



Baltic Sea research at Tvärminne Zoological Station in 2000-2010 supported by the Walter and Andrée de Nottbeck Foundation

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1. BACKGROUND

The Walter and Andrée de Nottbeck Foundation was established in 1970. According to the constitution of the Foundation, its main objective is to support environmental research entailed by the technical development.

On October 5, 1972, the Board of the Foundation decided to support environmental research in the Baltic Sea, primarily microbiological investigations. In order to realise this aim, the Foundation signed a cooperation agreement with the University of Helsinki on January 26, 1973. According to the agreement, the Foundation would support microbiological research in the Baltic Sea, which up to that day had almost been neglected in Finland. The work should mainly be conducted at Tvärminne Zoological Station. This decision created the basis for developing the station to a modern research environment. The close-knit relationship between the Foundation and the Station has helped transform Tvärminne into a major research centre of marine research in Finland.

The Baltic Sea suffered a long stagnation period in the 1960's. Lack of oxygen and increased hydrogen sulphide concentration in deep-water layers had reached larger areas than recorded ever before. The influence of agricultural nutrient load was recognised as a marked eutrophication problem had developed in many coastal areas. Hazardous substances had accumulated in the marine ecosystem, especially in coastal areas off cities and industrial

centres. These environmental problems were widely discussed in the media.

The serious development of the Baltic marine environment motivated a profound study of the Baltic marine ecosystem, its structure, function and regulating factors, in order to get a sound basis for planning realistic protection measures. Special interest was focused in the influence of the nutrient load on the system. The Nottbeck Foundation thus targeted its research in the Baltic Sea ecology at an early stage, even before international organisations begun to address their interest on the serious ecological problems of this marine environment.

The Nottbeck Foundation wanted to support targeted research projects and especially concentrate upon questions earlier neglected in Baltic Sea research. This motivated the support to marine microbiology during the first years of the Foundation's activity at Tvärminne. After that, the emphasis of research efforts turned to taxonomical research of planktonic algae and then to gaining more detailed information on the structure of the marine ecosystem, which had become threatened by eutrophication and other human influences.

The activity of the Foundation in supporting research during the period 1973-1988 was described in a synopsis published in 1989: [Niemi, Å.], Walter och Andrée de Nottbecks stiftelse, Historia över Stiftelsens verksamhet 1973–1988 för att understöda östersjöforskningen. – 69 pp. Helsingfors 1989. A second synopsis covers the years 1989-1999: Åke Niemi and Carl-Adam Hægström, Verksamheten 1989-1999 för understöd av Östersjöforskning vid Tvärminne Zoologiska Station. – 13 pp. including an appendix, Helsingfors 2001.

2. The strategy of support

In the 1970's and 1980's, the Foundation gave support to Baltic Sea research by announcing grants. A primary grant for one year, with the possibility of prolongation during several years, was awarded to a senior researcher supposed have a doctoral degree. The senior researcher should manage the research projects supported each year and take responsibility both over the research activities and laboratory material belonging to the Foundation. According to an agreement with the University of Helsinki, 1.5 laboratory workers were arranged for the disposal of the senior researcher in Tvärminne. The Foundation paid the salaries for these persons during the first two years of research activity.

Moreover, the Foundation awarded annual doctoral and licentiate grants and short-lasting research grants for special projects in marine biology every year. Supporting young researchers has been an excellent way to introduce young skilled students to Baltic Sea research at an early stage in their studies.

The Foundation paid for several international research seminars at the Tvärminne Zoological Station. International scientists were invited to take part in seminars and research projects at the Foundation's expense. Further, the Foundation financed much needed research equipment, which would otherwise have been unattainable. The equipment were placed at the Tvärminne Zoological Station and greatly helped to develop the station as a research center.

From the very beginning, the Foundation underlined the importance of developing close contacts to international laboratories and scientists. At a board meeting of the Foundation, prof. **Ilmo Hela**, Member of the Academy of Finland and Director of the Finnish Institute of

Marine Research in Helsinki, stressed the importance to encourage young scientists to participate congresses, international meetings and seminars in order to gain necessary contacts and scientific experience. The Foundation has followed this principle since then.

3. Research activities until 1999

The Foundation's first senior scientist **Pentti Väätänen** (grant period 1973–1978) studied the composition of Baltic Sea bacterial communities, their seasonal development and regulating factors. Special interest was directed to the influence of nutrient load from surrounding land areas. The next senior scientist was **Guy Hällfors** (grant period 1979–1983) who studied the Baltic Sea phytoplankton and periphyton communities, species composition and taxonomy in the coastal waters and open sea areas. The knowledge of phytoplankton composition in the Baltic Sea increased essentially and the microalgal taxonomy in Finland rose to an international level during this period.

The third senior scientist **Jorma Kuparinen** (grant period 1984–1986) concentrated his research on the structure and function of the pelagic microbe communities, the carbon flow in the ecosystem and regulating physical, chemical and biological factors. During his period, larger research teams were established and the publication activity was strongly directed towards an international scientific forum.

At an early stage, the Foundation had also supported ecophysiological laboratory studies on Baltic Sea benthic animals (especially *Monoporeia affinis* and *Pontoporeia femorata*). An ecophysiological laboratory was gradually built up at the Tvärminne Zoological Station by Dr. **Magnus Lindström**. Many foreign scientists have worked in this laboratory up to now.

In 1986, the Nottbeck Foundation established cooperation with the Academy of Finland, the Maj and Tor Nessling's Foundation and the University of Helsinki in order to give a strong support to study the Baltic Sea pelagic ecosystem (the Pelag Project). This was a continuation of Jorma Kuparinen's research. He was employed by the Academy of Finland as a senior scientist. The supported projects were now led by research teams with senior and younger scientists and students.

Harri Kuosa took over the responsibility of the scientific activity as the Foundation's senior scientist at Tvärminne 1987, the grant period lasting until 1991. He had worked as a young scientist in the Pelag project and had good qualifications to lead the pelagic research. Under his leadership, the scientific work concentrated on the role of microbial loop (heterotrophic organisms and autotrophic picoplankton) in the carbon flow in the Baltic Sea pelagic system.

The modern ecosystem research requires knowledge over several areas of expertise – a teamwork of biologists, chemists and specialists in physics and statistics. In consequence, several younger scientists worked in the projects lead by a senior scientist. The Foundation's support was mainly directed to project teams.

Over the years, an extensive scientific material had been collected and many new scientific questions had arisen. Based on the earlier results, a new project, the SILMU-project (Influence of the changing climate on the Baltic Sea ecosystem), was initiated in the 1990's. The project led by **Harri Kuosa** covered several scientific problems, which had emerged during the earlier years. He was appointed a researcher at the Finnish Institute of Marine

Research in Helsinki in 1992, but he superintended several projects supported by the Foundation at Tvärminne during the years to follow, making the scientific cooperation between the Finnish Institute of Marine Research and Tvärminne very close. The reevaluation of old material resulted in several academic examinations and many scientific publications in international journals.

The financial support by the Foundation increased and it was directed to more diverse Baltic Sea ecology research during the 1990's. Studies continued on the microbial structure, function, production and the carbon flow of the pelagic community. The role and the interaction between different trophic levels were studied. Attention was paid to the role of zooplankton as a regulating factor in the pelagic ecosystem, the regulating role of pelagic fish on zooplankton community and the transport of organic material to the sediment. Macroalgal studies and the vegetation in flad areas were new projects. Winter ecology, i.e. the biology in and below the sea ice, became an important field of study. The previous projects on benthic animal ecology and physiology and algal taxonomy was still supported to some extent. A few other small special projects got support, too.

A more detailed description of the research activities in the 1990's is given in the following report: Niemi, Å. & Hæggström, C.-A. 2001: Walter och Andrée de Nottbecks Stiftelse. Verksamheten 1989-1999 för understöd av östersjöforskningen vid Tvärminne zoologiska station. – 35 pp. Helsingfors.

4. The scientific activities with focus on 2000-2010

As the Foundation's capacity to support basic research considerably increased in the 1990's, it was time to change the funding system and support larger projects. The Board of the Foundation decided, in order to activate the Baltic marine research at Tvärminne, that the ongoing long-term projects should be finished in 1999-2000. The aim was to ask for new research ideas and targets as a basis for new projects for the years to come.

The research from the year 2000 onwards was based on partly continuing and further developing earlier projects and partly on new research ideas. Most of the support was directed to team projects including a senior scientist and some younger scientists and students. Projects were usually planned for a duration of 3–5 years. Support was also given to scientists working with their doctoral thesis, lasting on average 4–5 years.

Dr. **Harri Kuosa** was appointed Professor in Baltic Sea research for a five-year-period starting on January 1, 2002, followed by a second five-year-period in 2007-2011. These two professorship periods (2002-2011) were donated to the University of Helsinki by the Foundation. The total salary including the overheads was paid by the Foundation. This was a vital step in the scientific work at Tvärminne. As the professorship was located at the Tvärminne Zoological Station, it was possible for professor Kuosa to coordinate the research activity and plan and supervise the scientific work all year round there.

The year 2006 was the last year for several long-term projects supported during the previous years. At this stage, the Expert Group of the Foundation was complemented with two esteemed Swedish scientists on Baltic Sea ecology, prof. **Ragnar Elmgren**, University of Stockholm and prof. **Ulf Båmstedt**, University of Umeå. In order to renew the targets, the new Expert Group and the Board of the Foundation had a profound discussion concerning the

support policy of the coming years. New projects were started in 2007, and several scientific problems arisen in earlier projects were also supported in renewed projects.

The research activities were categorised as follows:

- International level projects including a leading senior scientist, researcher and students.
- A single scientist with some assisting students.
- Scientist working for his or her doctoral dissertation.
- *Pro gradu* grants for students working on their Master's thesis.

Projects supported during the early 2000's:

Studies on the pelagic microbes, carbon flow and regulation factors: The Mixotrophy project

This heading includes a number of individual projects supported by the Foundation. It was a continuation of the research begun already several decades ago in the Pelag projects and even earlier.

The microbiological studies on carbon flow continued. **Riitta Autio** studied the dissolved organic carbon in the microbial loop and the production of bacterioplankton in the Baltic Sea. After defending her doctoral thesis *Studies on bacterioplankton in the Baltic Sea with special emphasis on the regulation and growth*, **Riitta Autio** began research on the importance of mixotrophy in the Baltic Sea. She visited Horn Point Laboratory in Maryland, USA during May – August 2000, in order to get experience of the methodology needed.

From 2001, the studies on pelagial ecosystem continued as the **Mixotrophy-project** titled *Closing the carbon budget for the Gulf of Finland. Mixotrophy in the Baltic Sea food webs*. The project was led by **Riitta Autio** with **Janne-Markus Rintala** and **Outi Setälä** as co-workers. Riitta Autio's team worked parallel with the project *Carbon sink regulation in the Baltic Sea* led by Dr **Risto Lignell**. **Jonna Piiparinen** studied phytoplankton, ciliates and bacteria and **Laura Hoikkala** DOC and DON in the Baltic Sea pelagial in 2002.

The Mixotrophy project continued in 2002–2004. **Riitta Autio** studied the role of mixotrophy in the Baltic Sea food web. Particular attention was paid to the mixotrophic dinoflagellates by **Outi Setälä** and **Janne-Markus Rintala**. **Laura Hoikkala** studied factors regulating production and photochemical decomposition of dissolved organic substances in coastal waters in **Risto Lignell**'s project funded from other sources. Both projects ended in 2004, but the researchers continued their work at Tvärminne in partly new projects.

The Foundation decided to support four main projects in 2005. The fundamental target was still the structure and function of the Baltic pelagic ecosystem. The earlier studies in this field caused new questions and new problems to be solved. Understanding the role of dissolved organic substances and the mixotrophic organisms in the ecosystem is of great importance in order to establish the carbon flow system in the Baltic Sea. It is also a key question in understanding the function of the pelagic ecosystem.

Thus, the Foundation continued supporting the research on the structure and carbon flow in the ecosystem in a new project, The **MIXO-DOM project** (MIXO points to the mixotrophy and DOM to the dissolved organic matter). **Riitta Autio** and **Risto Lignell** were given the

responsibility to lead the project.

The MIXO-DOM project included several topics to be studied. **Outi Setälä** studied the role of dinoflagellates in the Baltic food web. **Laura Hoikkala** investigated the factors controlling biological and photochemical decomposition of dissolved organic carbon and nitrogen. **Janne-Marcus Rintala** concentrated on the mixotrophic dinoflagellates in the Baltic Sea. **Sanna Sopanen** studied the influence of dinoflagellate toxins on copepod zooplankton. **Jonna Piiparinen** focused on studies of bacteria in sea ice.

The MIXO-DOM project ended in 2006. Pelagic studies continued, however, under other headings. Many studies related to the carbon flow in the pelagic ecosystem were already done in connection to ice ecological studies.

Baltic ice ecology

The studies of the pelagic ecosystem and its function had shown that the winter conditions played an essential role in the annual carbon and nutrient flow in the marine ecosystem. Algae and algal communities were observed in the brine channels in ice and in the water column below in coastal waters off Tvärminne already in the 1960's and 1970's. Algal species common during vernal plankton bloom were observed in the ice and species more or less specific for ice environment were observed, too. Further, heterotrophic organisms were found to be common in ice. Similar observations of algae and heterotrophic organisms in ice had been described in polar marine areas. Thus, the sea ice biota seem to be similar in different polar areas. This was the background to the profound studies in ice biology that **Johanna Ikävalko** began in the 1990's. She got experience in polar ice biology by taking part of polar expeditions on board German research vessel *Polarstern*. Ikävalko continued her successful cooperation with colleagues at the University of Kiel, and the Foundation started to support sea ice research in the Baltic Sea in the 1990's.

The biological research started by describing autotrophic and heterotrophic organisms in the sea ice and the seawater close to the sea ice. Chemists and physicists were involved in the ice sea studies, too. In general, the ice communities are very complex. **Johanna Ikävalko** and **Harri Kuosa** found that the ice communities in the southern archipelago of Finland differ from those in the polar seas by having both marine and fresh water species due to riverine inflows to the brackish Baltic Sea.

The interesting results encouraged the Foundation to continue supporting studies on the biological activity in ice in 2000. The project was managed by **Johanna Ikävalko**. The species composition and the succession of Baltic Sea ice organisms were studied by **Laura Forsström**. **Hermann Kaartokallio** studied bacterial processes and nutrient dynamics in the ice, **Janne-Markus Rintala** the ecology of mixotrophic dinoflagellates and **Kristian Spilling** studied the ecophysiology of winter phytoplankton. Moreover, **Jens Ehn** investigated the **geophysical** conditions in ice. **Kimmo Karell** participated in the project by studying the ice biota, while **Vilma Rouvinen** started studies in sea ice bacteria using DNA-techniques in 2001.

Jari Uusikivi began studies on the physical properties of the ice in 2005. The optical conditions and radiation are essential factors regulating production and processes in the ice. This project continued in 2006–2008.

The studies on sea ice biota continued as the project **Sea Ice Ecology** (SIE), which was funded from the beginning of 2007. The new targets were based on the existing knowledge. However, the research focused in detailed studies of the biology and ecology of bacteria and heterotrophic organisms in Baltic Sea ice, molecular studies (DNA and RNA), influence of UV on ice bacteria, mixotrophy of dinoflagellates and the light climate inside and below the ice. In 2008, the support was quite substantial, showing that the Foundation regarded the work as nationally important.

The ice project in 2008-2010 was divided into two sub projects:

- **Baltic Sea biogeochemistry – the role and importance of photochemistry and bacterial processes** (superintended by **Riitta Autio**)
- **Biodiversity of Baltic Sea ice algae and ciliates** (superintended by **Jaanika Blomster**).

The different targets were divided as follows:

Eeva Eronen studied bacterial community dynamics in relation to biogeochemistry, **Susann Haase** the role and importance of photochemistry and bacterial processes and **Markus Majaneva** the biodiversity of sea ice algae and ciliates in the Baltic Sea. **Jonna Piiparinen** investigated the spatial variability in sea ice bacterial processes in the sea areas from the Gulf of Finland to the Bothnian Bay and the impact of UV radiation on bacteria. **Janne-Markus Rintala** studied the biodiversity of Baltic Sea ice algae and ciliates.

Algal taxonomy and ecology

Studies on algal taxonomy were supported by the Foundation already at the beginning of its activity, because although an essential research field it did not get support from governmental funds or universities. Thus, **Guy Hällfors** worked as the Foundation's senior scientist at Tvärminne in 1979–1983. He established a solid base for modern microalgal taxonomy of Baltic Sea phytoplankton. After his period as the Foundation's senior scientist, he was regularly supported for his taxonomic research. **Guy Hällfors** established good contacts with algal taxonomists in Denmark, Sweden and Estonia. He also began to use electron microscopy methods on micro-scaled microalgae in Tvärminne. **Seija Hällfors** and **Harri Kuosa** worked in this taxonomical field, too.

It was found early on that many autotrophic and heterotrophic microalgae, especially chrysophytes and dinoflagellates were abundant in coastal waters and in the open sea. Many species were undescribed, **Guy** and **Seija Hällfors** managed to describe several *Chrysochromulina* species in the Tvärminne area. Cooperation with skilled Danish algologists from Copenhagen was of great importance.

Anke Kremp began to study dinoflagellates using modern methods she had learned during visits to international laboratories. She made profound studies on *Scrippsiella hangoei* and *Peridiniella catenata*, their ecology and life cycle in the 1990's. Several papers were published in peer reviewed international journals. Her doctoral dissertation, ²²*The role of life cycle in the population dynamics of the bloom-forming dinoflagellates Scrippsiella hangoei and Peridiniella catenata in the Baltic Sea*²², was published in the year of 2000. Although she focused on the functional role of dinoflagellates, also her high-level taxonomical studies were continued.

Anke Kremp worked with **Outi Setälä** in the BALDINO project during 2007–2010. This project concentrated on the distribution of potentially toxic planktonic species and their toxins in the Baltic Sea. The biodiversity and ecology of bloom forming dinoflagellates was studied and superintended by **Outi Setälä**. The biodiversity and ecology of blooming cold-water dinoflagellates in the Baltic was studied by **Annica Sundström**. During the period 2004-2009, **Heidi Hällfors** was funded for describing the dinoflagellate community composition and its variation in the Baltic Sea. **Sari Pertola**'s studies on alien dinoflagellate species, specifically *Prorocentrum minimum*, revealed new taxonomical and ecological information and her thesis *Diffusive and ship-mediated spread of dinoflagellates in the Baltic Sea with Prorocentrum minimum as a special case* was published in 2006.

The EZECO project

The Foundation supported research on processes regulating the structure and function of zooplankton, the EZECO- project (1999-2001). This project, led by **Markku Viitasalo**, included two parts: **The influence of the nutrient quality on zooplankton production** and **The interactions between zooplankton and predators**. The following studies were conducted.

- **Jonna Engström-Öst**, the influence of harmful algae on the nutrition of zooplankton.
- **Marja Koski**, the feeding and production of common planktonic copepods, the effects of food, predation and of blue-green algal blooms.
- **Sandra Green**, the influence of predation on zooplankton.
- **Maiju Viherluoto**, the influence of light and predation on nutrient uptake of mysids.

Several other students worked in the zooplankton project in order to do their doctoral dissertation.

- **Miina Karjalainen**, the transport of harmful substances from one trophic level to another via ciliates and copepods.
- **Tarja Katajisto**, the life cycle strategy of copepods, especially the environmental influence on copepod resting eggs and their role in the recruitment of new generations.

An extensive scientific material was collected in the EZECO project, partly in collaboration with scientist from abroad. Numerous scientific papers and several doctor dissertations were published based on the EZECO project's material.

Ecology in shallow archipelago inlets in 2001-2003

After the EZECO project was finished, **Markku Viitasalo** was involved as a leader in several studies on Baltic Sea ecology, which were compiled into a project during 2001–2003. The following studies were included under the heading above.

- **Sandra Green**, the influence of mussels on the species composition of zooplankton in shallow inlets.
- **Tomi Hakala**, the influence of predation on the development of herring spawning.
- **Miina Karjalainen**, the transport and enrichment of blue-green algal toxins from ciliates to copepods.
- **Samuli Korpinen**, the role of gammarids in the littoral food webs and the influence

- of blue-green algae on their reproduction and abundance.
- **Sirpa Lehtinen**, the phytoplankton occurrences and regulating factors in archipelago flads.
- **Eveliina Lindén**, the influence of the vegetation type on the nutrition of copepods and how mysids are able to avoid predation
- **Sanna Suikkanen**, the influence of blue-green algal blooms on the Baltic phytoplankton communities.
- **Maiju Viherluoto**, the nutrition of mysids.
- **Satu Viitasalo**, the influence of mysids on the resting eggs of the brackish water water flea *Bosmina*.
- **Mats Westerbon**, the factors influencing the distribution of blue mussel *Mytilus* near its limit of occurrence.

Several students got their Master's degree during the three years of this project. Their main results were published in scientific journals.

The influence of changes in the Baltic Sea on the archipelagic ecosystem

During the latter part of the 20th century, essential changes were recognized in the Baltic Sea environment. Climate change appeared as a plausible factor influencing the Baltic Sea ecosystem. The Nottbeck scientists began to study the influence of predicted climate change effects on the ecosystem. **Markku Viitasalo** compiled the different interests to a project he superintended. The project 2004–2006 included the following studies:

- **Jonna Engström-Öst**, the influence of eutrophication on the behaviour of fish larvae in 2006
- **Sandra Green**, the influence of mussels on the composition of zooplankton in shallow inlets.
- **Miina Karjalainen**, the accumulation of nodularin in littoral organisms.
- **Eveliina Lindén**, the choice of habitat by mysids and how they are able to avoid predation.
- **Sari Lehtinen**, the structure and function of the flad ecosystem.
- **Jaana Lindberg**, how the changes in the Baltic influenced the herring.
- **Jari-Pekka Pääkkönen**, the interaction between zooplankton and fish exposed to toxins of blue-green algae.
- **Sanna Suikkanen**, the influence of blue-green algal blooms on the Baltic Sea plankton community.

This project resulted in several academic examinations and scientific papers.

Littoral studies

Several littoral studies taking place at Tvärminne archipelago were supported by the Foundation during the period 2000–2010. **Ari Ruuskanen** managed the **Algae project** in 2001–2003 and the **Littoral project** in 2004–2006.

The bladder wrack (*Fucus vesiculosus*) populations suffered a serious decline in the late 20th century around the coasts of the Baltic Sea. After his doctoral dissertation *Ecological*

responses of Fucus vesiculosus L. along environmental gradients in the northern Baltic Sea in 2000, **Ari Ruuskanen** continued his research on the bladder wrack supported by the Foundation. He studied the factors regulating the occurrence, ecology and morphological variation of bladder wrack in different localities along the coast of Finland. **Niko Nappu** participated the research by studying the dynamics in the bladder wrack belt during 2000–2005.

Several shorter projects were included in the Littoral project, even though some of them on a very different theme. **Mats Westerborn** studied the factors regulating the occurrence of blue mussels at its distribution limit in the northeastern Baltic Sea, and **Hermann Becker** participated in the study.

Olli Mustonen studied the biological factors influencing the variation in *Mytilus*' abundance and the importance of *Mytilus* for predators in 2006. **Samuli Korpinen** studied the role of gammarids in the littoral food web and how cyanobacteria could influence their reproduction and density.

Studies on the development of the flad vegetation in the archipelago

The Foundation supported **Riggert Munsterhjelm**'s research on the vegetation in shallow brackish water bays (flads) in the Tvärminne area during several periods from the late 1980's onwards. His work is a fundamental description how the aquatic habitat and its vegetation develops in a land uplift area when a brackish water inlet changes via a semi-enclosed bay to a flad and finally to a small freshwater lake (a glo lake). Munsterhjelm's results were published in his doctoral thesis *Natural succession and human-induced changes in the soft-bottom macrovegetation of shallow brackish bays on the southern coast of Finland* in 2005.

The role of the alga *Chara tomentosa* in the flad ecosystem was realised during Munsterhjelm's studies. **Catherine Henricson** continued studying *Chara tomentosa* and its ecology and environmental requirements in the field and in laboratory conditions. She was supported by the Foundation up to 2007. In addition, several other small studies were done in flad biology with the support of the Foundation

Ecophysiological studies on Baltic Sea benthos animals

Magnus Lindström built up the ecophysiological laboratory at the Tvärminne Zoological Station during the 1980's. Several studies on the ecophysiology of *Monoporeia affinis* and its occurrence in the bottom sediments in relation to the oxygen content were carried out in the laboratory. Some of the studies were done in cooperation with scientist from abroad. **Magnus Lindström** did eye physiological studies also on other benthic animals. The ecophysiological laboratory was regarded as a valuable part of the Station's activity and thus the studies were supported by the Foundation over a long time.

Magnus Lindström studied how the macroscopic fauna oxygenated the bottom sediment through bioturbation in laboratory conditions during 1999–2000. The temperature preference of the cold-adapted crustaceans *Monoporeia affinis* and *Pontoporeia femorata* were studied in cooperation with researchers from the Finnish Institute of Marine Research, Helsinki and the University of Turku.

Further, the protective mechanism in the crustacean eye was studied in cooperation with prof **Michail Ostrovsky**'s research group from the Russian Academy of Sciences. The orientation capacity of crustacean eye was studied together with **Alberto Ugolini**'s group (University of Florence).

In discussing the ecophysiological items in 2006, the Foundation's Expert Group and the Board decided on support for this research field. Thus, ecophysiological studies on benthos animals were funded from 2007 onwards. **Magnus Lindström** continued the laboratory studies on how bioturbation influences oxygen conditions in bottom sediments. In cooperation with **Brita Sundelin** (University of Stockholm), they studied *Monoporeia affinis* as a hypoxia-specific marker for Baltic Sea environmental testing.

New projects in 2007

Five new projects were supported in 2007:

The project **Functioning and nutrient response of pelagic plankton food webs** was led by **Risto Lignell** in 2007–2010. This study is closely connected to **Lignell**'s earlier studies on the production and flow of organic carbon and nitrogen in the Baltic Sea pelagial.

The project **Cyanobacteria interaction with mesozooplankton and the upper trophic levels – an integrative approach** was led by **Jonna Engström-Öst** from 2007 to 2009. The following co-workers participated in the project with their own subprojects:

- **Susanna Halttunen**, the influence of the toxic cyanobacteria *Nodularia* on the escape reaction of calanoid copepods, in 2008.
- **Anu Vehmaa**, harmful phytoplankton and climate change effects upon copepod survival and reproduction, in 2008.
- **Päivi Sillman**, the bacteria, picocyanobacteria and flagellates in the plankton community, in 2009.

The project **The strategy and success of invasive species in the Baltic food webs** was led by **Maiju Lehtiniemi**. New species invading the Baltic Sea was considered as a threat in the Baltic Sea ecosystem already in the late 20th century. Several minor studies had already been done. It was thus motivated to support the new project. The following co-workers participated with their sub-projects:

- **Tarja Katajisto**, the cladoceran *Cercopagis pengoi*, its resting eggs and life cycle, in 2007–2010.
- **Jyrki Torniainen**, the predation of mysids on herring roe and spawn, in 2007.
- **Satu Viitasalo-Frösén**, the ctenophore *Mnemiopsis leidyi*, in 2008–2009.

Other research funded by the Foundation included the project **Predicting large scale changes in coastal habitats. Dynamics of key species in their habitats over an environmental gradient in the western Gulf of Finland** led by **Mikael Kilpi** in 2007, and a blue mussel study led by **Mats Westerborn**, in which **Maria Koivisto** and **Anu Riihimäki** were responsible for a part of the studies.

The project **Consequences of oxidative stress in the Baltic Sea food web** was managed by **Markku Viitasalo** in 2007. It included different studies on the influence of cyanobacteria on

the ecosystem:

- **Miina Karjalainen**, the influence of cyanobacteria on the ecosystem.
- **Jari-Pekka Pääkkönen**, the interaction between zooplankton and fish exposed to cyanobacteria.
- **Sanna Rönkkönen**, the content of carbon, nitrogen, phosphate and lipids in zooplankton.

Personal grants given to young scientists working on their doctoral thesis:

- **Mats Westerborn** investigated the factors influencing the occurrence of the mussel *Mytilus* near its geographical distribution limit in the Baltic Sea during the period 2000–2007. He defended his doctoral dissertation *Population dynamics of blue mussels in a variable environment at the edge of their range* in 2006.
- **Olli Mustonen** studied the interaction between the blue mussel and the eider duck in the Gulf of Finland in 2000 and 2006.
- **Raisa Nikula** studied the genetic structure in the mussel *Macoma baltica*. She defended her dissertation *Phytogeography and hybrid swarms: history of brackish water bivalve diversity in North European marginal seas* in 2008.
- **Pasi Ylöstalo** worked with plankton photosynthetic parameters and production models of phytoplankton in the Baltic Sea during the period in 2004–2009.
- **Andreas Vetterli** was supported to study the diversity and function of microbes involved in the nitrogen cycle in Baltic Sea sediments in 2008–2010.
- **Anna Villnäs** got grants to study the disturbance and ecosystem function – the role of changing biological traits for the resilience of benthic communities in 2008–2009.
- **Janica Borg** got support to study littoral fish communities and their habitats in an altered Baltic Sea ecosystem in 2009–2010.
- **Asta Audzijonytė** studied the origin, diversity, changes and adaptation of the mysid fauna in the Baltic Sea during 2004–2006. She defended her doctoral dissertation *Diversity and zoogeography of continental mysid crustaceans* in 2006. She got a small grant for studying the genetic diversity and the distribution of two cryptic taxa within *Hediste (Nereis) diversicolor* in the eastern Baltic Sea in 2007.
- **Jaana Tuomainen** studied the community structure of microbes in ice using molecular methods in 2006–2007.
- **Petr Strelkov** studied the blue mussel *Mytilus edulis* × *trossulus* hybrid zone in the Baltic Sea, twenty years after, in 2009.

5. International activity

When the Foundation decided to focus its activity on supporting the Baltic Sea ecosystem research at Tvärminne, the establishing of international research cooperation was underlined. It was of profound importance to develop a contact network with scientific expertise abroad in order to take the research to an international level. As earlier mentioned, prof. **Ilmo Hela** strongly underlined the importance of sending young scientists to international seminars and congresses to acquire contacts and scientific experience. In consequence, the Foundation supported young researchers' visits to laboratories abroad and encouraged them to participate in specialised scientific courses and, in particular, to learn new methods and make acquaintance with modern instrumentation.

The Foundation has funded scientific meetings and seminars at Tvärminne, for instance by

paying the expenses of invited international scientist to lecture and work at Tvärminne. The contacts with scientists and laboratories abroad increased greatly since the 1980's when the scientific teamwork in marine biology really began at Tvärminne. For instance, the established contacts with the Institute of Polar Ecology at the University in Kiel have resulted in mutual courses, scientific projects and exchange of scientists. Researchers at Tvärminne have participated expeditions to polar sea areas. The joint courses were led by teachers from the universities in Kiel and Helsinki. Close contacts have been established with esteemed algal taxonomists from many countries (see chapter 6 below).

The Foundation can with great satisfaction state that the good international contact network developed and the successful recruitment of scientists has been of paramount importance for the future marine biological research at Tvärminne.

6. Foreign scientists at Tvärminne

In order to increase and develop the international contacts and scientific cooperation, the Foundation has positively encouraged and supported scientific work of foreign scientists at the Tvärminne Zoological Station. Generally, scientists in collaboration with project teams have been invited and supported. Foreign Baltic Sea biology researchers with interesting research questions have been funded to work at Tvärminne. During the period 2000-2010, the following scientists from abroad got support to work at the Tvärminne Zoological Station or another institute with solid connections to Tvärminne:

2000 – Dr. **Sture Hansson** and prof. **Bengt-Owe Jansson** (University of Stockholm), Dr. **Andre W. Visser** and Dr. **Brian Mac Kenzie** (University of Copenhagen), M.Sc. **Klaus Meiners** and Dr. **Katrin Schmidt** (University of Kiel), Dr. **Jonne Kotta** and M.Sc. **Helen Orav** (Tallinn), Doc. **Erich Kukkk** (University of Tartu) and prof. **George Russell** (University of Liverpool).

2001 – Dr. **Peeter Ennet**, prof. **Rein Tamsalu**, Dr. **Jonne Kotta** and M.Sci. **Helen Orav** (Tallinn) and **Erich Kukkk**, **Thomas Kiörboe** (University of Copenhagen), Dr. **Dan Gustafson**, Dr. **Matt Johnson** and prof. **Diane Stocker** (Horn Point Laboratory, University of Maryland, USA) and prof. **Lars Rudstam** (USA).

2002 – **Dan Gustafson**, **Diane Stocker**, **Erich Kukkk**.

2003 – Dr. **John Bowman** (University of Tasmania, Australia), **Erich Kukkk**, Dr. **Ivan Neelov** (St. Petersburg), Dr. **Iris Werner** (Institut für Polar Ökologie, Kiel), prof. **George Russell**, prof. **David Thomas** (University of Wales, Bangor).

2004 – Dr. **Jörg Dutz** (Institut für Ostseeforschung, Rostock), Dr. **Sigrun Huld Jonasdottir** and Dr. **Marja Koski** (Danmarks Fiskeriundersøgelse, Charlottenlund), M.Sc. **Aimar Rakko**, University of Tartu, **Diane Stocker**, **Iris Werner**.

2005 – Dr. **Susanna Hajdu** (University of Stockholm), M.Sc. **Towe Holmborn** and Dr. **Ingela Isaksson** (University of Copenhagen), **Erich Kukkk**.

2006 – The following scientists worked/visited in Tvärminne: **Iris Werner**, **Susanna Hajdu**, Dr. **Brita Sundelin** (University of Stockholm), **Erich Kukkk**.

Prof. **Harri Kuosa** arranged a workshop ISPOL-project (Antarctica) in which more than 20 foreign scientists participated.

2007 – **Tina Elfving, Haldor Haldorsson, Marie Löv, Martin Reutgard, Brita Sundelin** and **Annica Sundström** (University of Stockholm) worked at Tvärminne as guest researchers. Further visitors were **Erich Kukk, George Russel, Colin A. Stedmon** (University of Copenhagen), **David Thomas**. prof. **Kunio Shirasawa** visited Tvärminne as a teacher in a field course on snow and ice.

The project **Do benthic animals affect the recruitment of *Nodularia spumigena* blooms in the Baltic Sea?** was supported by inviting MSc **Agnes Karlsson**, MSc **Francisco Nascimento** and MSc **Johan Näslund** (University of Stockholm) to visit Tvärminne over a period of some weeks.

2008 – **Elena Gorokhova, Hedvig Hagfors, Marie Löv, Martin Reutgard, Brita Sundelin** and **Annica Sundström** worked at Tvärminne as guest researchers. Further visitors were **Peder Larsson** (Umeå university), **David Thomas**.

The project **Hypoxia-specific biomarkers for *Monoporeia affinis* as a tool for Baltic Sea environmental testing** was supported. This project was led by Dr. **Brita Sundelin** with **Marie Löv** and **Martin Reutgard** (University of Stockholm), and the Foundation's researcher **Magnus Lindström** as co-workers.

Prof. **David Thomas** (Bangor, UK) was invited to Finland by the Academy of Finland. In 2008 The Foundation paid for his stay in Tvärminne, as well as for his travel and some research material.

2009 – **David Thomas** worked at Tvärminne together with two with younger researchers **Frances Burrows** and **Alexandra Deamer-John** in the new FiDiPro project managed by David Thomas and partly supported by the Foundation. Further visitors were **Sven Blomqvist** and **Nils Ekeröth** (University of Stockholm)

The project **Hypoxia-specific biomarkers for *Monoporeia affinis* as a tool for Baltic Sea environmental testing** was supported during 2009. The project was led by Dr. **Brita Sundelin** with **Sven Blomqvist** and **Nils Ekeröth** (University of Stockholm), and the Foundation's researcher **Magnus Lindström** as co-workers.

2010 – The FiDiPro project continued with **David Thomas** as the project leader and **Frances Burrows** and **Alexandra Deamer-John** as co-workers. prof. **Paul Withers** and Dr. **Colin Stedmon** visited Tvärminne in connection with this project. During a course arranged by the Nordic Marine Academy at Tvärminne prof. **Öivind Moestrup** (University of Copenhagen), prof. **Lars Edler** (University of Lund) and prof. **Jacob Larsen** (University of Copenhagen) acted as teachers.

7. The policy and publication

A great change took place in the publication policy among Finnish scientists in marine biology from the 1970's onwards. Before that, scientists traditionally published their results

in national Finnish journals. Especially since the 1980's, young scientists tried to publish their results in valued international peer reviewed scientific journals. This change was particularly caused by the fact, that when appointing teachers and researchers at the universities and research institutes, reviewers from abroad were asked to give their expert reports on the applicants. These reviewers made their evaluations mainly based on articles published in internationally acknowledged journals.

At the same time, the ecological research was increasingly developing towards teamwork with several scientists working in the same project. The results were usually published as joint articles. This has caused the evaluation of an individual researcher's scientific capacity more difficult than earlier. The same problem occurs when evaluating a doctoral thesis consisting of several joint publications, a case very common today.

However, there has always been a need to publish results also in domestic journals and report series. Especially some scientific results on environmental issues that demand urgent action may reach national public faster through native channels. Besides, in current society also science should be visible and understandable to the general public.

8. Academic examinations and training of marine biologists

When the Foundation began supporting Baltic Sea research at Tvärminne, basic education in marine biology was started at the University of Helsinki, and within few years, it reached a rather satisfactory volume. Most of the students, who since the middle of the 1980's had taken their Master's, Licentiate or Doctor's degree in hydrobiology at the Faculty of Science, had specialised in marine biology. Some examinations supported by the Foundation were also taken in limnology at the Faculty of Agriculture and Forestry.

The *pro gradu* grants for M.Sc. students, a support for 3–4 months scientific work at Tvärminne have been the start of a career for many marine biologists. Grants for longer periods have made it possible for younger researchers (on postgraduate level) to complete their Licentiate and Doctor's degree. Support of several years (usually 3–4) for senior scientists who have reached the Ph.D. level has made it possible to establish larger research projects involving both doctoral students and younger scientists. Experience has shown that the best training for young scientists and students is to work in a project led by a prominent senior scientist. It is an effective way to get acquainted with scientific questions of current interest and learn the state-of-the-art methods in the specific research field. It is also good training for scientific thinking, processing and analysing results, and the multiphase process of manuscript preparation for publication in peer reviewed international journals. One principal aim is to learn teamwork, a prerequisite in modern marine research.

The Foundation has strongly supported young scientists by defraying their expenses in participating in international science courses and conferences. Its importance increased when the Nordic Council for Marine Biology, arranging each year several marine biology courses within easy reach for Nordic students, was discontinued in the 1980's. It is important that researchers at an early stage learn to present their research results in posters and lectures for an international scientific public, learn to discuss their results and defend their theories and ideas, and in general take part in the scientific discussion. Scientific meetings are crucial for establishing personal scientific networks, which may lead to different forms of collaboration and exchange of scientific knowledge and ideas. This has also happened at several

international seminars arranged at Tvärminne.

The projects supported by the Foundation have generally been successful. The results and publications are of a good international standard and many of them have reached recognition. This has been a great aid in career building and the researchers supported by the Foundation have been appointed to various positions in governmental research institutes and universities and as senior scientists in the Academy of Finland. Many projects have developed into larger research units, which have gained support from different sources. In such projects, the scientific education has been very successful.

The positive development of marine biological studies led to the University of Helsinki decision to change the description of the *Professorship in ecology, especially the biology of the Baltic Sea* to a *Professorship in marine biology, especially the ecosystem of the Baltic Sea and therein occurring changes* in 1999. When the new professorship was announced vacant in the autumn of 1999, 16 scientists handed in their applications to the University of Helsinki. Dr. **Jorma Kuparinen** was appointed to the chair.

9. The establishing of the Baltic Sea professorship at Tvärminne Zoological Station

Both the management at Tvärminne and the Foundation found the continuation of basic research on the Baltic Sea ecosystems of utmost interest in order to get real knowledge of ecosystem functions, regulating processes, eutrophication problem and possible solutions, etc. All this knowledge is of profound importance for societal decision-making.

Therefore, the Foundation appointed a planning group (prof. **Allan Johansson**, distinguished lagman **Robert Mattson** and prof. **Åke Niemi**) with the task to plan for a five-year professorship, located at Tvärminne, and funded by the Foundation. Negotiations began with the authorities of the University of Helsinki, e.g. the Rector, in 2000. These negotiations continued in 2001, and led to the result that the Chancellor of the University appointed Dr. **Harri Kuosa** to the Walter and Andrée de Nottbeck Foundation's research professorship for the period January 1, 2002 – December 31, 2006. This was the first scientific post located at Tvärminne all year round.

Professor **Kuosa**'s task was, among others, to strengthen the international contacts. This led to co-operation between Tvärminne and many research institutes abroad (see Chapter 6 above). Besides his own research projects, he supervised the different main projects supported by the Foundation and supervised several doctoral theses. The Foundation's plan was to continue the professorship after 2006, and after negotiations with the University, the Chancellor appointed **Harri Kuosa** for a second five-year period lasting from January 1, 2006 to December 31, 2011. After the discontinuation of the Finnish Institute of Marine Research, the importance of the Tvärminne Zoological Station and its professorship became more important than ever.

10. The need for marine biologists in Finland and their position in the community

The environmental problems have become more urgent since the 1970's. With the increasing destruction in all marine environments, the role of environmental specialists will become even more important in the future. The Foundation's activity has helped to educate a great number of marine biologists with environmental skills at an international level, and many of them have obtained prominent positions at universities, various governmental institutes and the private sector.

Many scientists, who begun their career as the Foundation's grant holder in Tvärminne, have been teaching in Tvärminne or Viikki, at the University of Helsinki, instructed students in their work for their doctoral or master's theses, thus effectively contributing to the scientific education at the University. Close contacts with earlier stipendiaries, who now have positions in various institutions, form an important channel for young scientists to gain information and opportunities.

The strong development of the Biological laboratory and Division at the Finnish Institute of Marine Research in Helsinki (non-existing in the 1960's), grew from the 1970's on so that the Biological Division was the largest division in the Institute. The activity focused on basic research of the Baltic ecosystem and monitoring of the ecological conditions of marine areas. A close cooperation arose between the Tvärminne Zoological Station, the University of Helsinki and the Finnish Environment Institute (SYKE).

The Government of Finland decided to discontinue the Finnish Institute of Marine Research in Helsinki in 2008, in spite of all conflicting opinions and expert viewpoints from national and international scientists and organisations. The former Finnish Institute of Marine Research was divided and the physics section was transferred to the Finnish Meteorological Institute, while the biologists and chemists, the work of whom was closely connected with the physicists, were moved to the new Marine Research Centre of the Finnish Environment Institute (SYKE). The publically funded basic marine research in Finland suffered notably. Scientists in other Baltic Sea countries regretted the negative change in Finnish Baltic Sea policy with fewer resources for basic research.

The Foundation has done its best to aid in the difficult situation by directing its assets to high quality basic marine research. The Foundation's support has proven to be of utmost importance for marine research at the University of Helsinki, and indeed for marine research in Finland, making Tvärminne Zoological Station one of the national centres for marine research in Finland.

Walter and Andrée de Nottbeck Foundation List on publications

WALTER AND ANDRÉE DE NOTTBECK FOUNDATION SCIENTIFIC REPORTS

The following issues were published in 2000–2010:

- No. 19. **Autio, R.:** Studies on bacterioplankton in the Baltic Sea with special emphasis on the regulation of growth. 2000. 34 pp. ISBN 951-97529-8-6.
- No. 20. **Blomster, J.:** Molecular and morphological approaches to the evolutionary history of the *Enteromorpha-Ulva* species complex. 2000. 24 pp. ISBN 951-97529-9-4.
- No. 21. **Ruuskanen, A.:** Ecological responses of *Fucus vesiculosus* L. along environmental gradients in the northern Baltic Sea. 2000. 20 pp. ISBN 951-98521-0-7.
- No. 22. **Kremp, A.:** The role of life cycle in the population dynamics of the bloom forming dinoflagellates *Scrippsiella hangoei* and *Peridiniella catenata* in the Baltic Sea. 2000. 31 pp. ISBN 951-98521-1-5
- No. 23. **Vihertuoto, M.:** Food selection and feeding behaviour of Baltic Sea mysid shrimps. 2001. 35 pp. ISBN 951-98521-2-3 (paperback); ISBN 951-45-9828-8 PDF
- No. 24. **Engström-Öst, J.:** Effects of cyanobacteria on plankton and planktivores. 2002. 29 pp. ISBN 951-98521-4-X (paperback); ISBN 952-10-0267-0 PDF
- No. 25. **Setälä, O.:** Studies on planktonic brackish water microprotozoans with special emphasis on the role of ciliates as grazers. 2004. 48 pp. ISBN 951-98521-5-8; ISBN 952-10-2188-8 (PDF)
- No. 26. **Munsterhjelm, R.:** Natural succession and human-induced changes in the soft-bottom macrovegetation of shallow brackish bays on the southern coast of Finland. 2005. 53 pp. ISBN 951-98521-6-6 (paperback); ISBN 952-10-2363-5 (PDF)
- No. 27. **Kaartokallio, H.:** Sea-ice ecology in the Baltic Sea with special emphasis on bacteria. 2005. 41 pp. ISBN 951-98521-8-2 (paperback); ISBN 952-10-2796-7 (PDF)
- No. 28. **Audzijonytė, A.:** Diversity and zoogeography of continental mysid crustaceans. 2006. 46 pp. ISBN 951-98521-9-0 (paperback), ISBN 952-10-2871-8 (PDF)
- No. 29. **Katajisto, T.:** Benthic resting eggs in the life cycles of calanoid copepods in the northern Baltic Sea. 2006. 46 pp. ISBN 952-99673-0-6 (paperback), ISBN 952-10-2933-1 (PDF)

- No. 30. **Lindén, E.:** Antipredator behaviour of Baltic planktivores. 2006. 58 pp. ISBN 952-99673-1-4 (paperback), ISBN 952-10-3210-3 (PDF)
- No. 31. **Spilling, K.:** On the ecology of cold-water phytoplankton in the Baltic Sea. 2007. 59 pp. ISBN 978-952-99673-2-2 (paperback), ISBN 978-952-10-3626-2 (PDF)
- No. 32. **Nikula, R.:** Phylogeography and hybrid swarms: history of brackish water bivalve diversity in North European marginal seas. 2008. 35 pp. ISBN 978-952-99673-3-9 (paperback), ISBN 978-952-10-4471-7 (PDF)
- No. 33. **Kostamo, K.:** The life cycle and genetic structure of the red alga *Furcellaria lumbicalis* on a salinity gradient. 2008. 34 pp. ISBN 978-952-99673-4-6 (paperback), ISBN 978-952-10-44772-4 (PDF)
- No. 34. **Rintala, J.-M.:** A systematic-ecological approach to Baltic Sea ice studies of algae and protists. 2009. 48 pp. ISBN 978-952-99673-5-3 (paperback), ISBN 978-952-10-5630-7 (PDF)
- No. 35. **Sopanen, S.:** Interactions between harmful algae and calanoid copepods in the Baltic Sea. 2009. 57 pp. ISBN 978-952-99673-6-0 (paperback), ISBN 978-952-10-5867-7 (PDF)

Other publications by researchers funded by the Foundation can be found on the home page of the Tvärminne Zoological Station, in the list **Publications from Tvärminne Zoological Station 1984-2015** (http://saari-web.it.helsinki.fi/TZS_publications_1984-2015.pdf).

A list of some of the *pro gradu* theses (Master's theses) supported by the Foundation can be found on the home page of the Tvärminne Zoological Station (http://saari-web.it.helsinki.fi/pro_gradut_Tvarminne_1911-.pdf).

Walter and Andrée de Nottbeck Foundation Stipendiaries and grants 2000–2010

Type of grant

1. Senior scientist (none appointed 2000–2010)
2. Researcher, ½-1 year grant
3. Researcher, >½ year grant
4. PhD student's grant
5. Licentiate and pro gradu grant
6. Support for international activities
7. Publishing
8. Other research work

Mo = grant duration in months (not applicable for the pro gradu grants)

Year	Grant holder	Type	Mo	Research theme
2003	Aaltonen, Tinto	3	1	The reproduction of <i>Fucus vesiculosus</i> during the autumn
2004		5		The algal flora and <i>Fucus vesiculosus</i> between Tvärminne and Kotka and the competition between <i>Fucus</i> and the green alga <i>Cladophora rupestris</i> in the Kotka area
2000	Anton, Ann-Marie	7	4	Writing of an article on <i>Effects on littoral brackish water model ecosystems exposed to UV radiation</i>
2004	Anttila, Ilkka	5		The influence of the turbidity caused by algae on the mating in the sand goby
2009	Arnkil, Anna	5		Diversity of faunal communities found within blue mussel patches: The influence of patch structure and edge effect
2008	Asmala, Eero	3	4	Functioning and nutrient responses of pelagic plankton food webs
2004-2005	Audzijonytė, Asta	4	4	The mysid fauna of the Baltic Sea: origin, diversity, changes and adaptation to the environment
2007		3	3	The genetic diversity and distribution of two cryptic taxa in the <i>Hediste (Nereis) diversicolor</i> group in northern and eastern Baltic Sea
2000-2002	Autio, Riitta	2, 3	29	Roles of bacterioplankton in pelagic ecosystems
2009	Avellan, Lena	5		Variability and dispersal potential in soft-sediment communities – implications for community connectivity and recovery after disturbance
2004	Backer, Hermanni	5		Blue mussels in the red alga zone

		4	3	The depth gradients of different blue mussel populations
2007	Bansfield, Danielle	5		Nodularin concentrations in muscle tissues of roach and flounder caught from the western Gulf of Finland and their health risk to human consumers
2007	Borg, Janica	5		The breeding habitats and their quality of the European flounder (<i>Platichthys flesus</i>) in the western part of the Gulf of Finland
2009-2010		4	24	Littoral fish communities and their habitats in an altered Baltic Sea ecosystem
2004	Borgström, Johanna	5		The depth gradients of the blue mussel and its accompanying species
2000	Dernjatin, Markus	5		Macroalgae expressing the state of the environment
2000	Ehn, Jens	5		The light conditions under the Baltic Sea ice
2002-2003		4	29	The geophysics of the sea ice environment of the Baltic Sea
2007	Eirtovaara, Sanna	5		The genetics and ecology of the newly found harmful dinoflagellate <i>Alexandrium ostenfeldii</i>
2000	Engström, Jonna	5	1	The influence of harmful algae on the feeding of Copepoda
2006-2007	Engström-Öst, Jonna	3	13	The influence of eutrophication on the behaviour of fish fry
2008		2	6	Cyanobacteria interactions with mesozooplankton and the upper trophic levels – an integrative approach
2007-2010	Eronen, Eeva	4	37	Bacterial community dynamics in relation to biogeochemistry in the Baltic Sea ice
2001	Forsström, Laura	4	12	The taxonomy and winter succession of the ice biota of the Baltic Sea
2010	Gammal, Johanna	5		Links between benthic fauna, sediment type and nutrient fluxes, and the influence of hypoxia on these links
2004	Granskog, Mats	2	12	The physical properties of the sea ice and their influence on the ecology of the ice and the biogeochemistry of the Baltic Sea
2000	Green, Sandra	4	12	The influence of changing environmental factors on the predation success of fish larvae
2001-2004		4	36	The influence of mussels on the species composition of zooplankton in shallow sea areas
2008-2010	Haase, Susann	4	31	Baltic Sea ice biochemistry; the role and importance of photochemistry and bacterial processes

2005	Hajdu, Susanna	6	1	Dinoflagellate studies at Tvärminne in cooperation with Heidi Hällfors and Anke Kremp
2000	Hakala, Tomi	7	2	Growth and feeding of yolk sac and first feeding Baltic herring larvae in the northern Baltic Sea
2000-2002		4	18	The ontogenetic development of Baltic herring larvae – the effect on predation success
2004, 2006-2010	Hällfors, Heidi	4	50	The ecology and distribution of dinoflagellates in the Baltic Sea
2001	Halttunen, Elina	5		The significance of the krills in the circulation of organic matter in fjords of northern Norway
2005	Halttunen, Susanna	5		The escape reactions in zooplankton during artificial currents and the influence of the toxic cyanobacteria <i>Nodularia spumigena</i> on the escape reactions
2008		2	6	The effects of toxic cyanobacterium <i>Nodularia spumigena</i> on the escape reactions of Baltic Sea calanoid copepods
2000	Hälvä, Panu	5		The sounds of killer whales in Norway
2007	Hänninen, Emmi	5		Verification of mapping procedures in the nationwide underwater mapping programme VELMU: the reliability and validity of underwater video techniques
2003	Härmä, Meri	5		The choice of mating areas of the perch (<i>Perca fluviatilis</i>) in the Tvärminne area
2003	Hauta-aho, Sari	5		Factors influencing the oxygen consumption in the bottom sediment of the northern Baltic Sea
2004	Heino, Sini	5		The competition for habitats between mysids and fish larvae in the littoral zone
2004	Helenius, Laura	5		Bioaccumulation, de-toxication and toxic effects of nodularin on the three-spined stickleback: in vivo experiments and small-scale field studies
2003-2007	Henricson, Catherine	4	60	Studies on the ecology, environment and disturbances of <i>Chara tomentosa</i>
2010	Hepolehto, Iina	5		The role of microbes in resilience and recovery of benthic ecosystems of the Baltic Sea
2001	Hirvonen, Anu	5		The structure and function of the zoobenthos in flats and shallow sea bays – differences between localities

2001	Hoikkala, Laura	5		Biological degradation of dissolved organic nitrogen (DON) in the coastal zone of the northern Baltic Sea
2002-2006		4	54	Dissolved organic carbon (DOC) and dissolved organic nitrogen (DON) in the coastal waters
2005	Holmborn, Towe	6	2	Studies on the reproduction of the copepod <i>Acartia bifilosa</i> and collecting eggs of the copepod <i>Eurytemora affinis</i> – study visit at Tvärminne
2000	Ikävalko, Johanna	3	2	Studies on ice organisms in the Ross Sea and the Baltic Sea
2001		3	4	The sea ice biology of the southwestern coast of Finland
2004	Immonen, Emmi	5		Pike larvae in eutrophicated habitats – effects on competition and predation risk
2010	Jansson, Anna	4	12	Ocean acidification in the Baltic Sea – what are the implications of climate change for the recovery potential of benthic communities?
2001	Järvenpää, Marja	5		The influence of the eutrophication on the reproduction and mating success in sand goby (<i>Pomatoschistus minutus</i>)
2001	Järvi-Laturi, Maria	5		Sand goby's (<i>Pomatoschistus minutus</i>) care of its fry on stony and sandy bottoms
2002	Järvinen, Sofia	5		The role of <i>Mytilus edulis</i> as a link between the pelagic and benthic ecosystems in the northern Baltic Sea
2000-2002	Kaartokallio, Hermanni	4	33	The nutrient dynamics and the bacterial processes of the sea ice of the Baltic Sea
2006		3	1	Bacteria in the sea ice community and in the biogeochemical cycles
2007	Kähkönen, Kirsi	5		Nitrogen in sediments of the Baltic Sea
2002-2003	Karell, Kimmo	4	23	Ice organisms and their fate in melting ice
2005-2007		4	18	The physical properties of sea ice and their influence on the ecology and biogeochemistry in the ice of the Baltic Sea
2000-2002	Karjalainen, Miina	4	26	The transfer of cyanobacteria toxins from one trophic level to another - Ciliata and Copepoda as model organisms
2006-2007		2	24	The accumulation of nodularin in littoral organisms
2000-2001	Katajisto, Tarja	4	14	The role of resting eggs in the life cycles of calanoid Copepods in the northern Baltic Sea
2007		2	12	Studies on the fishhook water flea (<i>Cercopagis pengoi</i>) and its life cycle

2008-2010		2	31	Resting eggs as an essential life history characteristic for a successful invader (the fishhook water flea <i>Cercopagis pengoi</i>)
2003	Kekkonen, Tiina	5		The influence of the quality of the habitat and the predation on the population structure of <i>Palaemon adspersus</i>
2004	Kiiltomäki, Anniina	5		Nutrients and chlorophyll along a gradient from Helsinki to Lübeck
2008	Kiljunen, Mikko	7	3	Writing a manuscript on Changes in food web length and structure after invasion of non-indigenous predatory cladoceran (<i>Cercopagis pengoi</i>)
2001	Kinnunen, Veijo	5		Macroalgae as indicators on the status of the long-term change in the aquatic environment
2003		3	1	Algae on and around the ship wreck of Vrouw Maria in the Archipelago Sea
2000, 2007	Kivi, Kai	3	1;1	Metazooplankton in the Baltic Sea
2006	Klötzer, Vanessa	5		Chemical mating signalling in the sand goby (<i>Pomatoschistus minutus</i>) – the effects of eutrophication and compounds causing endocrinological disturbances
2000	Koho, Jorma	4	5	The function and dynamics of brackish water fish communities
2004	Koho, Mikko	5		The use of nutrients of the Baltic herring and the Baltic sprat in the Gulf of Finland and the possible effect of mysids
2006-2007	Koivisto, Maria	5, 4	6	The significance of blue mussel habitats for the evertrebrate communities on hard bottoms: an experimental study
2000	Kokkonen, Marjaana	8	1	Identifying zooplankton taxa
2000	Koli, Antti	8	6	Photos of organisms in the Tvärminne area - study material for teaching
2000-2002	Korpinen, Samuli	4	24	The role of gammarids in the littoral food web and the influence of cyanobacteria on their reproduction and density
2000	Koski, Marja	4	2	Feeding and production of common planktonic Copepods: the effect of food and temperature
2000		3	1	The effect of low quality food on feeding, production and survival of Copepods

2002	Koskimies, Kai	5		The metabolism and change of nodularin <i>in vivo</i>
2000	Kremp, Anke	4	12	The role of life cycle in the population dynamics of the bloom forming dinoflagellates <i>Scrippsiella hangoei</i> and <i>Peridiniella catenata</i> in the Baltic Sea
2010	Krooks, Laura	5		Effects of habitat size and isolation on biodiversity in fragmented shallow offshore reefs
2004	Kuningas, Sanna	5		The reproduction of the pike in the Pojoviken and Tvärminne areas in 2004
2001	Lahtinen, Markku	5		The ecology and mating in the straight-nose pipefish (<i>Nerophis ophidion</i>) in the Baltic Sea
2000	Lahtinen, Titta	4	2	Carbon sink regulation in the Baltic Sea: dissolved organic carbon (DOC)
2008		3	5	Factors controlling the production of bacteria in the plankton community in the western part of the Gulf of Finland
2001	Lehtinen, Sari	5		The structure and dynamics of the zooplankton communities in flads
2003-2004		4	11	The phytoplankton communities of flads and factors regulating them
2009-2010		4	18	Accumulation and analysis methods of PST toxins produced by <i>Alexandrium ostenfeldii</i> in the aquatic food webs of Föglö archipelago, Åland Islands
2001-2002	Lehtinen, Sirpa	4	5	The phytoplankton communities of flads and factors regulating them
2000	Lehtonen, Topi	5		Why are some sand gobies (<i>Pomatoschistus minutus</i>) breeding on stony bottoms?
2005-2006	Lignell, Risto	2	22	Dissolved organic carbon and nitrogen dynamics off the SW coast of Finland
2004	Lindeberg, Janne	3	3	The changes in the Baltic ecosystems and how they influence the Baltic herring
2000	Lindén, Eveliina	5		Selective grazing by zooplankton on phytoplankton
2001-2006		4	61	The choice of habitats by mysids and how they avoid predation
2004-2005	Lindqvist, Lasse	3	4	Studies of the littoral communities in the Tvärminne area
2000, 2007-2009	Lindström, Magnus	3, 4	4;12	The bioturbation by macrobenthic organisms on the aeration of the bottom sediments of the Baltic Sea and the influence of hypoxia on this process

2008-2010		3	8	Phytoplankton effects on bioturbation of sediment, oxygen consumption and internal loading of phosphorus
2009		3	3	Multiple stressors: interactions between microsporidian infestation and contaminants
2009-2010		3	5	Effects of current speed and mechanical disturbance of the diffuse boundary layer on the oxygenation of the sediment at different degrees of hypoxia
2010		3	3	The significance of bioturbators on the phosphorous (P) exchange across the sediment water interface after oxygenation of anoxic sediments in the Baltic Sea
2010		3	3	Fate and impact of xenobiotics in the marine environment
2001	Londesborough, Sally	5		The structure and function of the zoobenthos in flads and shallow sea bays - investigation of one locality
2007	Luukkanen, Hannamari	5		The influence of the salinity on the fertilisation of the roe, the embryo development and the quality of the fry of the European flounder (<i>Platichthys flesus</i>)
2005	Majaneva, Markus	5		A comparison between different sampling methods for phytoplankton
2007-2010		4	48	Biodiversity of Baltic Sea ice algae and ciliates
2003	Mäki, Meeri	5		The sound of the sand goby (<i>Pomatoschistus minutus</i>) as a possible signal referring to the quality of the male
2000	Mäki, Miina	5		Macroalgae as indicators on the status of the environment
2009	Malinen, Maria	5		The annual ctenophore community and population dynamics in the northern Baltic Sea
2007	Mannerla, Miia	5		Fitness consequences of eutrophication for a three-spined stickleback population of the Baltic Sea
2009	Markkula, Sanna	3	1	Studies on comb jelly samples collected from R/V Aranda at Tvärminne and in the Gulf of Finland in the autumn of 2009
2003	Mattila, Hanna	5		Factors controlling the biological utilisation of photochemically degraded dissolved organic matter at the SW coast of Finland
2001	Meriläinen, Tuuli	5		Fish communities in shallow water areas with flads as examples
2009	Miettunen, Elina	5		Hydrodynamic conditions near the bottom in the coastal area of the Gulf of Finland
2009	Mikkonen, Mirva	5		Interaction between plankton and the toxic cyanobacteria <i>Anabaena</i>

2000-2002	Munsterhjelm, Riggert	4	18	Macrophyte vegetation in the archipelago of western Nyland
2005		4	5	The dynamics of the macrophyte vegetation in the archipelago flads of western Nyland
2003	Munter, Karoliina	5		The influence of hypoxia on the biomarkers of the blue mussel
2001	Mustonen, Olli	4	10	The interaction between the eider duck and the blue mussel
2006		4	12	Biological factors influencing the variation in the biomass of blue mussels (<i>Mytilus edulis</i>) and its relation to predation
2000-2005	Nappu, Niko	4	64	The dynamics of the <i>Fucus vesiculosus</i> belt in the northern Baltic Sea
2000	Narinen, Maija	5	1	The spring succession among plankton algae in coastal ice of the Baltic Sea
2010	Nieminen, Aija	5		Does human induced increased clay turbidity enhance the amount (competition ability) of <i>Anabaena</i> cyanobacteria in marine environment?
2006	Niiranen, Susa	5		The estimation of the number of pikocyanobacteria in the Baltic Sea with the aid of the fluorescence of the phycobilins
2007	Nikula, Raisa	4	7	The genetic structure of <i>Macoma balthica</i>
2010	Oja, Johanna	3	2	Sampling and preparing samples of <i>Alexandrium ostenfeldii</i> collected in the archipelago of Föglö, Åland Islands
2001	Ojala, Petri	4	4	Benthic animals in different flad stages
2006	Ovcarenko, Irina	5		Genetic diversity and distributions of two cryptic taxa of <i>Hediste (Nereis) diversicolor</i> group (Polychaeta) in the northern and eastern Baltic Sea
2006-2007	Pääkkönen, Jari-Pekka	2	21	Studies of the interaction between zooplankton and fish exposed to toxic cyanobacteria
2007	Packalén, Anna	5		Biomarker studies in the genus <i>Gammarus</i>
2009	Peltonen, Hanna	5		Seasonal changes in ctenophore communities and factors regulating their distribution
2000-2002	Pertola, Sari	5	16	A taxonomic study on Dinophyceae

2002-2003	Piiparinen, Jonna	4	19	Studies on phytoplankton, ciliates and bacteria
2005-2010		4	66	Spatial variability in sea ice bacterial processes studied from Gulf of Finland to Bothnian Bay and the impact of UVA radiation on bacteria
2007	Pitkänen, Henrietta	5		The changes in the aquatic vegetation and their reasons, e.g. dredging, in the Ekenäs area
2007	Pulkkinen, Eija	3	1	Functioning and nutrient responses of pelagic plankton food webs – a mesocosm experiment
2008	Pusa, Isabel	5		Appearance of cyanobacterial toxins and factors affecting toxin production
2005	Raimala, Johanna	5		The occurrence of okadaic acid and okadaic acid producing dinoflagellates (<i>Dinophysis</i> spp.) in the western Gulf of Finland during June to August 2005
2004	Rakko, Aimar	6		Factors controlling the growth and biomass in filamentous cyanobacteria
2005	Riihimäki, Anu	3	1	Studies of the algal communities: their structure and function (in connection with the studies of Ari Ruuskanen and Mats Westerborn)
2006		5		The historical changes in the distribution of <i>Fucus vesiculosus</i> in the Bothnian Sea
2007		3	2	Blue mussel studies connected to Mats Westerborn's project
2007	Riikonen, Marko	5		The water surface algal films causing optical light phenomena
2005	Rintakoski, Simo	5		Partner selection in the sand goby
2001-2003	Rintala, Janne-Markus	4	36	The ecology of the dinoflagellate <i>Scrippsiella hangoei</i> and the diatom <i>Thalassiosira baltica</i> in the Baltic Sea
2005-2008		4	42	The ecology of mixotrophic dinoflagellates in the Baltic Sea
2009-2010		2,3	10	Biodiversity of Baltic Sea ice algae and ciliates
2001	Roine, Tuomo	5		Heterotrophy and phototrophy in the Arctic and Baltic Sea ice
2000	Rönkkönen Sanna	5		The variation in the growth of the Baltic herring during the 20th century
2002		7	5	Writing an article on the growth of the Baltic herring during the 20th century
2007		4	12	Studies on the content of carbon, nitrogen, phosphate and fatty acids in zooplankton

2005	Rouvinen, Vilma	3	4	Studies on bacteria in the Baltic sea ice by microscopy and with DNA methods
2006		4	12	The structure, annual variation and the influence of DOM and other nutrients in the bacterial community in the sea ice
2000	Ruokanen, Lotta	5		The variation in the growth of the Baltic herring (<i>Clupea harengus membras</i>) during the 20th century
2000	Ruuskanen, Ari	4	8	Ecological responses of <i>Fucus vesiculosus</i> L. along environmental gradients in the northern Baltic Sea
2000-2002		3	34	Perennial macroalgae as indicators on the status of the long-term change in the aquatic environment
2006		2	12	The morphology and ecology of macroalgae, esp. <i>Fucus vesiculosus</i> , in different sea areas
2007		7	6	Preparing manuscripts on material collected earlier, e.g. during the IBP period in the 1960s
2008		3	3	Does increased sea temperature affect reproduction ecology of <i>Fucus vesiculosus</i> in the Gulf of Finland
2001	Salemaa, Heikki	3	4	The population dynamics of macroscopic Crustacean of the northern Baltic Sea
2010	Salo, Elina	5		The effects of fragmentation in the bladder wrack (<i>Fucus vesiculosus</i>) zone on the invertebrate communities
2008	Salomaa, Kaarina	5		Species-specific algal sedimentation, bioturbation and sediment processes
2010	Salonen, Maiju	4	3	The effect of eutrophication on the behaviour ecology of pike larvae (<i>Esox lucius</i>)
2000-2001	Sandberg-Kilpi, Eva	3	3	The bottom fauna of the Pojoviken bay
2009	Sareyka, Jörg	5		Differences in stress tolerance in different species and populations of gammarids – the invasive exotic species <i>Gammarus tigrinus</i> and its influence on the domestic species
2005	Selin, Marita	5		The influence of the increasing mass of filamentous algae on the choice of environment of the larvae of three-spined stickleback
2007	Seppälä, Jukka	3	1	Functioning and nutrient responses of pelagic plankton food webs – a mesocosm experiment
2000-2004	Setälä, Outi	4	46	The role of mixotrophy in the Baltic Sea food webs
2005		4	12	Studies on <i>Dinophysis</i>

2006-2007		2	24	Studies on the role of <i>Dinophysis</i> in the food webs of the Baltic
2008		2	12	Biodiversity and ecology of bloom forming and potentially harmful dinoflagellates in the
				Baltic Sea
2009		3	3	Studies on zooplankton
2008	Sillman, Päivi	5		Allelopathic interactions between spring phytoplankton species
2009		3;2	10	Studies of samples of samples with bacteria, pikocyanobacteria, flagellates and phytoplankton in the project Cyanobacteria interactions with mesozooplankton and the upper trophic levels
2004-2009	Sopanen, Sanna	4	53	Interactions between harmful algae and calanoid copepods in the Baltic Sea
2000	Spilling, Kristian	5		Do nutrients play a role in <i>Peridiniella catenata</i> bloom termination?
2001-2002		4	22	Ecophysiology of winter phytoplankton
2005		4	2	Ecophysiology of winter and spring phytoplankton
2003	Stenfors, Karolina	5		The succession and species composition of diatoms during the spring blooms of 2000 and 2002 in the northern Baltic Sea
2009	Strelkov, Petr	3	3	Re-analysis of the blue mussel <i>Mytilus edulis</i> × <i>M. trossulus</i> hybrid zone in the Baltic Sea, twenty years after
2003-2005	Suikkanen, Sanna	4	7	The influence of cyanobacteria blooms on the phytoplankton communities of the Baltic Sea
2007		4	4	Allelopathic effects of filamentous cyanobacteria on phytoplankton in the Baltic Sea
2005, 2006-2007	Sundström, Annica	5;4	14	The succession of spring blooming dinoflagellates in the northern Baltic Sea and the development of LSU rRNA oligonucleotide technique for molecular detection of the isomorphic species <i>Scrippsiella hangoei</i> and <i>Woloszynskia halophila</i>
2006	Suurkuukka, Heli	5		The reaction of the mud snail (<i>Hydrobia ulvae</i>) to disturbance in the soft sediment bottoms of the Baltic Sea
2008	Tahvanainen, Pia	5		Eukaryotic picoplankton diversity in the western Gulf of Finland
2010	Tahvanainen-Mäenpää, Pia	4	12	The toxic dinoflagellate <i>Alexandrium ostenfeldii</i> in the Baltic Sea – intraspecific diversity and implications for expansion

2005	Tammilehto, Anna	5		Molecular detection of isomorphic "red tide" dinoflagellates in the northern Baltic Sea
2008	Teräsraanta, Laura	5		Fauna communities living on <i>Fucus vesiculosus</i> and the effect of archipelago openness
2008	Tikkanen, Hanna	5		Relationships of optical properties and water colours in the Gulf of Finland
2005, 2007	Torniainen, Jyrki	5, 7	2	Predation pressure of littoral mysids on herring eggs and yolk-sac larvae
2006-2007	Tuomainen, Jaana	4	8	Studies of the sea ice community with molecular biological methods
2000-2001	Uitto, Anna	2	14	Photosynthetic and bacterial carbon pathways in metazooplankton nutrition in the Baltic Sea
2010	Ukkonen, Heini	5		Ecology of Täktbukten, a shallow D442 bay on the south coast of Hangö
2003	Uusikivi, Jari	2	8	Modelling work in the project Baltic Sea ice – processes and interactions
2005, 2007		4	26	Studies on the physical properties of sea ice and the influence of sea currents and turbulence on the ice organisms and how the boundary layer between ice and water affects the organisms
2008		4	7	Interaction between ice physical properties and ice ecology in the Baltic Sea: ice optical properties
2010	Uusitalo, Jasmina	5		Assessing the ecological role of cormorants (<i>Phalacrocorax carbo sinensis</i>) at local scales in a benthic brackish-water ecosystem
2004	Valtonen, Terhi	5		The content and toxic effects of nodularin in the eider duck during its mating season in the western part of Gulf of Finland
2008	Vehmaa, Anu	4	7	Cyanobacteria interactions with mesozooplankton and the upper trophic levels – an integrative approach
2005	Veneranta, Jyrki	5		The occurrence and the habitat of the fry of <i>Coregonus lavaretus widegreni</i> in the eastern part of Gulf of Finland
2008-2010	Vetterli, Adrien	4	33	Diversity and function of microbes involved in the nitrogen cycle in the Baltic Sea sediment
2000-2001	Viherluoto, Maiju	4	15	Food selection and feeding behaviour of Baltic Sea mysid shrimps
2001	Viitasalo,	3	5	Ecology in shallow sea bays

	Markku			
2001	Viitasalo, Satu	5		Survival of copepod eggs after passing through a predator's digestive tract
2003		4	2	The influence of predation by vertebrates and evertebrates on the resting eggs of the copepods <i>Eurytemora affinis</i> and <i>Pseudocalanus elongatus</i>
2008-2009	Viitasalo-Frösén, Satu	3	5	Impacts of the American comb jelly (<i>Mnemiopsis leidyi</i>) on the Baltic food web
2008	Villnäs, Anna	4	10	Disturbance and ecosystem function – the role of changing biological traits for the resilience of benthic communities
2005	Vuoristo, Mikko	5		Organisms associated with blue mussels in localities with different exposition between Hanko/Hangö and Tvärminne
2007	Weckman, Anna	5		Oil and bentso[a]pyrene (BaP) influencing the oxidative stress biomarkers in blue mussels (<i>Mytilus</i> spp.) in laboratory and field experiments
2001-2004	Westerbom, Mats	4	38	Factors influencing the distribution of blue mussel <i>Mytilus</i> near its limit of occurrence
2007		3	5	Blue mussel studies in the Tvärminne area
2004	Westerlund, Antti	5		Langrangian follow-up of dissolved organic matter in the Baltic sea that emanates from the
2007	Yli-Renko, Maria	5		The behaviour of the three-spined stickleback (<i>Gasterosteus aculeatus</i>) during cyanobacteria blooms
2004-2006	Ylöstalo, Pasi	4	22	The strategies for acclimatisation and the dynamics of the cyanobacteria of the Baltic Sea
2007-2009		4	20	Photosynthetic parameters of the Baltic Sea phytoplankton and primary production models