic Sea was known as an oligotrophic area until the middle of the last century. Then nutrient inputs from land increased drastically. It resulted in a significant increase of all stock parameter starting with nutrients, via phytoplankton, zooplankton, including pelagic fish. Individual body mass would be an important initial information for the calculation of production (P), respiration (R), and consumption (C) by individual specific P/B -, P/R- and R/C- ratios. Concerning temperature or salinity signal, there are some indicator species: *Pseudocalanus* spp. was substituted by *Arctia* spp. in the longer period of lower salinity in the central Baltic Sea before 1993 (Kononen *et al.*, 1996); *Acartia tonsa* is a typical warm water species mostly abundant during warm summer month (e.g. Arndt and Heidecke, 1973); *Bosmina* spp. indicates also warm summer seasons (Hernroth and Ackefors, 1979); and *Oithona similis* indicates effective renewal of deep water in Gotland Basin (Wasmund *et al.* 2004). Evaluating the seasonal production/consumption ratios (P/C) could be helpful to evaluate changes in the control of the system. For example the question whether diatoms regulate copepod production would require to ask for diatom production (availability) and consumption rate by copepods feeding on diatoms at the same time and place. In order to know what questions need to be solved a sensitivity analysis concerning various single influences on complex ecosystem level is needed. Paper presented the existing German zooplankton monitoring data (list of stations and collected parameters). Database contains information on abundance and taxonomic composition including developmental stages and sex. Mysids and especially jellies and ctenophores are still seldom sufficiently quantified.

Michael Olesen (Marine Biological Laboratory, University of Copenhagen) provided a paper describing the role of copepods in retention and remineralization of nutrients in the mixed layer (SGPROD 2005, Annex 3). Major part of the primary production in the Baltic Sea is based on recycled nutrient. By comparing primary production data for the whole Baltic with figures of new production for different region of the Baltic, it can be demonstrated that regenerated production makes up between 50 and 75 % of total production. Since copepods are the most important grazers on phytoplankton in the Baltic, the magnitude of regenerated production is likely to be tightly coupled to the presence of copepods.

Interesting fields for further work on the role of copepods were proposed:

- studies on interaction between copepods and primary production,
- studies on retention and degradation of matter processed by copepods,
- compilation of data for comparing the magnitude of regenerated production and the presence of zooplankton in stratified systems,
- studies of copepod regulating mechanisms.

2.5. Introduction Meeting on LL ZOO Activities, 28-29 January 2005

The current status of zooplankton indicators of productivity and eutrophication has been described. The up-to-date activities of the BSRP Lead Laboratory on Zooplankton and Ichthyoplankton have been summarised as well.

Michael Olesen (Marine Biological Laboratory, University of Copenhagen) once again underlined the role of copepods in retention and remineralization of nutrients. Substantial part

of the primary production in the Baltic Sea is based on recycled nutrient. Most (> 80 %) of the fecal matter from copepods is recycled within the mixed layer in the Baltic Sea. Copepod grazing enables nutrients to be recycled and exploited 4-9 times before leaving the euphotic zone. The copepod activity seems 3-4 times higher in the Baltic Sea than in the Kattegat.

The group discussed the further work regarding identification of reliable zooplankton indicators of productivity and eutrophication, and after discussion, it was decided that data and key persons identification will be continued after the meeting. Participants will come back to this point during the Warnemuende Workshop.

Among the most promising data sources, there are those collected by Latvian Fisheries Research Agency, Estonian Marine Institute, and Institute of Aquatic Ecology (University of Latvia).

2.6. First HELCOM MONAS Zooplankton Monitoring Expert Workshop, 9-11 March 2005

Lutz Postel in the introduction to the meeting provided several answers to the fundamental question “Why to keep zooplankton monitoring and should we improve it?” Some of them referred directly to the role of zooplankton as valuable indicators:

- central role of zooplankton within the food web,
- zooplankton should indicate the ecosystem’s health by the community composition,
- it shows shifts, e.g. between more and less saline periods,
- current data sets become more and more statistically significant in respect to environmental/climatological trends: examples were presented in order to underline the value of such series, like the break down of the *Pseudocalanus spp.* population in the end of the 1980s and the regular up and downs of the *Bosmina spp.* concentrations following warm and cold summer periods.

This example emphasised the demand of the acceptance of zooplankton as a mandatory (core) parameter within the monitoring system of HELCOM.

Piotr Margonski informed the workshop participants about the sense indicators and the ongoing activities at the “indicator front”. Principally, an indicator should mirror a complex reality in a condensed way, basing on analyzed monitoring data and data collections. The following list includes examples of zooplankton indicators successfully used to determine the ecological status of water bodies:

	increasing with increasing trophy	decreasing with increasing trophy	Reference
total zooplankton abundance	x		Project MANTRA-East (Integrated Strategies for the Management of Transboundary Waters on the Eastern European fringe – The pilot study of Lake Peipsi and its drainage basin) Nõges T. <i>et al.</i> (2003) and Margoński P. <i>et al.</i> (2003)
total zooplankton biomass	x		
mean zooplankton individual mass		x	
abundance of rotifers	x		
biomass of rotifers	x		
dominance of rotifers in total zooplankton	x		
biomass of copepods		x	
dominance of <i>Daphnia</i> in crustacean biomass		x	
zooplankton/phytoplankton ratio		x	
<i>Brachionus angularis</i> abundance	x		

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Up to now, HELCOM itself proposed indicators more generally describing changes in the pelagic system of the Baltic Sea like zooplankton community structure or the density of indicative (sensitive) species.

Additionally indicator species were mentioned for environmental conditions, which have consequences for the survival of commercially important fish stocks, for example the ratio between *Pseudocalanus spp./Acartia spp.* or *Temora longicornis* respectively in the Baltic proper. Additional *Oithona similis* concentration in the deep water of could give hint on the development of salinity and oxygen conditions. Elena Gorokova and Juha Flinkman summarized the workshop discussion in this respect and underlined the key function of zooplankton in the pelagic ecosystem, i.e. in determining the degree of the environmental trophy on one hand and considering fishery related aspects on the other. In this context zooplankton indicators could "...provide information that is needed to mitigate environmental problems and decision maker":

Indicator	Related to:
total abundance of neritic copepods	fish feeding conditions
presence of certain species (<i>Conochilus spp.</i> , <i>Keratella cochlearis tecta</i> , etc.)	eutrophication
<i>Acartia/Pseudocalanus</i> abundance ratio	salinity/oxygen conditions; quality and quantity of fish food
mean zooplankter size	fish feeding conditions, eutrophication
Zooplankton/phytoplankton biomass ratio	efficiency of energy transfer, eutrophication

(summarised by Juha Flinkman and Elena Gorokhova, modified by Piotr Margoński)

Participants agreed to develop reliable zooplankton indicators up to the next HELCOM MONAS Meeting in autumn 2005.

Because of its central role in the pelagic food web and hence its impact on both water quality and fish stocks, HELCOM MONAS 2005 and the 27th Meeting of HELCOM Commission (HELCOM 27/2006) are asked to improve the status of zooplankton within COMBINE as core parameter.

2.7. ICES BSRP/HELCOM/UNEP Regional Sea Workshop on Baltic Sea Ecosystem Health Indicators, 30 March to 1 April 2005

The ICES/BSRP Study Group on Ecosystem Health (SGEH) was tasked by the ICES Baltic Committee to "Organize BSRP Workshop in 2005 with participation of experts from HELCOM and US EPA on the topic of ecosystem health indicators in the Baltic Sea" (EH 2005).

Jan Thulin (BSRP) & Ken Sherman (US-NOAA) presented the Large Marine Ecosystem concept. The Large Marine Ecosystem approach has been developed by US NOAA (e.g., Sherman and Skjoldal 2002) and currently 10 LMEs are used to delineate the coastal regions of the US. These Large Marine Ecosystems are being used to form a basis for US ocean policy. The differences among these 10 LMEs are based largely on differences in bathymetry, hydrography, trophodynamics, and productivity. The LME approach focuses on five modules (Productivity, Fish and Fisheries, Pollution and Ecosystem Health, Socioeconomic, and Governance) to determine an appropriate suite of indicators to be use in an assessment of ecosystem health. Indicators of the Productivity Module used in the Northeast Shelf LME are: primary productivity, chlorophyll *a*, SST, water column temperature, photosynthetically active radiation (PAR), nitrogen, and zooplankton biomass and abundance.

Jesper Andersen presented the current status of HELCOM EUTRO project (Development of tools for a thematic eutrophication assessment). The project specified three categories of assessment criteria: (I) causative factors, (II) direct effects, and (III) indirect effects. The Workshop Sub-group on Effects of Eutrophication proposed to modify the list of HELCOM EUTRO assessment criteria for Category III (Quality Element PLANKTON):

1. changes in proportion of selected indicative zooplankton taxons (side specific)
2. zooplankton/phytoplankton biomass ratio (which is related to efficiency of energy transfer and ecosystem health)

3. Datasets useable for assessing the role of zooplankton dynamics for ecosystem based management

3.1. Description of databases

3.1.1. Database of the Latvian Fisheries Research Agency (LatFRA)

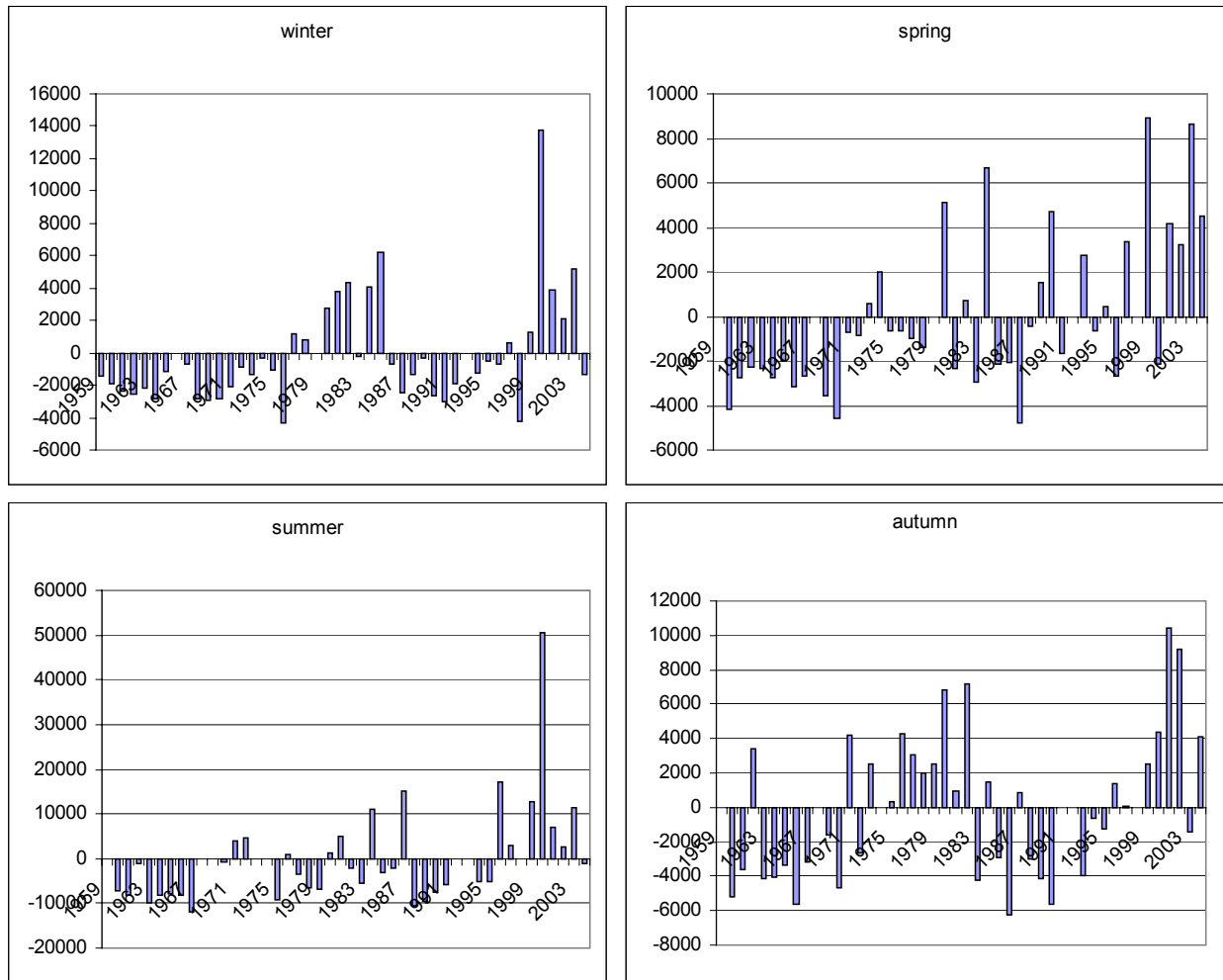
The monitoring performed by the Latvian Fisheries Research Agency (LatFRA) has been conducted with varying intensity since 1959 with the goal to understand the effect of zooplankton on local commercial fish populations. The basic information regarding available dataset is presented in Table 3.1.1.1.

Table 3.1.1.1. Basic information regarding available dataset

Country	Latvia
Monitoring programmes	LatFRA-monitoring
Lat	east of 18deg
Long	east of 15deg
Station depth	variable, max. 200m
Period of data available	1959-2004 (with gaps)
Frequency	seasonally (in general February, May, August, November)
Gear/diam	Juday/36cm
Mesh	160um
Depth	variable, max. 100m
Ancillary data	temperature, salinity
Contact person	Georgs Kornilovs, Christian Möllmann
e-mail	georgs.kornilovs@latzra.lv, cmo@dfu.min.dk
Location of data	LatFRA, Riga, Latvia
Observations	variable number and location of stations

Fig. 3.1.1.1. shows the combined biomass development of the dominating calanoid copepods (*Pseudocalanus sp.*, *Acartia spp.*, *Temora longicornis*, *Centropages hamatus*) in the different seasons. Generally biomass was low at the beginning of the time-series and increased during the late 1970s/early 1980s. After decreasing stock during the late 1980s/early 1990s calanoid biomass peaked during recent years.

Fig. 3.1.1.1. Combined biomass development of the dominating calanoid copepods (*Pseudocalanus sp.*, *Acartia spp.*, *Temora longicornis*, *Centropages hamatus*) in the different seasons.



A change in the dominance from *Pseudocalanus sp.* and *T. longicornis/Acartia spp.* during the last two decades has been documented. Decreased *Pseudocalanus sp.* standing stocks have been caused by decreasing salinities due to the reduced inflow frequency of North Sea waters, while *Acartia spp.* and *T. longicornis* increased due to warmer temperatures (Möllmann et al. 2000, 2003a). Both hydrographic effects being ultimately driven by climate (Hänninen et al. 2000, Matthäus and Nausch 2003). The trends in these copepod species have been shown to affect cod recruitment (Hinrichsen et al. 2002, Köster et al. 2005) as well as pelagic fish growth (Rönkkönen et al. 2003, Möllmann et al. 2003b, 2005).

3.1.2. Database of the Institute of Aquatic Ecology University of Latvia

Institute of Aquatic Ecology has been sampling zooplankton according to HELCOM methodology since 1993 at 10-16 stations in the Gulf of Riga. The sampling frequency at the stations varies from 4 to 18 times. Two stations are regarded as high-frequency ones and sampled most often. Simultaneously with zooplankton, data on hydrographic and nutrient parameters are collected, as well as chlorophyll a and phytoplankton species composition and abundance. Zooplankton data were stored at HELCOM data base (till 1996) and now are sent to ICES database (since 2003). At the IAE data are partly in the Paradox format (the first attempts in early 1990s to create the database) and in the Excel sheets. Data are gradually converted to Access format which is the new biological database format.

The Gulf of Riga is a semi-enclosed estuarine sub-basin of the eastern part of the Baltic Sea. It has a surface of 19,330 km² and it is up to 67m deep. As Gulf of Riga is relatively shallow (the average depth equals 26m), the water column is usually well mixed and thus homogeneous from late autumn to early spring with at least partial ice cover during most of winters. A temperature and salinity stratification usually prevails from April to October – November.

Generally, the zooplankton of the Gulf of Riga is similar to that of the Central and Northern Baltic but the features of brackish water complex are more pronounced. The number of zooplankton taxa varies from 12 in central part to 45 in coastal area of the Gulf of Riga. The zooplankton community consists of Copepoda, Cladocera and Rotatoria groups with maximal values of abundance and biomass in summer seasons.

Research is focused on:

- temporal and spatial distribution of zooplankton community in the Gulf of Riga;
- biology of arctic relict *Limnocalanus macrurus* (long-term changes, vertical distribution, feeding patterns);
- biology of invasive species *Cercopagis pengoi* (long-term changes, abundance, biomass, vertical distribution, impact on natural zooplankton community);
- biology of endemic species *Bosmina longispina* (long-term changes of abundance, reproduction);
- studies of spatial and vertical distribution of *Eurytemora affinis*, and egg and faecal pellet production of *Acartia bifilosa*.

3.1.3. Database of the Estonian Marine Institute, Universitu of Tartu

Two sampling locations were selected from Estonian national monitoring programme representing Gulf of Finland (59°32'N, 24°41'E) and Gulf of Riga (58°13'N, 24°18'E). Zooplankton was collected by means of vertical hauls of Juday plankton net (mouth opening 0.1 m² and mesh size 90 µm). Data from both regions are available since 1993. In recent years both stations have been sampled at least 10 times per year, but sampling has been much infrequent in some years. The database contains zooplankton abundance data to the species level, and to the level of developmental stages in the case of copepods.

Zooplankton of Baltic Sea is typically rather small in size. Dominating copepod species in Estonian waters are *Eurytemora affinis* and *Acartia bifilosa*, most numerous cladoceran is *Bosmina coregoni* and rotifers also constitute rather big share of total zooplankton abundance. The maximum zooplankton biomass is usually observed in late summer; the abundance may in some years reach high numbers already in spring especially in Gulf of Riga (Figures 3.1.3.1

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and 3.1.3.2). The abundance peaks in summer do not show any trend over the whole period, but the maximum zooplankton abundance observed in spring (May –June) has increasing trend in both areas. The chlorophyll *a* in May as well as in August shows slight increase in both areas and water transparency has decreased respectively (Figure 3.1.3.3 and 3.1.3.4).

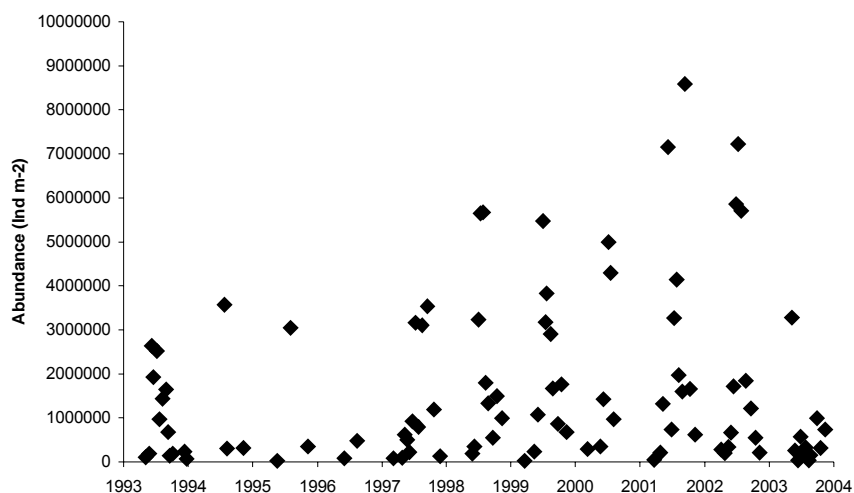
There was another zooplankton monitoring program in Gulf of Finland during 1963-1992. Samples were collected with Juday net (mesh size 168 μm) up to four times per year. Zooplankton abundance has been higher in sixties and seventies and somewhat lower in eighties (Figure 3.1.3.5). The decrease in zooplankton numbers in early eighties has been explained mostly by the beginning of stagnant conditions and lowered salinity (Lumberg and Ojaveer, 1991).

The basic information regarding selected stations is presented in Table 3.1.3.1.

Table 3.1.3.1. Summary information on selected stations.

Country	Estonia (1)	Estonia (2)	Estonia (3)
Monitoring programme	Monitoring of fish food resources	HELCOM Monitoring	HELCOM Monitoring
Sampling location	Gulf of Finland, Baltic Sea	Gulf of Finland, Baltic Sea	Gulf of Riga, Baltic Sea
Latitude (N)	59°43.0'	59°32.2'	58°13.0'
Longitude (E-W)	25°01.0'	24°41.3'	24°18.5'
Station Depth (m)	100m	44m	10m
Period of data available	1963-1992	1993-ongoing	1993-ongoing
Frequency (number of cruises/yr)	1-4 cruises/yr	3-12 cruises/yr	1-12 cruises/yr
Gear/diam (cm)	Juday net 38cm	Juday net 38cm	Juday net 38cm
Mesh (μm)	168	90	90
Depth of sampling (m)	0-bottom	0-bottom	0-bottom
Ancillary data	no	hydrography, nutrients, chlorophyll, phyto.cells	hydrography, nutrients, chlorophyll, phyto.cells
Contact person	Arno Põllumäe		
Email address	arno@sea.ee		
Location of data	Estonian Marine Institute, University of Tartu		

Figure 3.1.3.1. Zooplankton abundance in Gulf of Finland 1993-2004.



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Figure 3.1.3.2. Zooplankton abundance in Gulf of Riga 1993-2004

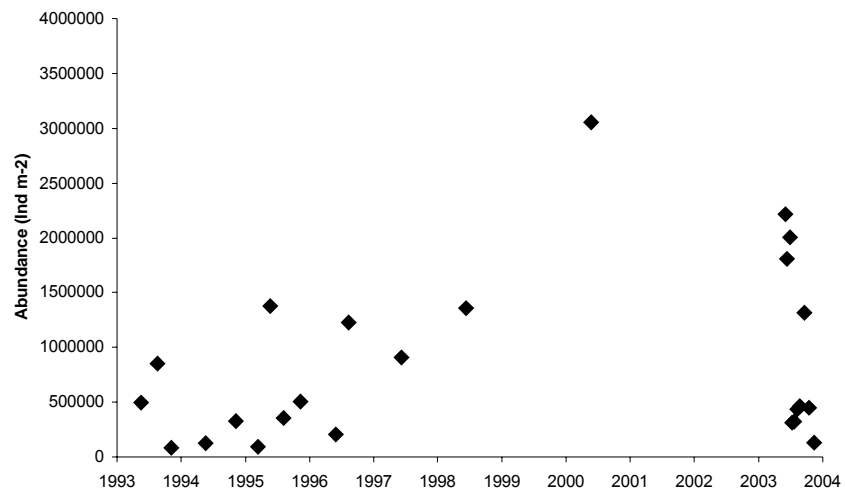


Figure 3.1.3.3. Chlorophyll *a* and water transparency in Gulf of Finland 1993-2004.

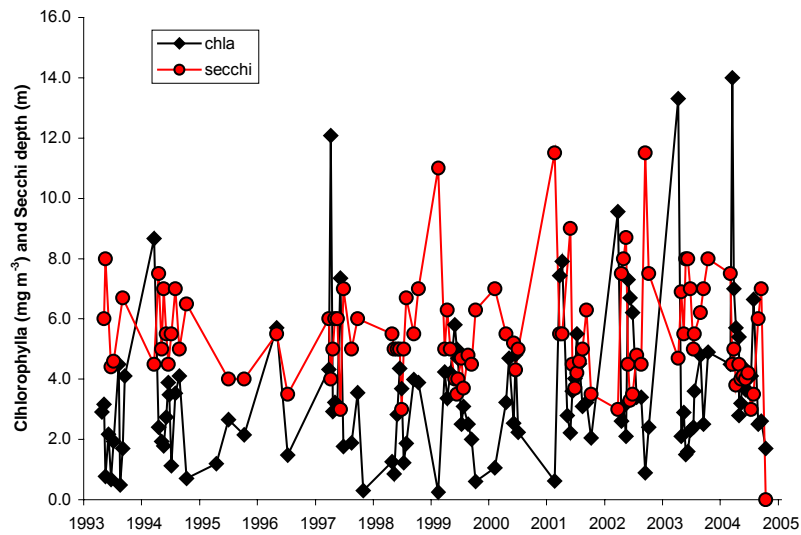


Figure 3.1.3.4. Chlorophyll *a* and water transparency in Gulf of Riga 1993-2004.

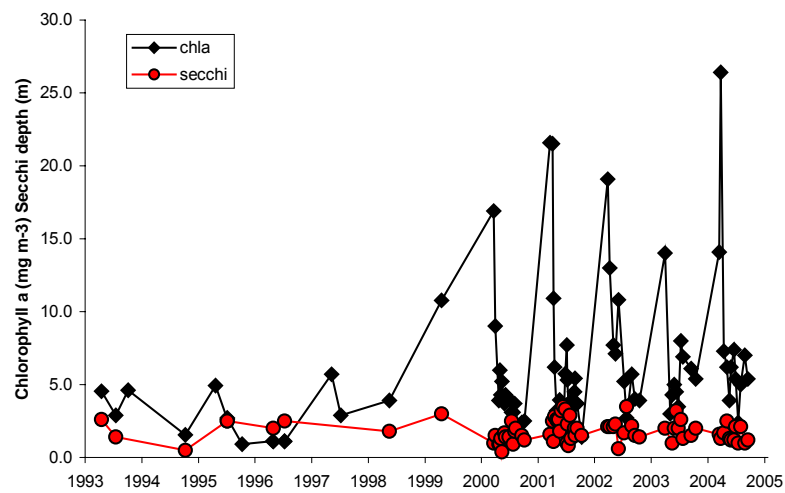
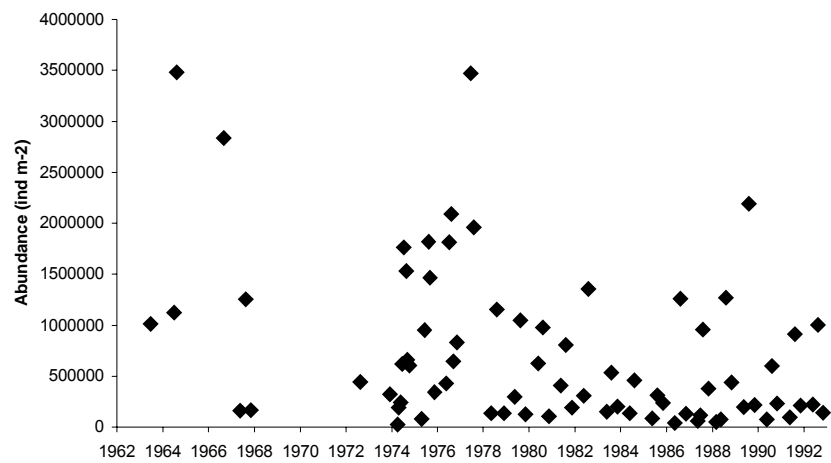


Figure 3.1.3.5. Zooplankton abundance in Gulf of Finland 1963-1992.



3.2. Position of Technical Assistant to the Lead Laboratory on Zooplankton and Ichtyoplankton on zooplankton indicators of eutrophication and productivity

Position of Technical Assistant to the Lead Laboratory on Zooplankton and Ichtyoplankton on zooplankton indicators of eutrophication and productivity will be established. The Technical Assistant will be responsible for the following services:

- (a) Perform statistical analysis of proposed zooplankton indicators of productivity and eutrophication on the basis of selected databases
- (b) Report the result of the analysis to the Lead Laboratory on Zooplankton and Ichtyoplankton, including description of analysed data, description of methods used, and list of identified zooplankton indicators
- (c) Contribute to preparation of the Zooplankton Indicator Fact Sheet(s) for the HELCOM MONAS Meeting in autumn 2005

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