The archaeology of WINGS

Birds and people in the Baltic Sea region during the Stone Age

by

Kristiina Mannermaa

Academic dissertation

To be publicly discussed, by due permission of the Faculty of Arts at the University of Helsinki, in auditorium XII, on the 13th of June 2008 at 12 o´clock.

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Contents

Original papers

This dissertation is based on the following papers, which are referred to in the text with Roman numerals:

I Mannermaa, K. 2002. Bird bones from Jettböle I, a site in the Neolithic Åland archipelago in the northern Baltic. In: Bochenski, Z.M., Bochenski, Z., & Stewart, J. R. (Eds.) Proceedings of the 4th Meeting of the ICAZ Bird Working Group, Krakow, Poland, 11-15 September, 2001. *Acta zoologica cracoviensia* 45 (special issue), 85-98. (Reprinted with permission by Institute of Systematics and Evolution of Animals, Polish academy of Sciences)

II Mannermaa, K. 2003. Birds in Finnish prehistory. *Fennoscandia archaeologica* XX, 3-39. (Reprinted with permission by the Archaeological Society of Finland)

III Mannermaa, K. & Storå, J. 2006. Stone Age exploitation of birds on the Island of Gotland, Baltic Sea. A Taphonomic Study of the avifauna. *International Journal of Osteoarchaeology* 16, 429-452. (Reprinted with permission by John Wiley & Sons Ltd.)

IV Mannermaa, K & Lõugas, L. 2005. Birds in the subsistence and cultures on four major Baltic Islands in the Neolithic (Gotland, Åland, Hiiumaa and Saaremaa). In: Grupe, G. & Peters, J. (Eds.) Feathers, Grit and Symbolism. Birds and Humans in the Ancient Old and New Worlds. *Documenta Archaeobiologiae* 3, 179-198. (Reprinted with permission by Verlag M. Leidorf, Rahden/Westf.)

V Mannermaa, K. In press. Birds and burials at Ajvide (Gotland, Sweden) and Zvejnieki (Latvia) about 8000-3900 BP. *Journal of Anthropological Archaeology*. (Reprinted with permission by Elsevier)

Preface

My interest in archaeology began seriously in 1992 during my period as a student of Spanish in Salamanca, Spain. Visiting magnificent caves with Paleolithic rock art such as El Buxu and Tito Bustillo in Asturias changed my life in few weeks. At that time, I was a student in geography at the University of Helsinki (Faculty of Mathematics and Natural Sciences), and dedicated to my MA degree about issues concerning developing countries and in particular, Latin America. However, the burning interest in past societies had arisen, and I decided to begin studies in archaeology as a secondary subject in Finland. Later I became interested in osteoarchaeology. After having conversations with Pirkko Ukkonen, I chose to specialize in animal osteology. After finishing my studies in geography in 1998, I worked as an osteologist on various archaeological projects, mainly analyzing bone materials from excavations. In 2001, I received official permission for doing a PhD in the Faculty of Human Sciences.

First of all, I want to thank my supervisor Pirkko Ukkonen (Department of Archaeology and Ancient History, Historical Osteology, University of Lund) for all her help, advice and patience during this project. She was the one who first advised me in to specialize in avian osteology and she, in the initial phases, led me to the world of osteology. Jyrki Pynnönen, a friend and an enthusiastic ornithologist, was one of the first interested in the topic of the first appearances of bird species in Finland. His encouragemnt was important for me in choosing birds for the subject of an archaeological study. Two other persons also had significant impact during the early phase of this project: the late Ari Siiriäinen, Professor of Archaeology and the late Ann Forstén, Professor of Zoology (both at the University of Helsinki) are thanked for their encouragement, trust and support. My second supervisor, Professor of Archaeology Mika Lavento (Institute for Cultural Research, University of Helsinki) has always been positive and optimistic towards my work. I am especially grateful for his scholarly help and support during the last phase of the project. Professor Milton Nuñez (Department of Art Studies and Anthropology, University of Oulu) has supported my work and helped me with different kinds of scholarly matters. Petri Halinen is kindly thanked for various academic discussions over the years, as well as valuable comments on a previous version of the manuscript. My co-authors, head of the Laboratory Lembi Lõugas (Geoarchaeology and Ancient Technology, Institute of History, University of Tallinn) and Associate Professor Jan Storå (Archaeozoology Laboratory, University of Stockholm) are cordially thanked for their friendship and fine cooperation. They both have also helped me in many ways in enabling me to study the archaeological bird bone materials from Estonia, Åland and Gotland for the present study. I am grateful to Ilga Zagorska (Institute of Latvian History at the University of Latvia) for providing access to the Zvejnieki material and the fine assistance over the years we have known each other.

Several persons working at the Natural History Museum, University of Helsinki have helped me in various practical matters for which I am grateful. Risto Väisänen and Juhani Lokki have been kind enough to let me work with the osteological collections. Both also deserve to be praised for taking an initiative in organizing the basis of a bird bone reference collection. Martti Hildén and Aulikki Järvikivi are to be credited with the realization of this collection in practice. Torsten Stjernberg is thanked for interesting discussions during our common time on the fourth floor of the Zoological Museum, and Seppo Sulkava for teaching me avian osteology. I also want to thank Roni Andersson and other staff in the Taxidermy Department for helping and supervising me in cleaning skeletons and bones.

The work with the Ålandic bone materials was made possible by Antiquarian-in-Chief Marita Karlsson (Museibyrån/Arkeologi, Mariehamn). Silvana Fagerholm, Niklas Stenbäck, Rudolf Gustavsson, Niklas Stenbäck, Kim Darmark and Jan-Erik Tomtlund (all from the Museibyrån/Arkeologi, Mariehamn) are thanked for their company and interesting discussions during the fieldwork on Åland in 2000–2001. I would also like to thank the Antiquarian Kenneth Gustavsson (Museibyrån/Arkeologi, Mariehamn) for letting me work with the Otterböte material. The stays on Signilskär in the Åland Archipelago have helped me to get in touch with an environment not too far from what prehistoric Åland might have had. I thank Jörgen Eriksson and Ålands Fågelskyddsförening for letting me stay and work at the bird ringing station at Signilskär.

I thank the late Inger Österholm, Göran Burenhult and Johan Norderäng, all at University College Gotland for access to the Ajvide assemblages.

The analysis of the materials for this dissertation would perhaps not have been possible without two fellowships. In 2002–2003, I was able to analyze bird bones for two months at the Zoological Museum in Copenhagen and two months in the Swedish Museum of Natural History in Stockholm. Those visits were made possible by Programmes COBICE (Copenhagen Biosystematics Center) and High Lat (Swedish Museum of Natural History) (both funded by European Community – Access to Research Infrastructure action of the Improving Human Potential Programme). I thank the museum staff, friends and colleagues Gitte Gotfredsen, Inge Bødger-Enghoff, Kim Aaris-Sørensen, Jeppe Møhl and Knud Rosenlund for various kinds of help and good company during my stay in Copenhagen. I am gratefult to the staff at the Swedish Museum of Natural History, and especially Per G.P. Ericson, Peter Mortensen, Olavi Grönwall and Jorma Uusitalo for all their help. Professor Elisabeth Iregren and Ola Magnell in Lund (Department of Archaeology and Ancient History, Historical Osteology, University of Lund) are thanked for their friendship and scholary assistance.

I want to express thanks to my colleagues at the Institute for Cultural Research, Department of Archaeology: Anna Wickholm, Eeva-Maria Viitanen, Mikael Manninen, Antti Lahelma, Teemu Mökkönen, Vesa-Pekka Herva, Sanna-Maria Kivimäki, Tuija Kirkinen and Mervi Suhonen. This work has gained much from your support, discussions and company over the years. All members of the seminar for graduates in Department of Archaeology at the University of Helsinki are thanked for comments

and fruitful discussions about my dissertation. The office secretary Tuovi Laire has not only been always willing to help in different ways, but has also been great support and company during my years at the Department of Archaeology.

Eeva-Kristiina Harlin assisted me in gathering bird material at the Osteological Laboratory, Stockholm University, which was of great help. The following persons have also provided valuable aid: thanks to Professor Mikael Fortelius (Institute of Biotechnology, Department of Geology, University of Helsinki), Professor Jussi-Pekka Taavitsainen (School of Cultural Research, Department of Archaeology, University of Turku), and Päivi Pykälä-aho, Leena Ruonavaara, Eeva-Liisa Schulz, Sirkka-Liisa Seppälä, Petro Pesonen, Kaarlo Katiskoski and Markku Torvinen (Finnish National Board of Antiquities, Department of Archaeology).

Professor Norbert Benecke (The German Archaeological Institute DAI) and University lecturer Jari Okkonen (Department of Art Studies and Anthropology, University of Oulu) are gratefully acknowledged for evaluating the dissertation before it was published.

I am grateful for the financial support of various foundations. My first grant was provided by the Maj and Tor Nessling Foundation in the year 2000. In the years 2002–2003, I was generously provided two one-year grants from the Finnish Cultural Foundation. In 2004, before our first baby was born in September, my work was funded by the Ella and Georg Ehrnrooth Foundation. Returning to the dissertation after a 1.5-years maternity leave in year 2006 was made possible by a post as a PhD researcher in the Finnish Graduate School in Archaeology and a grant by the Nordenskiöld stiftelse. The Swedish-Finnish Cultural Foundation has acknowledged me with grants in 2000 and 2003 for travel expenses, which enabled me to do the research on the settlement materials from Ajvide (on Gotland and in Stockholm). The grave material in Ajvide was studied with support for travel expenses from the Finnish Graduate School in Archaeology. The grants for travel expenses for various conferences and meetings were provided by the Finnish Concordia Foundation and the University of Helsinki. Funding for radiocarbon dates was provided by Oskar Öflunds Stiftelse and the Finnish Graduate School in Archaeology.

Finally, I want to express my gratitude to my family. This dissertation would never have been finished without my husband Antti, who has offered a lot of help and support, and stood by my side during better and worse periods of the project. His extensive knowledge of animal ecology and environmental questions, as well as his scientific enthusiasm has been a great support during this project. Our son Ahti and daughter Sirri are thanked for being so wonderful. I thank my father Tuomo, and my sisters Hanna and Rauna, and my brother Lauri for support and encouragement. The Clusius family (Rauna, Petri, Tuomas and Tuure) have saved me many times by offering babysitting for Ahti. Petri Clusius has kindly designed and realized the layout of this book.

Margot Stout Whiting has proofread the manuscript of the summary and papers II and V and corrected my English.

Abstract

In this doctoral dissertation bird bone material from various Stone Age sites in the Baltic Sea region is investigated. The study period is approximately 7000–3400 BP, comprising mainly Neolithic cultures. The settlement material comes from Finland, Åland, Gotland, Saaremaa and Hiiumaa. Osteological materials were used for studying the economic and cultural importance of birds, fowling methods and principal fowling seasons. Birds in burials at two large cemeteries, Ajvide on Gotland and Zvejnieki in northern Latvia were investigated in order to study the roles of birds in burial practices. Despite usually low numbers of bird bones in osteological materials from prehistoric sites, it could be shown that waterbirds and several grouse species were economically important in the Stone Age cultures of the study area. The breeding period was the main fowling period in the Baltic Sea area during the Stone Age. Fowling has been most important in coastal areas. The burial finds indicate that some common ideas about waterbirds (perhaps as messengers or spirit helpers) might have existed in the northern European Stone Age.

Keywords: birds, bones, prehistory, Neolithic economy, Baltic Sea area, prehistoric fowling, animals in graves

1. Introduction

It is known from ethnographic sources that birds played important roles in the subsistence of various northern cultures (e.g., Anisimov 1991; Napolskikh 1992; Storå 1966, 1968). These prominent roles of birds are not, however, well reflected in archaeology. It is common for archaeological studies in northern Europe not to mention fowling in discussions of subsistence (e.g., Götherström *et al.* 2002:262; Pesonen 2002:27; Kriiska & Tvauri 2007:70–72), or they suggest a marginal role for fowling (e.g., Ekman & Iregren 1984; Forsberg 1985:25; During 1987:140; Gumiński 2005:130, 141). Absence or scarcity of birds in the bone assemblages have often been seen as an indication of the minor role of birds in the economy or belief system, or explained by taphonomic loss (e.g., Aaris-Sørensen 1980:146; Moora & Lõugas 1995:478; Ukkonen 1996a:74; Segerberg 1999:191; Nuñez & Okkonen 1999:113; Kotivuori 2002:149 [unpubl.]). Some studies do, however, propose an important role for birds (e.g., Matiskainen 1989a; Nuñez 1991; Nuñez & Gustavsson 1995:241; Nuñez & Storå 1997:152; Nuñez & Okkonen 1999:113–114; Kriiska 2001:17; Stenbäck 2003:205; Okkonen 2003:224; Eriksson 2004). This is specially suggested for islands and coasts, and for specific seasons (e.g., Storå 1968; McCartney 1975; Brothwell *et al.* 1981; Serjeantson 1988; Nuñez & Gustavsson 1995:241). Nuñez & Gustavsson (1995, see also Nuñez 1996:29–32) emphasize the significance of recurrent places of open water in the hunting of waterbirds in winter and early spring. Most of the papers on fowling and utilization of birds in prehistoric Europe deal with individual sites or a couple of sites with similar cultural backgrounds. This is especially true for early 20th century approaches, but even today, few studies exist where birds are a basis for more extensive archaeological investigation (e.g., Sutherland 1986 [unpubl.]); Gotfredsen 1998; Daugnora *et al.* 2002; Gumiński 2005), or where archaeological bird remains are studied in a larger area (e.g., Piehler 1976 [unpubl.]).

Bones of birds, like those of other animals, have been found in different archaeological contexts (e.g., Larsson 1989; Kannegaard Nielsen & Brinch Petersen 1993; Jennbert 2003a; Facciolo & Tagliacozzo 2006). Animal bones found in human graves can often be connected to the burials (e.g., Zagorskis 1987, 2004; Larsson 1989; Burenhult 2002, but see also Mannermaa *et al.* 2007), but it may be difficult to find direct evidence for animal use at settlement sites. Mammal bones in human graves from the Mesolithic and Neolithic have often been studied and interpreted in detail (e.g., Larsson 1989; Zagorska & Lõugas 2000; Morey 2006; Bäcklund Blank & Fahlander 2006; Munt & Meiklejohn 2007), but bird remains in human burials have not been discussed with such precision (but see Jaanits 1961; Janzon 1974; Mannermaa 2006).

The utilization of birds in the Stone Age, within the perspective of the Baltic Sea area, has not been comprehensively investigated before. Bird bones in archaeologi-

cal contexts can provide information about hunting preferences, burial practices and even indicate the roles of birds in belief and ideology systems, or in social organization (e.g., clan totemism). Birds are also interesting in archaeology because they can give rather detailed information about the ecological setting or the hunting season (e.g., Serjeantson 1988; Eastham 1997; Pike-Tay *et al.* 2004; Gál 2006). In modern zooarchaeology, animals – mammals, birds, fish and invertebrates – are considered as a potential part of the economy, culture and ideology of prehistoric societies (e.g., Serjeantson 1997; Jennbert 2003b; Jones O'Day *et al.* 2004; Pluskowski 2005; Bartocievitz 2005; Marciniak 2005; Fiore & Zangrando 2006; Pollard 2006).

The rather scarce archaeological evidence presented in this dissertation should partly be seen as a reminder that birds were also part of everyday life in prehistoric times. Birds were seen and heard daily and their behavior may have affected peoples' daily activities. Bird song filled spring and summer mornings and the first restlessness of migratory birds in late summer was a sign of approaching autumn. In certain places and during some seasons, they were an important source of food and raw materials, but birds were also present in areas where they were not actively exploited. Birds were a natural resource, in a concrete and rhetorical way, and they – I believe – also had a role in how people perceived their environments.

Traditional methods of investigating prehistoric diet are studies of animal bones found at settlement sites, and analysis of stable carbon and nitrogen isotopes from human remains in graves (e.g., Lidén 1995; Lidén *et al.* 1995; Budd *et al.* 2003; Eriksson 2003). Chemical analyses from the crust deposited in pottery sherds have also provided good results for the investigation of prehistoric diets (e.g., Leskinen 2003). The diet of prehistoric groups is affected by several ecological and cultural factors. We do not know how much a certain group of people could follow their own choices or preferences or how much they had to make use of almost all available resources. Seasonal, periodical and yearly variation of resources affected dietary choices (Minc & Smith 1989), and there may have been several categories for animals according to their share in the diet. For example, Lee (1972) has listed the status of plant food of !Kung Bushmen for primary, major, minor, supplementary, rare and problematic species. Similar ranks may have existed for animal food among prehistoric groups. Staple foods usually vary throughout the year. Suitability of meat for storage purposes may affect the food choices (Ingold 1986:198–221; Rowley-Conwy & Zvelebil 1989).

Food has essential meaning in life. Eating is a social act and a basic need. Attitudes towards food may be strictly regulated in a society, and some animals were perhaps eaten or not eaten because of ideological beliefs. Guiding, restricting and supporting taboos and rituals have always been connected to food and eating (e.g., Parker Pearson 2003; Jones & Richards 2003; Insoll 2004:75–76; Marciniak 2005:61–74). From historical evidence we know, for example, that meat of the common crane (*Grus grus*) was eaten by the Saami in Finnmark but it was considered unclean by the Skolt Saami and was not eaten (Itkonen 1948:36,370; Paulaharju 1961:118–119). The concept of what is edible changes from society to society and should be never estimated from the

perspective of another society (Cott 1947; Parker Pearson 2003:4). Archaeological and ethnographical data indicate that rituals and taboos can be connected to food and eating (e.g., Parker Pearson 2003; Janik 2003; Jones & Richards 2003; Insoll 2004:75–76). Food in itself may be conceded a high social and symbolic value particularly among hunting societies, and the eating of certain animals may have followed a very strict ritual code or order (Jackson & Scott 2003:553; Kansa & Campbell 2004; Serjeantson 2006).

Outline and aims of the dissertation

The focus of my dissertation is to investigate the use and importance of birds in the subsistence in prehistoric, mainly Stone Age, Finland, Åland, Estonia and Gotland (Fig. 1B). Ritual and ideological roles are also investigated, mainly based on two cemeteries, Ajvide on Gotland and Zvejnieki in Latvia. The idea is to study how birds were utilized by humans in a large geographic area in order to see general economic, ecological and cultural differences and similarites.

The study is based on four published articles (Papers I-IV) and one article in press (Paper V) dealing with birds and the relationship between birds and humans. The main interest is studying in what ways birds were utilized by humans, how much birds may have contributed to human diet at different sites, and what can be said about the ideological aspects of birds and the relationship between birds and people in the area studied. I start my dissertation by looking at one of the most famous Neolithic sites in Finnish prehistory, Jettböle I (Paper I). The site is located in Åland Islands and represents groups of Scandinavian Pitted Ware culture, which (as a culture) never entered continental Finland (but see Miettinen 1999; Laulumaa 2004). Osteological material from Jettböle I is very well preserved, but Stone Age bone materials from the Finnish mainland are poorly preserved and consist of burnt bone fragments. It is well known that such material is not the best for making precise quantative interpretations about animal utilization (e.g., Ukkonen 1996a, 2001, but see also Siiriäinen 1981; Matiskainen 1989a; Hiekkanen 1990; Halinen 2005). However, the relative large number of osteological studies allows the identification of major patterns of bird usage. The aim of Paper II is to gather the available information from Finnish sites and to interpret fowling during different periods. Finnish archaeological bird finds have not been reviewed thoroughly before this.

The third study was written together with Jan Storå and deals with the settlement site Ajvide on the west coast of the island of Gotland, Sweden (Paper III). Our responsibility in the paper was divided so that I did the taxonomic identification of the bird bones and conducted the fracture analysis. The fracture analysis was repeated by Storå. Cultural and natural marks on bones were investigated together. The preliminary version of the manuscript was written by me but the final version of the paper was co-authored. The bird bone material from Ajvide is well preserved but derives from a large excavation area. Ajvide, like Jettböle I, represents the Middle Neolithic

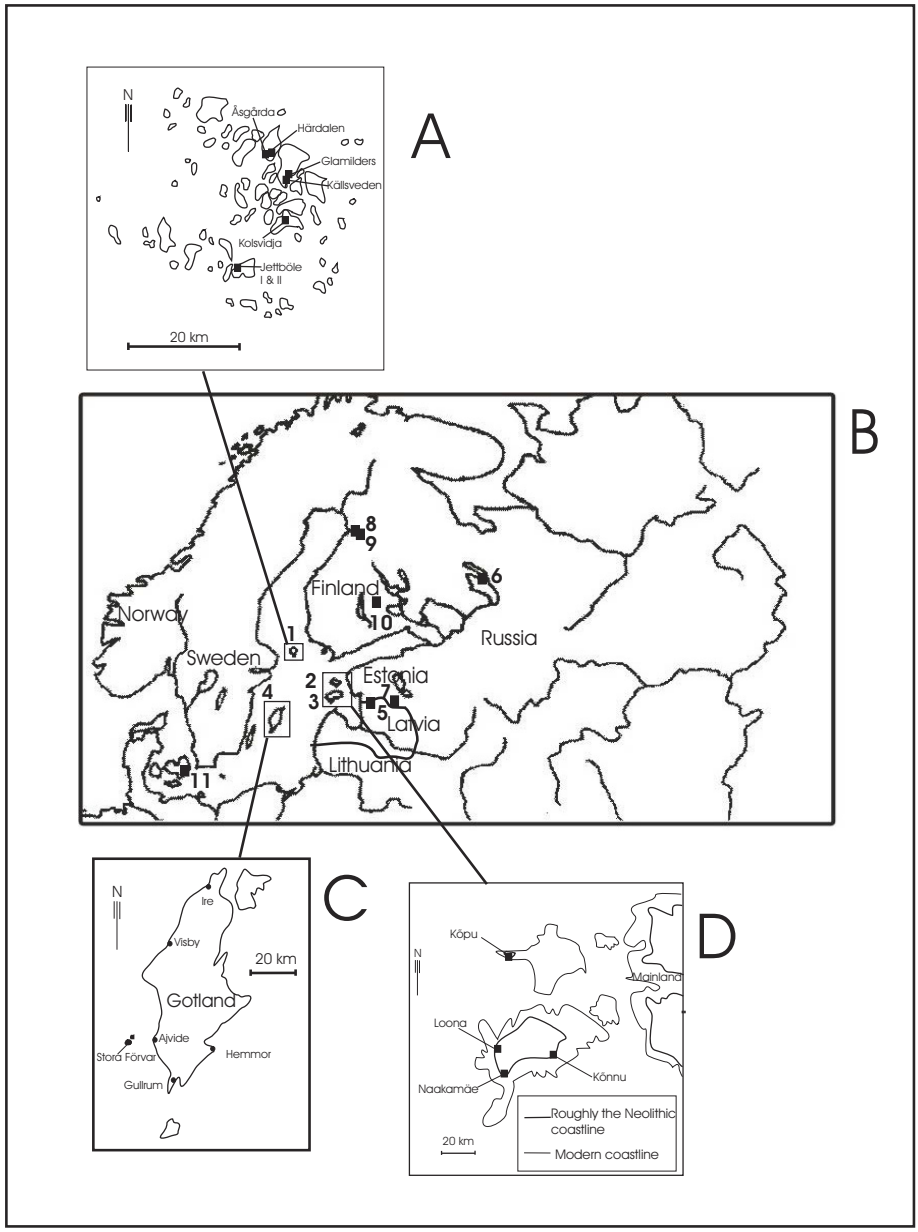

Fig. 1. *The research area and the important sites.*
A. *Map of the Åland Islands during the Neolithic and the location of the sites discussed in this study. The shoreline follows roughly 30 m.a.s.l., dated to the later phase of the Pitted Ware Culture. Adapted from a drawing by Jan-Erik Tomtlund.*
B. *1= Åland, 2= Hiiumaa, 3=Saaremaa, 4=Gotland, 5=Zvejnieki, 6=Yuzhniy Oleniy ostrov, 7=Tamula, 8=Yli-Ii Kierikki, 9= Ylikiiminki Vepsänkangas, 10=Joroinen Kanava, 11= Vedbæk Bøgebakken.*
C. *Map of Gotland and the location of the sites discussed in this study. Modern shoreline.*
D. *Map of Islands of Hiiumaa and Saaremaa and the location of the sites discussed in this study. Adapted from Kriiska 2001.*

Scandinavian Pitted Ware culture. The main aims of this paper were to make a taphonomic study on bird bones in order to investigate the origin of the bird bone material, and to interpret the roles of birds in the subsistence economy and life of Ajvide inhabitants. Environmental areas around the settlement as well as seasonality of the settlement are also discussed.

In the fourth component of this dissertation, fowling is investigated in a wide perspective and alongside other parts of the economy, the hunting of mammals and fishing (Paper IV). The study area includes four main islands in the central part of the Baltic Sea (Åland, Gotland, Saaremaa and Hiiumaa). I have identified some of the bones included in the study (samples from Åland, Ajvide and some of the samples from Saaremaa and Hiiumaa), and my co-author, Lembi Lõugas has identified the rest of the bone material (samples from Kõpu in Hiiumaa and Kõnnu in Saaremaa). The first version of the manuscript was written by me but the final version was co-authored. In order to better understand the exploitation of birds, we have included mammals and fish materials in the study. A large amount of this data has been taken from literature. The main aims were to compare the utilization of birds in these islands, and to investigate the cultural and ecological factors affecting the intensity of bird utilization.

The final component deals with birds in Neolithic burials (Paper V). Two sites, Middle Neolithic Ajvide and multiperiod Zvejnieki in Latvia are in focus, but also some other important burial sites are discussed. The goal of this study is to investigate the roles of birds in mortuary practices, and the ideological significance of birds for these societies. Some of the bones in Zvejnieki have been radiocarbon dated in order to study the depositional history and the origin of bird bones in burials.
This dissertation is an overview of the relationship between humans and birds in prehistoric Baltic Sea area. The main questions can be crystallized in the following:

- How did people utilize bird fauna during the Neolithic Stone Age in the Baltic Sea area and which factors affected their choices?
- How important was fowling in the Stone Age economy at the studied sites?
- How does the utilization of birds differ at sites in diverse ecological settings in the Baltic Sea area?
- What kinds of symbolic meanings were connected to birds and how could bird remains reflect ideology?
- What can bird data say about the living environments, fowling methods or the material culture?
- How can the depositional history of bird bones be studied and what is the importance of taphonomic investigation in avian archaeozoological studies?

A brief outline of the subsistence economy and animals in graves in Stone Age Finland, Åland, Gotland and Estonia

The fishing and hunting of large land mammals at inland sites and seals at coastal sites have been considered the main source of livelihood of the Stone Age non-agrarian groups in the Baltic Sea area (Siiriäinen 1981, 1982; Ekman & Iregren 1984; Matiskainen 1989a, 1989b; Hiekkanen 1990; Nuñez 1991; Ukkonen 1996a, 1996b, 1996c; Storå 2001; Kriiska 2001). Domestic animals were introduced to the Finnish mainland only during the Late Neolithic Kiukainen Culture (Ukkonen 1999; Lang 1999) (For the chronology of the prehistoric periods in the research area, see Fig. 2). Land mammals

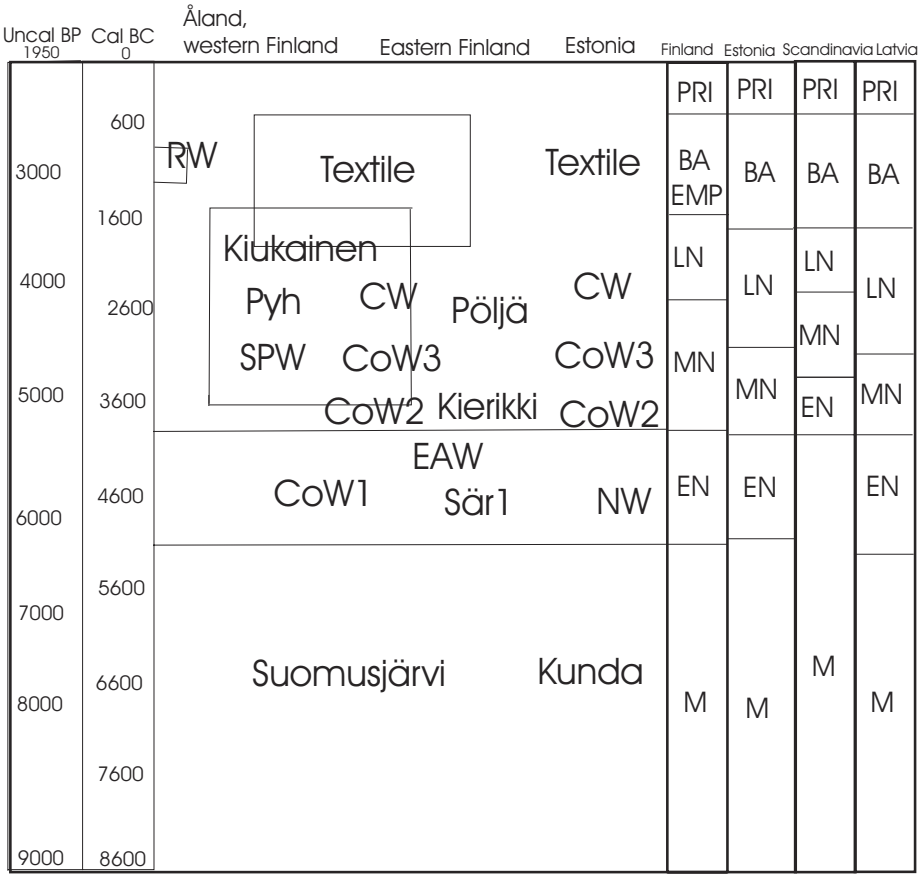

Fig. 2. *A rough prehistoric chronology of the study area, cultures and archaeological periods. Abbreviations: NW=Narva Ware, Sär 1=Säräisniemi 1 Ware, EAW=Early Asbestos Ware, CoW1=Early Comb Ware, CoW2=Typical Comb Ware CoW3=Late Comb Ware, SPW=Scandinavian Pitted Ware, Pyh=Pyheensilta Ware, Kierikki=Kierikki Ware, CW=Corded Ware, Kiukainen=Kiukainen Ware, Textile=Textile Ware, RW=Rusticated Ware, M=Mesolithic, EN= Early Neolithic, MN= Middle Neolithic, LN= Late Neolithic, EMP=Early Metal Period, BA=Bronze Age, PRI= Pre-Roman Iron Age. Modified from Lang 1999, Carpelan 1999, 2000, 2002, Kriiska 2001, Rankama & Ukkonen 2001.*

are present in the refuse faunas from the coastal Mesolithic and Neolithic sites in Finland, but seals seem to predominate in the bone assemblages (Forstén 1972; Forstén & Blomqvist 1977; Zvelebil 1981; Siiriäinen 1981; Matiskainen 1989a; Leskinen 2003). European elk (*Alces alces*) and beaver (*Castor fiber*) were the most important mammals hunted in the Stone Age inland sites of eastern Finland, but freshwater fishing probably provided the primary food supply here (e.g., Ukkonen 1996a:78; Mökkönen 2001, 2002; Nurminen 2007). Fishing and the hunting of the wild reindeer (*Rangifer tarandus*), beaver, European elk and seals (Phocidae) were important at Stone Age sites in northern Finland (Kotivuori 2002 [unpubl.]; Ukkonen 2004; Halinen 2005).

The Middle Neolithic Scandinavian Pitted Ware culture on the Åland Islands seems to have been based on marine resources. In their animal utilization, people concentrated on seal hunting, fishing and fowling (Storå 2000). Occasional bones from domestic mammals identified in the Middle and Late Neolithic materials from Åland indicate that these animals had been introduced, but did not have significant economic importance (Paper IV, Lidén 1995; Storå 2000).

The animal food economy among Gotlandic Scandinavian Pitted Ware Culture seems to have had a more diverse basis than on the Åland Islands, but fish and seals were also principal prey for them (Rowley-Conwy & Storå 1997; Storå 2001, 2002; Eriksson 2004). Domestic animals are present in assemblages, but not in such magnitude that it would indicate intensive animal keeping on Gotland (Storå 2002).

Osteological and stable carbon isotope studies point to a high dependence on marine resources on the Estonian islands during the Stone Age (Lõugas *et al.* 1996a; Kriiska 2001). The year-round base of subsistence is not easy to study because most of the sites on Saaremaa and Hiiumaa have been interpreted as seasonal settlements or hunting camps (Jaanits *et al.* 1982; Lõugas 1997b; Kriiska 2001). Animal bones at Estonian sites indicate that the list of game animals was more variating during the Neolithic than during the Mesolithic. At inland sites, people hunted mainly European elk, beaver and wild boar (*Sus scrofa*) (also fishing and fur animal hunting were important), while on the coasts people relied more on seals and fish (Kriiska & Tvauri 2007:70–72). The Loona site on Saaremaa is quite special because there the hunting of wild boar or domestic pigs seems to have been significant during the Corded Ware phase (Lõugas *et al.* 1996a, Lõugas *et al.* 2007).The spread of the cereals and domestic animals took place over a relatively long period – between 5000–2700 cal BC in Estonia (Lõugas *et al.* 2007). However, agriculture as a basis for subsistence had developed only in the Middle part of the Bronze Age, about 1000 cal BC (Lõugas *et al.* 2007)

Animal remains are commonly found in Stone Age graves in northern Europe. Artifacts made of bone, antler and teeth are most common, but also unmodified animal bones are sometimes found in graves. The presence of unmodified animal remains in burials has been frequently interpreted as remains of meals (consumed during the funeral or intended for the dead or for spirits) (Larsson, 1989; 1990; Burenhult, 1997a:60; Kriiska & Tvauri 2007:62). Tooth pendants have been interpreted as parts of necklaces or other decorations on clothes and garments such as headgear, belts

and pouches. They may also have carried symbolic significance as part of an animal cult (e.g., as hunting trophies) or some kind of special protective items (Jaanits, 1957; Larsson, 1989, 2006; Zagorska & Lõugas, 2000: 227, 242). Knowledge about the roles of animals in burial practices in northern Europe are mostly based on cemeteries with well-preserved osteological materials like Late Mesolithic Vedbæk Bøkebakken in Denmark, Skateholm in southern Sweden, Yuzhniy Oleniy ostrov in Lake Onega, Russia, or Neolithic cemeteries like Tamula in southern Estonia, and Ajvide and Ire on Gotland. One of the best studied Stone Age cemeteries in northern Europe is Zvejnieki in northern Latvia. Here the use and significance of animal bones in decoration and ideology have been studied with detailed analyses of modified and unmodified bones (Zagorska & Lõugas 2000; Larsson 2006; Lõugas 2006; Mannermaa 2006), as well as zoomorphic figurines (e.g., Wyszomirska 1984; Zagorskis 1987, 2004; Iršėnas 2000; Zagorska 2000). In contrast with some neighboring areas, the lack or scarcity of preserved bones in Stone Age burials in Finland prohibits the interpretation of uses of animals in burial practices (Edgren 1993:59–65, 2006; Halinen 1999; Katiskoski 2004).

Most of the articles dealing with animal bones in human graves concentrate on mammal species. For example, the presence of dogs in human burials or various separate dog burials have been widely discussed (e.g., Larsson 1989; Kannegaard Nielsen & Brinch Petersen 1993; Bäcklund Blank & Fahlander 2006; Morey 2006). The roles of birds in burial practices have not been investigated before this study. Gurina (1956) gives a detailed list of the mammal species found in the Yuzhniy Oleniy ostrov burials, but bird and fish bones, although present, were not at all analyzed to species (but see Mannermaa *et al.*, forthcoming). Mammal and fish bones at Late Mesolithic Skateholm are discussed and mentioned in several papers (e.g., Jonsson 1986, 1988; Larsson 1989), but bird bones are not. One exception is the study of Gunborg Janzon (1974) where she gives a detailed description and analysis of tubular bird bone beads from Middle Neolithic graves at Ire and Visby on Gotland. However, even here no analysis of bird species is given (although some general notes on bird taxa supplied by osteologist Johannes Lepiksaar are mentioned).

Trends in (avian) zooarchaeology

The present study is among the first zooarchaeological doctoral dissertations in Finland. It continues the long archaeo-osteological research tradition in northern Europe. The history of archeo-osteological research in Finland started near the end of the 19th century, when zoologists J.A. Palmén and D.A. Wikström analyzed material from Iron Age graves in Karelia (Schwindt 1893). The material consisted of bones from domestic and wild mammals, but also fish and domestic chicken, *Gallus gallus* were identified. The archaeologist Theodor Schwindt interpreted fish bones as probable food remains from ritual meals connected to mortuary activities, but did not give any interpretation for chicken bones (Schwindt 1893:192). Almost 20 years later, the Danish zoolo-

gist Hertluf Winge identified mammal, bird and fish bones from Stone Age sites in Karelia and from the Middle Neolithic site Jettböle I on Åland (Ailio 1909; Winge 1914 [unpubl.]). The investigation of animal bones from Finnish archaeological sites began a new era in the 1970s and 1980s when zoologists Ann Forstén and later Mikael Fortelius started cooperarating with archaeologists (e.g., Forstén 1972; Fortelius 1981). In this period, the Stone Age hunting economy was discussed in a number of papers based on the relatively few available osteological analyses of Finnish settlement sites (e.g., Zvelebil 1981; Siiriäinen 1981; Matiskainen 1989b). A more detailed picture of the Stone Age hunting economies was gathered systematically only in the 1990s when a number of papers were published in connection with two multidisciplinary research projects. One concentrated on eastern Finland and the other on northern Finland (Ukkonen 1996a; 1996b, 1996c, 2004; Kirkinen 1996a, 1996b; Lavento 2004).

Compared to Finland, archeo-osteology has a stronger tradition in Scandinavia and Estonia. Osteological analyses of archaeological materials in Scandinavia were, in the initial phase, made by zoologists and often used in faunahistorical studies, along with geological animal finds (e.g., Ekman 1922; Degerbøl 1933; Løppenthin 1955; Liljegren 1975). Economic utilization of birds and other animals was discussed in a number of articles (e.g., Winge 1900; Degerbøl 1942). A similar trend can be seen in Estonia where the earliest archaeo-osteological analyses were made by geologists and palaeozoologists (e.g., Constantin Grewingk, Kalju Paaver, and Johannes Lepiksaar) (Kriiska & Lõugas 2006).

Somewhat later, the famous archaeologist Grahame Clark (1948) published a major review of prehistoric fowling in Europe. This seminal paper summarized the knowledge of prehistoric fowling in a comprehensive way that had not been attempted before. Elliot W. Dawson (1963) reviewed the use of bird remains in archaeology with an extensive geographical summary. Dawson (1963:259) stressed that birds are often seen as difficult to determine as to species mainly because of the lack of high quality comparative skeleton collections in museums. Thus, one of the main reasons, as suggested by Dawson (1963:259), for the neglect of bird remains in archaeology was the lack of adequate collections and interested specialists.

Methods of bird skeleton identification have progressed since the times of Clark and Dawson. Several groundbreaking dissertations written in the Palaeoanatomical Institute of Ludwig-Maximilians-Universität Münich (e.g., Bacher 1967 [unpubl.]; Woelfle 1967 [unpubl.]; Erbersdobler 1968 [unpubl.]; Kraft 1972 [unpubl.]) are important in this respect. More recent studies concerning species identification, appropriate reference material and analysis methods in general are those by von den Driesch (1976), Gilbert *et al.* (1996), Bocheński (1994), Baumel & Witmer (1993) and Cohen & Serjeantson (1996). The founding of the International Council of Archaeozoology (ICAZ) in 1975 and later, its special bird working group, opened up a new era for archaeo-ornithological research (e.g., Bocheński *et al.* 2002; Grupe & Peters 2005).

Since the 1980s and 1990s zoologists, paleontologists and archaeo-osteologists in Scandinavia, Estonia and Finland have been working in intensive cooperation with

archaeologists. Many researchers have worked with archaeological bird materials alongside mammals and fish, in order to study faunal history and archaeological questions, (e.g., Kim Aaris-Sørensen [1978, 1980, 1988], Lembi Lõugas [1997a; Lõugas *et al.* 1996a, 1996b, Veski *et al.* 2005; Lõugas *et al.* 2007], Pirkko Ukkonen [1996a, 1996b, 2001, 2004]). The work of specialized bird osteologists, like Anne Karin Hufthammer (Montevecchi & Hufthammer 1990), Per G.P. Ericson (1987a, 1987b, 1988, 1989; Ericson & Tyrberg 2004), Leif Jonsson (1988), Anne Birgitte Gotfredsen (1998) and Liv Ljungar (1996 [unpubl.]) has improved our knowledge of the history of bird fauna in Fennoscandia and Baltic countries, as well as the human exploitation of birds in prehistory.

For a long time, the study of animals in archaeology dealt mostly with questions about subsistence (e.g., Grant 2002). In the 1960s and 1970s, animals were interpreted within an economically-focused framework, emphasizing cost-efficiency and environmental determinism. Typically, zooarchaeologists saw bones in settlement sites as remains of food or as raw material for artifacts. From about the 1980s, postprocessual archaeology, and the increasing interest in social and cultural matters in prehistoric life, emphasized the need for a more diverse perspective on animals. Following this tendency, more effort has been put into investigating the non-material aspects of the roles of animals in prehistory. Grant (1991) questioned whether symbolic and ritual can be separated in zooarchaeological research, and the supposition that human behavior could be motivated by wholly economic or wholly religious considerations (see also Ingold 2000). In the same year, Gifford-Gonzalez (1991) published a theoretical paper about using ethnographic analogies in zooarchaeology. She concluded that a more collaborative mode of investigation between zooarchaeologists and other specialists is needed (Gifford-Gonzalez 1991:246). Zimmermann Holt (1996) also saw ethnographic data as an important support for constructing alternative interpretations about animal data in archaeology.

During recent years, zooarchaeology has more and more broadened its scope to include more explanatory and interpretative subjects. Modern zooarchaeologists often investigate the ecological, social and cultural aspects of the life of the prehistoric people (e.g., Gifford-Gonzales 1991:226; Storå 2001). Zooarchaeology is not only the study of animal remains, but it also includes studies of, e.g., artifacts depicting animals, animals in pottery decoration or art presentations, and documentary sources. Animals definitely meant more than material benefits to prehistoric people. At its best, zooarchaeology is the study of past interactions between humans and animals, involving the analysis and interpretations of animal remains in archaeological deposits and other available data. Social or ideological attitudes to animals – social perceptions of animals, beliefs, ritual aspects – may be difficult to study at sites where the context is not clearly determined. However, the possible existence of immaterial uses has to be recognized in, for example, interpretations of species composition in archaeological materials. Understanding the role of animals in a belief system may provide inferences as to why certain animal species are not present in a faunal assemblage.

Animals, and artifacts made of their bones, may have contributed to social ranking and hierarchy in prehistoric societies, or they may convey inequality (Jones O'Day *et al.* 2004; Marti-Grädel *et al.* 2004). Approaches adapted here include perspectives on the diversity of aspects of birds in human life, including economic and social but also ideological and even religious aspects. However, human-animal relations in Stone Age northern Europe could also have been based on the practical and efficient ways of engaging with the natural environment (animals, plants, landscapes, etc.) rather than to the worship of greater deities (e.g., Herva 2007, see also Ingold 1986).

Often only a detailed investigation of the contexts of bone materials from archaeological sites can enable the interpretation of the ritual or social roles of animals. For example, social differences and economic specialization are indicated in a taphonomic study of animal bones at a Neolithic lake shore settlement in Switzerland (Marti-Grädel *et al.* 2004). Morey (2006) has investigated the social relationship of dogs and humans by studying dog burials and dogs associated with human burials. Based on the concentrations of seal bones and disarticulated human bones at sites, Storå (2001, see also Götherström *et al.* 2002) has emphasized the ritual, economic and social importance of seals for Middle Neolithic people on the Åland Islands. An intriguing example comes from Turkey (about 5500 cal BC), where ritual food preparation and manners of consumption have been revealed by studying the taphonomy of animal bones from funeral deposits and settlement contexts (Kansa & Campbell 2004). The use of the interpretive approach in zooarchaeology has been profoundly discussed by Marciniak (1999, see also 2005). He underlines the need for a two-fold zooarchaeological analysis, where the first part includes the empirical and explanatory analysis followed by the interpretative analysis (Marciniak 1999:299, 309–313).

The social roles of birds in prehistoric societies have been investigated in a number of recent studies. For example, birds were important in traditional medicine in pre-Hispanic Mexico (Corona-M. 2005). Common crane bones found in Neolithic Çatalhöyük have been interpreted as remains of a ritual crane disguise, used by people in ritual dances (Russell & McGowan 2003). Complete skeletons of at least fourteen white-tailed sea eagles (*Haliaeetus albicilla*) were buried separately or together with humans in burial tombs in Late Neolithic Orkney. A recent interpretation of these burials sees eagles as representations of the surrounding landscape and important evidence of how people have perceived animals and the environment (Jones 1998). Peregrine falcons (*Falco peregrinus*) and whooping cranes (*Grus americana*) could be interpreted as signs of high social rank in the burial mounds in the Southern United States about AD 1000 (Jackson & Scott 2003).

2. Sites and assemblages

2.1. Geographical and chronological outline

The material from settlement sites consists of bird bone samples from 115 sites on the Finnish mainland, six bird bone samples from Åland, six bird bone samples from Gotland, three bird bone samples from Saaremaa and one bird bone sample from Hiiumaa (Tables 1–3). Materials from burials derive from Ajvide, Zvejnieki and Taipalsaari Vaateranta (eastern Finland).

Bird samples from Åland (except Kolsvidja I), Ajvide, Saaremaa (except Kõnnu) and Zvejnieki (Papers I, III, IV, V) have been analyzed by myself. I have also identified or re-identified the samples from Finnish mainland (see App. 1 in Paper II). These bird bone materials constitute the main material for my dissertation. Bird bones from additional sites from Gotland, and mammal and fish bones from Åland, Saaremaa, Hiiumaa and Gotland are also discussed (Paper IV) but data was taken from literature (see Table 1).

Sites included in this study range chronologically from the Early Mesolithic to the Early Metal Period (Finland) and the Bronze Age (Otterböte site on Åland). The focus is on the Neolithic period. The geographical area covers the northernmost Finland, islands of Åland, Saaremaa, Hiiumaa and Gotland, Estonia and northern Latvia (Fig. 1). The general chronology in the study area is presented in Fig. 2. Dates are given in both radiocarbon years (BP) (if available), and calibrated to calendar years (cal BC). The calibration of radiocarbon years was taken from the literature (if given), or measured by using the OxCal program for radiocarbon calibration version 4.0.

The ecological settings of the area are connected to the general ecological and climatic development of northern Europe after the end of the last glaciation. Land uplift has resulted in significant changes in the Baltic Basin as well as inland lakes (Saarnisto 1970; Eronen 1983; Björck 1995). The history of the Baltic Sea can be divided into four main periods, mainly based on the salinity (Björck 1995; Hyvärinen 2000). The material for the present dissertation accumulated mainly during the Litorina phase, beginning about 7500 BP (Hyvärinen 2000). One sample, Antrea Korpilahti in Vuoksenranta (Karelia) represents the earlier Ancylus Lake phase (9230±210 BP, Hela-269, or about 8500 cal BC) (Carpelan 1999:160).

2.2. Osteological assemblages

The focus is on the Neolithic but also materials from Finnish Mesolithic, Early Metal Period and Bronze Age are included (Paper II). The emphasis in my thesis is on the Finnish material, settlement materials from Jettböle I and Ajvide, and on the burial materials from Ajvide and Zvejnieki (Papers I, II, IV, V). I have identified or checked the identification of these materials myself. The largest assemblages derive from Jettböle I and Ajvide, and the preservation of bone material from these sites is excellent.

Finnish mainland

Finnish sites are discussed in Paper II. The sites included in this study were excavated by various archaeologists during the period 1900–2002 and are located throughout the whole area of Finland. It is important to note that the extent of the excavated area and also the excavation techniques vary between different excavations and these affect the documentation of the finds and their interpretation.

One of the most critical problems in interpreting burnt bone samples from the Finnish mainland is that the material is seriously biased due to the poor general preservation of bones in Finnish soils (e.g., Ukkonen 2001:13–14). Practically all Finnish Stone Age and Early Metal Period bone samples are burnt and highly fragmented. Burnt bone material is perhaps only an arbitrary selection of animal bones originally deposited at the site. Some bones may survive burning better than others and this affects the composition of material (Iregren & Jonsson 1973; Okkonen 1991; Lyman 1994:386–390; Sigvallius 1994). Bones were most likely burnt during cooking, waste disposal, specific rituals or in a structure fire. The positive side is that when bones are burnt, they can relatively safely be connected to human activities.

Fragmentation and shrinkage due to burning cause limitations in bone identification. This is a critical problem especially in bird identification because even complete bones of species in the same genera are often very alike and difficult to separate from each other. Dating of the bone assemblages is also often difficult. Many Finnish Stone Age sites were occupied over a long time period. Some of the bird samples from the Finnish mainland cannot be dated to a certain archaeological period due to the mixing of cultural layers. In order to date bird bones, I have studied the contexts of bones from the excavation reports housed in the National Board of Antiquities or from literature. Excavators were also consulted if possible and needed. After writing Paper II, more detailed data about the dates of bird bones from three sites in northern Finland, Enontekiö Museotontti, Inari Vuopaja N and Inari Vuopaja, have been published. Bird bones from the first two sites can be dated to the Mesolithic period (Halinen 2005). However, one bone of an indeterminate diver in Inari Vuopaja can be dated to the Early Neolithic (Sär 1) but another to the Late Mesolithic (Halinen 2005; Halinen, pers. comm. 2007).

The documentation does not always allow the precise determination of the cultural phase where a certain find belongs. I have excluded all multiperiod sites from the

Table 1.
Data of the sites and material in this study. (All excavation years of the sites have been mentioned, but bone materials of all excavation years are not necessarily included in this study). Chronological outline: ***M****=Mesolithic ca. 8800-5200 cal BC,* ***N****=Neolithic ca. 5200-1500 cal BC,* ***EN****=Early Neolithic ca. 5200-4000 cal BC,* ***MN****=Middle Neolithic =ca. 3300-2700 cal BC,* ***LN****=Late Neolithic 2350-1800 cal BC,* ***EMP****=Early Metal Period ca. 1800-500 cal BC,* ***BA****=Bronze Age ca. 1500-500 cal BC (Edenmo et al. 1997, Carpelan 2002). For the names and chronology of pottery styles, see Fig. 2. NISP= Number of Identified Specimens.*

Location	Archaeologist and excavation year(s)	Dating	Pottery	Bird NISP	Mam-Mals NISP	Fish NISP	Osteogist(s)	References
Finland								
Coastal Mesolithic sites (n=2)	See Paper II, App. 1 and 2	M	-	51	x	x	See Paper II, App. 1	
Inland Mesolithic sites (n=9)	See Paper II, App. 1 and 2	M	-	35	x	x	See Paper II, App. 1	
Coastal Neolithic sites (n=21)	See Paper II, App. 1 and 2	N	Sär 1, EAW, Ka I, Ka II, Ka III, NAW, Pyh, Kiukainen	325	x	x	See Paper II, App. 1	
Inland Neolithic sites (n=31)	See Paper II, App. 1 and 2	N	Sär 1, EAW, Ka I, Ka II, NAW	179	x	x	See Paper II, App. 1	
Finland inland EMP (n=5)	See Paper II, App. 1 and 2	EMP	Textile Ware?	24	x	x	See Paper II, App. 1	
Åland:								
Kolsvidja I	Meinander 1952, Vikkula 1981, Lindqvist 1982	MN	Late Comb Ware, Older Pitted Ware	4	1384	2150	P. Ericson (mammals, fish, birds)	Storå 2000, Stenbäck 2003 Ericson 1988
Jettböle I	Cederhvarf 1905, 1906, 1908, 1911, Storå & Stenbäck 1999	MN	Older Pitted Ware	1574	>2814	x	J. Storå (mammals) H. Winge (mammals, birds 1905) K. Mannermaa (birds 1906, 1908, 1911)	Storå 2000:61, Stenbäck 2003
Härdalen	Nuñez & Pitkänen-Darmark 1990-1991	MN	Older Pitted Ware	96	>36		K. Mannermaa (birds)	Storå 2000:64, Stenbäck 2003
Glamilders	Cederhvarf 1906, Nordman 1925, Hackman 1926, Väkeväinen 1975, Lukkariniemi-Nuñez & Pitkänen-Darmark 1986, Vaara 2004	MN	Older Pitted Ware, Later Pitted Ware	277	>94	x	J. Storå (mammals), K. Mannermaa (birds)	Storå 2000:65, Stenbäck 2003:108-110
Källsveden	Cederhvarf 1906, ??? 1957, 1975	MN	Later Pitted Ware	102	>577	x	J. Storå (mammals), K. Mannermaa (birds)	Storå 2000:66, Stenbäck 2003:93
Åsgårda II	Storå 1991, 1992, 1993	MN, LM	Later Pitted Ware, Kiukainen Ware	99	>1211	x	J. Storå (mammals), K. Mannermaa (birds)	Storå 2000, Stenbäck 2003
Otterböte		BA	Rusticated Ware				A. Forstén (mammals, birds), K. Mannermaa (birds)	Forstén 1977, Gustavsson 1997

Saaremaa:								
Kõnnu	V. Lõugas and L. Jaanits 1977-1978	EN	Narva Ware	10	x	x	L. Lõugas	Lõugas 1997a
Naakamäe	L. Jaanits 1958,1959, 1962	MN Ca. 2900-2700 cal BC	Typical Comb Ware, Late Comb Ware	62	13937	x	K. Paaver (mammals), L. Lõugas (mammals and fish), K. Mannermaa (birds)	Lõugas *et al.* 1996a, Lõugas 1997a
Loona	L. Jaanits 1957-1959 (A. Kustin 1956)	MN/LN Ca. 3000-2500 cal BC	Late Combed Ware, Corded Ware, (Textile Ware)	272	1657	x	K. Paaver (mammals), L. Lõugas (mammals and fish), K. Mannermaa (birds)	Lõugas *et al.* 1996a Lõugas 1997a
Hiiumaa:								
Kõpu I	A. Kriiska 1994	EN Ca. 6000-5500 cal BC	Narva Ware	182	3410	40	L. Lõugas	Lõugas *et al.* 1996b, Kriiska & Lõugas1999
Gotland:								
Ajvide upper (settlement)	Various 1987,1995-2006	MN Ca. 3100-2300 cal BC	Older Pitted Ware	678	>4154	9405	G. Astren, O. Persson, Å. Blomqvist, J. Storå, (mammals), K. Mannermaa (birds)	Burenhult 2002, Österholm 2002, Astren 1988, Persson & Persson, Blomqvist 1991, Storå 2002
Ajvide (burials)	Various 1987,1995-2006	MN Ca. 2900-2300 cal BC		x	x	x	K. Mannermaa	Burenhult 2002
Ire	Arwidsson 1956-1960	MN	Older Pitted Ware	76	6771	x	J. Ekman**,** Hegert, M. Landin	Janzon 1975, Ekman 1974, Landin 1981, Wallin & Martinsson-Wallin 1996
Hemmor	Wennersten 1903, Wallin & Martinsson-Wallin 1994-1995, Hedemark, Samuelsson & Ytterberg 1999	MN	Older Pitted Ware	8	>5572	6293	L. Hedell, P. Wallin & H. Martinsson-Wallin, J. Storå	Nihlén 1927, Hedemark *et al.* 2000, Lithberg 1914, Storå 2001
Gullrum	Hansson 1891-1893, 1899	MN	Pitted Ware	?	250	468	E. Nordenskiöld, L. Hedell	Lithberg 1914, Nihlén 1927, Ekman 1974, Janzon 1974
Visby	? 1869, Lithberg 1905, Wennersten 1909, Fardelin 1910, Nihlén 1924-1925, Lundberg 1936-1937, Flyg & Olsson 1983	MN	Pitted Ware	6	1424	1	Holmqvist?, J. Ekman, P. Wallin & P. Eriksson	Nihlén 1927, Janzon 1974, Wallin & Eriksson 1985
Stora Förvar G.--G.11, F	Kolmodin & Stolpe 1888-1893	EN, MN	Pitted Ware	>434		>500	C.O. Roth, P. Ericson, C. Lindqvist	Knape & Ericson 1983, Pira 1926, Rydh 1931, Lindqvist & Possnert 1997, Ericson 1989
Latvia								
Zvejnieki Mesolithic (burials)	F. Zagorskis 1964-1971, Zagorska & Larsson 2005-2007		-		x	x	L. Lõugas (Mammals, fish) K. Mannermaa (birds)	Zagorskis 1987, 2000; Larsson & Zagorska 2006
Zvejnieki Neolithic (burials)	F. Zagorskis 1964-1971, Zagorska & Larsson 2005-2007		-		x	x	L. Lõugas (Mammals, fish) K. Mannermaa (birds)	Zagorskis 1987, 2000; Larsson & Zagorska 2006

Table 2.

*Bird taxa from Stone Age sites on Åland, Hiiumaa, Saaremaa and Gotland and from Zvejnieki in Latvia. Meso=Mesolithic, NEO=Neolithic, SPW=Scandinavian Pitted Ware Culture, BA=Bronze Age. Some of the bone specimens in material with *) may not belong to the stated period. The + sign indicates that the species or taxon has been observed but the number of specimens is not available.*

Taxon	Latvia, Zvejnieki Burials Meso+Neo	Estonia, Hiiumaa settlement Neo	Estonia Saaremaa settlements Neo*)	Åland, Jettböle I settlement SPW	Åland, other settlements SPW	Gotland, Ajvide settlements SPW	Other Gotland settlements SPW	Gotland, Ajvide burials SPW	Gotland Stora Förvar cave, camp site SPW *)	Åland, BA (Otterböte)
Black-throated diver (*Gavia arctica*)	+		5				1+		2	
Red-throated diver (*Gavia stellata*)							1	+	3	
Indet. diver (*Gavia* sp.)					1	4				
Slavonian grebe (*Podiceps auritus*)										
Great crested grebe (*Podiceps cristatus*)			2							
Red-necked grebe (*Podiceps grisegena*)			1							
Red-necked grebe/Great crested grebe (*Podiceps grisegena*/*Podiceps cristatus*)			33						2	
Gannet (*Morus bassanus*)						1	1		1	
Great cormorant (*Phalacrocorax carbo*)		1	1	2		30	1	+	42	
Whooper swan (*Cygnus cygnus*			1	18	5	2	1	+		
Whooper swan/indet. swan (*Cygnus cygnus*/*Cygnus* sp.)			11	11	2	13			16	
Indet. goose (*Anser* sp.)			4	1	1			+		
Indet. goose *(Anser* sp./*Branta* sp.)				2		12	1		3	
Indet. duck (Anatidae)	+	1	46	128+ 114	333	49	3	+	7	
Mallard (*Anas platyrhynchos*)	+		2	4	2	3			5	
European wigeon (*Anas penelope*)						1				
Green-winged teal (*Anas crecca*)						7				
Indet. Anas sp.				2+1		24	+			
Tufted duck (*Aythya fuligula*)							1		1	
Aythya sp.	+		6						1	
Common eider (*Somateria mollissima*)			1	583+123	80	16	4		109	70
Velvet scoter (*Melanitta fusca*)			1	102+28	15	3			10	
Common scoter (*Melanitta nigra*)				2					4	
Melanitta sp.				23+4	3					
Common Goldeneye (*Bucephala clangula*)		2	2			3	1		8	
Long-tailed duck (*Clangula hyemalis*)		2	13		1	2			1	
Goosander (*Mergus merganser*)	+		1	8+2	3	4			10	
Red-breasted merganser (*Mergus serrator*)	+	1	x	2+5	1	4			4	
Mergus sp.			9	16	3					
Mergus sp./*Melanitta* sp.				8+1	5					
White-tailed sea eagle *(Haliaeetus albicilla*)		1	2	5	1	3	1			
White-tailed sea eagle/Golden eagle (*Haliaeetus albicilla*/*Aquila chrysaetos*)			3				1		19	
Rough-legged buzzard (*Buteo lagopus*)?									1	
Western honey buzzard (*Pernis apivorus*)									1	
Nothern Goshawk (*Accipiter gentilis*)			1			1			11	
Red kite (*Milvus milvus*)									2	
Accipitridae						8				

Northern hobby/common kestrel *(Falco subbutteo/F. tinnunculus)*						**1**				
Osprey (*Pandion haliaetus*)										
Willow grouse (*Lagopus lagopus*)										
Capercaillie (*Tetrao urogallus*)			**2**							
Black grouse (*Tetrao tetrix*)			**14**				**1**			
Hazel grouse (*Bonasa bonasia*)										
Galliformes			**16**							
Domestic chicken (*Gallus domesticus*)			**4**							
Common crane (*Grus grus*)						**2**		+		
Palearctic oystercatcher (*Haematopus ostralegus*)						**2**				
Water rail/Corncrake (*Rallus aquaticus/Crex crex*)					**1**					
Ruddy turnstone (*Arenaria interpres*)										
Indet. stint (*Calidris* sp.)					**1**					
Charadriidae						**11**				
Western curlew (*Numenius arquata*)				**2**		**1**				
Whimbrel (*Numenius phaeopus*)						**2**				
Whimbrel/Black-tailed godwit (*Numenius phaeopus/ Limosa limosa*)			**4**							
Indet. plover (*Pluvialis sp.*)			**1**				**2**			
Indet. wader (*Tringa* sp.)										
Eurasian woodcock (*Scolopax rusticola*)			**9**		**1**		**3**			
Scolopaciidae			**1**		**2**	**3**				
Ruff (*Philomachus pugnax*)				**1**						
Charadriiformes			**2**		**2**	**24**		+		
Greater Black-backed gull (*Larus marinus)*			**11**	**1**	**2**	**2**	**1+**		**10**	
Herring gull/Black-backed gull (*Larus argentatus/Larus marinus*)			**10**	**1**						**1**
Lesser black-backed gull/Herring gull (*Larus fuscus/ Larus argentatus*)			**4**		**1**		+		**19**	
Common gull (*Larus canus*)			**5**	**2+1**		**3**			**6**	
Arctic skua/Common gull (*Stercorarius parasiticus/ Larus canus)*						**1**				
Indet. gull *(Laridae*)			**10**	**1**		**28**		+		
Indet. tern (*Sterna* sp.)				**1**						
Great auk (*Alca impennis*)									**1**	
Razorbill (*Alca torda)*			**1**	**1+1**	**1**	**64**			**65**	
Guillemot (*Uria aalge*)						**29**	+	+	**7**	
Black guillemot (*Cepphus grylle*)			**4**	**13+1**	**10**	**57**	**1**		**25**	
Indet. auk (Alcidae)			**1**	1	**1**	**42**		+		
Indet. wader (*Charadriida.*)			**2**							
Indet. pigeon or dove (*Columba* sp./*Streptopelia* sp.)			**1**							
Wood pigeon (*Columba palumbus)*						**3**			**1**	
Columba sp.						**1**				**1**
Tengmalm's owl (*Aegolius funereus*)						**1**				
Eurasian cuckoo (*Cuculus canorus*)							**3**			
European nightjar (*Caprimulgus europaeus*)						**1**			**1**	
Common redstart (*Phoenicurus phoenicurus*)							**1**			
Jay (*Garrulus glandarius*)	+					**1**				
Carrion crow (*Corvus corone*)				**1+4**		**6**			**16**	
Raven (*Corvus corax*)									**1**	
Corvidae			**2**			**13**				
Indet. trush (*Turdus* sp).			**6**		**2**	**8**	**1**			
Eurasian skylark (Alauda arvensis)			**1**							
Indet. Passeriformes			**3**			**4**				
Indet. Aves	+	**173**	**86**	**292+23**	**77**	**150**	**60**	+	**?**	

Table 3.
Bird taxa from Finnish Mesolithic (Meso), Neolithic (Neo) and Early Metal Period (EMP). NISP=Number of Identified Specimens.

Taxon	Meso Ancylus Antrea net find NISP=11	Meso Litorina Coastal NISP=51	Meso Litorina Inland NISP=38	Neo Coastal NISP=354	Neo Inland NISP=179	EMP Inland NISP=22	Mixed Coastal NISP=57	Inland Mixed NISP=205
Black-throated diver (*Gavia arctica*)				**2**	**3**			
Red-throated diver (*Gavia stellata*)				**2**	**5**		**2**	**9**
Indet. diver (*Gavia* sp.)			**6**	**6**	**9**		**2**	**20**
Slavonian grebe (*Podiceps auritus*)				**5**				
Red-necked grebe/Great crested grebe (*Podiceps risegena*/*Podiceps cristatus*)				**3**	**4**		**2**	**4**
Whooper swan (*Cygnus cygnus)*					**2**			**1**
Indet. swan (*Cygnus* sp.)	**11**	**1**						**4**
Anser sp.							**1**	
Indet. goose *(Anser* sp./*Branta* sp.)								
Indet. duck Anatidae		**9**	**11**	**66**	**14**		**13**	**21**
Mallard (*Anas platyrhynchos*)				**21**	**3**			
Green-winged teal (*Anas crecca)*		**2**		**19**			**1**	
Anas sp.		**1**		**10**	**2**		**3**	**1**
Aythya sp.				**5**				**1**
Common eider (*Somateria mollissima*)				**2**				
Velvet scoter (*Melanitta fusca*)				**1**				
Smew *(Mergus albellus)*				**5**				
Long-tailed duck (*Clangula hyemalis*)		**2**		**6**			**3**	
Goosander (*Mergus merganser*)				**1**			**2**	
Red-breasted merganser (*Mergus serrator*)								
Mergus sp.				**1**				
White-tailed sea eagle *(Haliaeetus albicilla*)								
White-tailed sea eagle/Golden eagle (*Haliaeetus albicilla*/*Aquila chrysaetos*)				**4**	**2**	**1**		**2**
Osprey (*Pandion haliaetus*)				**4**				
Accipitriidae								**2**
Willow grouse (*Lagopus lagopus*)		**6**	**3**	**42**	**30**	**2**	**1**	**20**
Indet. owl Strigiformes				**4**				
Capercaillie (*Tetrao urogallus*)		**1**	**5**	**14**	**11**	**19**		**35**
Black grouse (*Tetrao tetrix*)		**1**	**1**	**11**	**26**			**11**
Tetraonidae			**4**	**3**	**23**		**2**	**8**
Hazel grouse (*Bonasa bonasia*)				**5**	**1**			
Ruddy turnstone (*Arenaria interpres*)								
Eurasian woodcock (*Scolopax rusticola*)								
Black guillemot (*Cepphus grylle*)								
European nightjar (*Caprimulgus europaeus*)				**1**				
Indet. Aves		**28**	**7**	**83**	**47**		**28**	**61**

chronological discussion (see Paper II). The Finnish samples were divided according to the chronological periods and location (coast/inland) (Table 1). Here I have further divided Neolithic assemblages into Early Neolithic, Middle Neolithic and Late Neolithic according to the pottery style(s) at the sites (Figs. 2 and 3).

The sites included in this study also have diverse characters. Mesolithic materials typically originate from areas where no visible constructions of dwellings can be located (but see, e.g., Pesonen 2002:22). More house and hut constructions have been recovered from the Neolithic (Karjalainen 1996; Ranta 2002; Halinen 2005). Bones can be found inside and outside the hut or house remains (Karjalainen 1996, 2002; Katiskoski 2002:190). Burnt animal bones at Finnish Stone Age sites most likely derive from fireplaces or hearths where remains of meals and other waste have been disposed. Sometimes bones are found inside an undisturbed hearth, but very often they are relatively equally spread in the excavation area without any concentration (Halinen *et al.* 1998; Leskinen 2002:164).

Detailed studies about the contexts and interpretations of the Finnish Stone Age sites have been recently published (Katiskoski 2002; Leskinen 2002, 2003; Okkonen 2003; Halinen 2005). My dissertation does not include detailed descriptions of Finnish sites or the contexts of animal bones. I have included all Stone Age and Early Metal Period sites with bird bones in this study and it is impossible to give descriptions of all of them here. In Finland, such an investigation could be useful in the study of the treatment of birds only at the sites with a large bone assemblage and a relatively high amount of bird bones. Ylikiiminki Vepsänkangas in Ostrobothnia (Fig. 1B) is one such site and will be presented here as an example. Another interesting site is Joroinen Kanava in eastern Finland (Fig. 1B). As this site was excavated after 2002, it was not included in my compilation of birds in Finnish prehistory (Paper II). However, it is so important from the point of view of birds in Finnish prehistory that it will be presented briefly here.

Yli-Kiiminki Vepsänkangas is one of the rare, so-called "clean" Stone Age sites in Finland. Only Early Neolihic Sär 1-type pottery has been found in the excavation in 1992, 1996 by Markku Mäkivuoti and 1997–1998 by Satu Koivisto (1998). The site was located on an island in the inner Stone Age archipelago. The shallow water and the small islands near the site must have been extremely suitable for breeding waterbirds. Thus, it is not surprising that the amount of bones of waterbirds was relatively high in the identified bone material (Paper II). A stone setting, apparently a hearth, was found at the site but otherwise no remains of dwellings were identified. The find material contains ceramics, quartz and stone arrowheads and knives (Koivisto 1998:47). Three small-sized, coarsely made Slettnes-type arrowheads were found. It is probable that these were used in hunting of waterbirds at Vepsänkangas.

Joroinen Kanava was excavated in 2002–2003 by Eeva-Liisa Schulz. The ceramics date the site to the Typical Comb Ware culture. The settlement find material includes mainly pottery sherds, quartz and burnt bones. Identified bones belong mostly to European elk, seal and fish (Schulz 2006a:133). The identified bird bones belong to

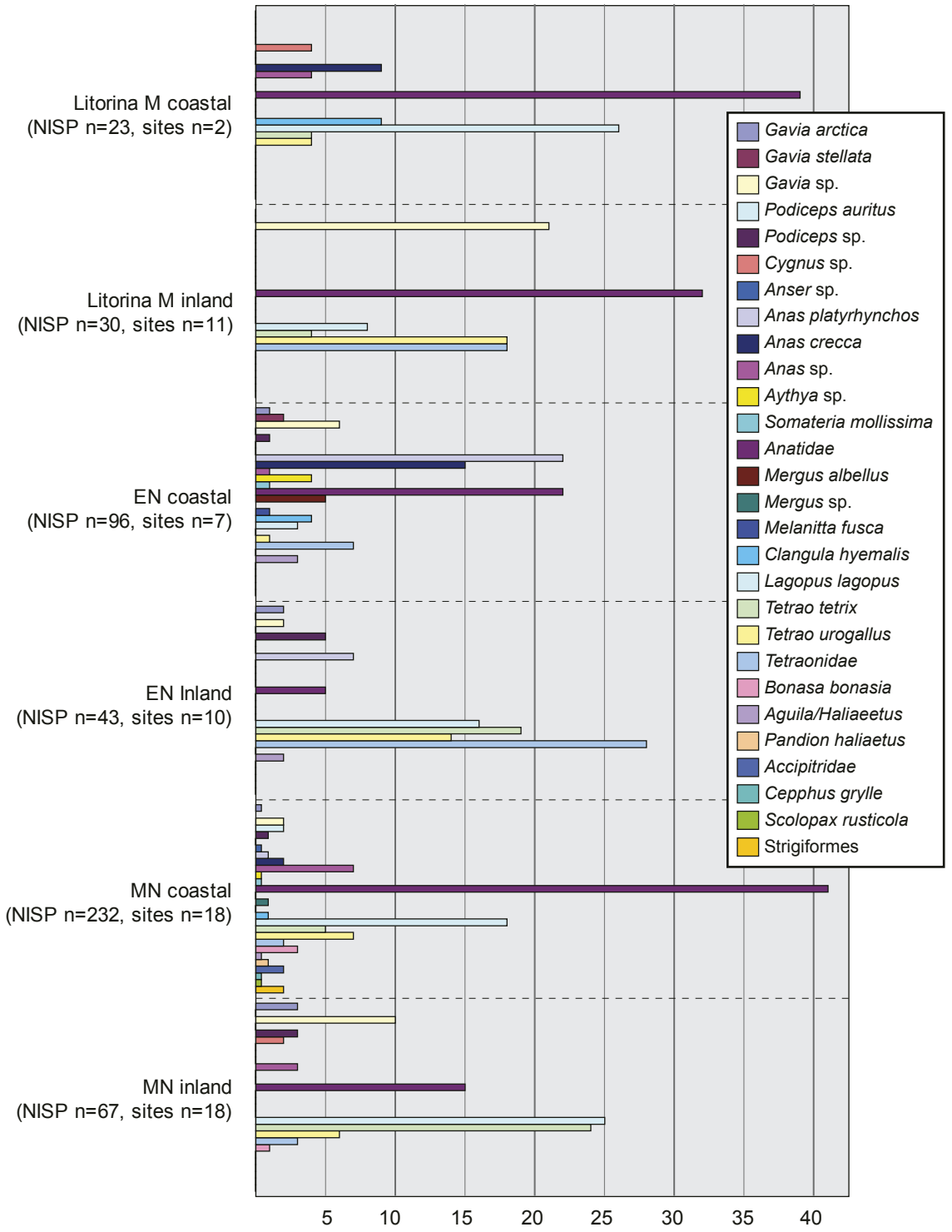

Fig. 3. *Distribution of bird taxa (Aves indet. excluded) (NISP%) at coastal and inland sites belonging to different cultural phases in the Finnish Stone Age. Only datable sites are included; Antrea Korpilahti was excluded. Neolithic sites were divided into phases according to archaeological dating based on ceramic ware types (see Fig. 2). M=Mesolithic; EN (Early Neolithic)=Sär 1, EAW, CoW1; MN (Middle Neolithic)= CoW2, CoW3, Kierikki, Pyh, Pöljä.*

waterbirds, for example, swans (most likely the whooper swan *Cygnus cygnus*) and divers (*Gavia* sp.). Interestingly, many of the pottery sherds, some of which were from large and some from small vessels, had waterbird –probably swan – patterned decoration (Schulz 2006b). Another interesting feature at Joroinen Kanava is that one single burial and one collective burial of at least six individuals were found in the settlement area (Mustonen 2005). Burials were recognized from the red-ochre features, occasional fragments of human tooth enamel and amber pendants, and stone artifacts. There are indications of potential ritual fires near the collective burial (Mustonen 2005). It is not impossible that the vessels with waterbird (swan) decoration may also be connected with burial rituals. The presence of swan bones in the bone assemblage as well as in pottery decoration may indicate that people at Joroinen Kanava had a special relationship, possibly connected to ideas of death, with swans (Schulz 2006a, 2006b).

Due to preservation factors, organic materials, like bones, are extremely rare in Stone Age burials in Finland (Miettinen 1992; Halinen 1999; Katiskoski 2004; Mustonen 2005). Therefore, the roles of animals in burial rituals in Finland are difficult to study. Bones of *Anas*-ducks and indeterminate birds were found in the Middle Neolithic burials at Taipalsaari Vaateranta in Eastern Finland. Bones were recovered under a layer of red-ochre and probably represent grave goods.

Åland, Finland

Jettböle I (Jomala)

In the Stone Age, Jettböle was situated on an island of about 3 km length in the southern part of the Åland Archipelago (Fig. 1A). The site was located on a sheltered sandy beach in the immediate vicinity of a rocky hill, today called Jettböleberget. Jettböle was excavated in 1906, 1908 and 1911 by Björn Cederhvarf (1912). Two activity areas, upper and lower, were recognized based on sherds of Pitted Ware pottery. Later these occupation phases were dated and called as Jettböle I and II (Stenbäck 2003:126). The older phase, Jettböle I, has been dated to about 4400–3800 BP (3300–2000 cal BC) (Lidén *et al.* 1995, Götherström *et al.* 2002). Occupation at Jettböle II is some 400 or 500 years more recent (Stenbäck 2003:94).

The bird bones derive from excavations in 1905, 1906 and 1908 (NM 4630, 4781, 5180, 5907) (Number of Identified Specimens NISP=1574, Papers I, II, IV). All bones derive from one of the largest excavation areas called Trench A (about 180 m²), which mainly reflect activities connected to the older occupation phase, Jettböle I (Götherstöm *et al.* 2002:44). The majority of the bird bones, most of which are unburnt, were found in a concentration located in the northern part of Trench A (squares I, VI and VII) (Table 4) (see Storå 2000; Fig.2). Another concentration of bird bones was found in the southern area of the same trench (mainly square 269). A hearth was excavated here which explains why relatively more burnt bird bones were found in this area compared to the northern concentration area. A third area, the eastern one, also yielded

bird bones, but they were very scarce. These three areas were also the richest areas in seal bones, lithics and pottery (Göthersröm *et al.* 2002, Fig. 5). Two radiocarbon dates from elk bones in square 269 (4375±60 BP, Ua-11465 about 3327–2890 cal BC) and square VII (4275±65 BP, Ua-10687 about 3090–2639 cal BC) (Storå 2000:61) indicate that the bones represent the same occupation phase. The northern concentration area can be described as a special activity area, perhaps used for slaughtering and butchering animals (Cederhvarf 1912; Storå 2000; Stenbäck 2003).The southern concentration with a hearth has been interpreted as a domestic construction (Cederhvarf 1912; Storå 2000).

Cederhvarf interpreted bones, pottery and lithics from Jettböle I as refuse from daily economic activities (Stenbäck 2003:131). Modern interpretation of the character of Jettböle I is more complex. It seems that Jettböle I represents a dwelling site but also a ritual and ceremonial locality (Götherstöm *et al.* 2002; Stenbäck 2003:201–208). The main arguments are the concentration of the finds as well as the fragmented human remains (Götherström *et al.* 2002; Storå 2001:40). Several human bones have cutmarks, and Grönroos (1913) already connected these marks with potential cannibalism (see also Nuñez 1995; Lidén *et al.* 1995; Nuñez & Lidén 1997; Götherström *et al.* 2002). Storå (2001:51) and Stenbäck (2003) emphasize the importance of the sea and seals in the ideology of the people at Jettböle I. Stenbäck (2003:202) also suggests that Jettböle I may have been a place where people went for hunting, fowling and fishing, and where catches were treated, but permanent settlements were located elsewhere.

There are slight variations in excavation methods in different field seasons which may affect the general composition of the find material and its interpretation. The first year excavation was done in squares and without vertical stratigraphy or sieving. The later years, stratigraphic layers were followed and the material was sieved (Stenbäck 2003:138–140).

There are some differences in the numbers of different taxa in Table V in Paper I and Appendix 4a in Paper IV. The material from the northern area was identified in 2001 (NISP 1240). In 2003, I analyzed other Jettböle material, mainly from the southern area (NISP 334). This consists of bones in the southern area and includes bones from both older and younger phases of Jettböle. In Papers I and II, only identifications made in 2001, representing Jettböle I, were discussed. All identified bones, representing Jettböle I and II are included in Paper IV.

Kolsvidja I (Sund)

In the Stone Age, Kolsvidja I was on an island in the central part of the Åland Archipelago (Fig. 1A). Excavations were conducted at Kolsvidja in 1952 by C. F. Meinander, 1981 by Anne Vikkula and in 1982 by Christian Lindqvist (Meinander 1957; Lindqvist 1988). The pottery at Kolsvidja I represents Late Comb Ware and the older Pitted Ware styles (Stenbäck 2003:93, 97). No bird bones were reported from the excavations of 1952 and 1981. The four unburnt bird bones discussed here originate from the excavation of 1982 (ÅM 529) and were identified by Per Ericson (1988) (Paper IV). Two in-

determinate bird bones were found in the cultural layers, one is a stray find. A bone of woodcock (*Scolopax rusticola*) was recovered in connection with the fine mesh sieving of cultural layer soil samples (Ericson 1988, Table 1). Even though the excavated area in 1982 was limited, the very low number of bird bones seems surprising in the Ålandic Middle Neolithic context. Based on the pottery decoration, Kolsvidja has been interpreted as one of the oldest Ålandic Pitted Ware sites (Meinander 1957:206).

Härdalen (Nääs)
The site was located on an island in the eastern part of the Stone Age Åland Archipelago (Fig. 1A). It was excavated in 1990 and 1991 by Maija Nuñez and Anne-Maaret Pitkänen-Darmark. A cairn or heap of fire-cracked stones from the Bronze Age was first discovered at the site (Nuñez 1990 [unpubl.]; Storå 2000:64). Under the cairn, a cultural layer from the Stone Age was found, including large amounts of lithics, unburnt and burnt bones, and potherds of older Pitted Ware. Few potherds of Late Comb Ware were also found. Eight bird bones, all burnt, originate from the excavation of 1990 (ÅM 642) and most likely belong to the Stone Age occupation layers. The majority of the bird bones from Härdalen originate from the 1991 excavation (ÅM 649) and can apparently be connected to the Stone Age cultural phase (NISP=58, Paper IV). Most (about 80 %) of these bird bones are unburnt. A human tooth, probably belonging to the Stone Age layers, was found, among other finds, at Härdalen (Storå 2000).

Glamilders (Saltvik)
Glamilders situated on a small island in the northern part of the Stone Age Åland Archipelago (Fig. IA). Most of the pottery represents older and later Pitted Ware on Åland (Stenbäck 2003:93,108). The excavation area covered ca. 185 m², but almost all animal bones were concentrated in the about 6 m² area of three or four rectangular stone enclosures, apparently hearths (Ailio 1909; Meinander 1964:13; Storå 2000:65).

Table 4.
The number of bird specimens (NISP) in different areas at Jettböle I.

N-area		**S-area**		**E-area**	
Square	**NISP**	**Square**	**NISP**	**Square**	**NISP**
I	759	261	2	LXVI	14
II	8	262	5	LXVII	10
V	41	263	38		
VI	224	268	14		
I & VI	4	269	99		
VII	115	263 & 269	38		
VIII	7	262 & 268	6		
X	9	269 & 275	1		
X & VII	13	277	3		
		278	10		

Bird bones (NISP 277, Paper IV) as well as other animal bones originate from B. Cederhvarf's excavation in 1906 (NM 4784 and NM 4785). Burnt bird bones were found among the stones in the stone enclosures (e.g., squares 90, 91, 95, 98, 106–109) as well as near them. Occasional bird bones were found in squares outside the stone enclosures (e.g., squares 116, 117). Three human bone fragments were found in the same find-rich area as the animal bones (Storå 2000:65) and were apparently deposited together with animal bones. Glamilders most likely represents a year-round settlement site with house or hut structures. A radiocarbon dating taken of elk bone from Glamilders gave an age 3580±60 BP, Ua-11462 (about 2130–1750 cal BC) (Storå 2000:61).

Källsveden (Saltvik)

Källsveden was located in the northwestern part of the Stone Age Åland Archipleago (Fig. 1A). The site was excavated in 1906 (B. Cederhvarf), 1957 (C.F. Meinander) and 1975 (Lea Väkeväinen). The bird bones discussed here derive from several test-pits from 1906 (NM 4789) (NISP=102, Paper IV). The almost half a meter thick cultural layer recovered in the test pits contained a large amount of bones, lithics and later Pitted Ware pottery, but no structures have been observed (Martinsson 1984 [unpubl.]; Storå 2000:66). Most of the bird bones, as well as those of other animals, originate from the two nearby test pits, 181 and 182. Even though the very uppermost part of the stratigraphy was mixed, I assume that all bird bones can be connected to later Pitted Ware occupation. About one third of the bird bones are burnt. Charred bird bones were found in the same pit (NM 4789:33, 54, 77) with charred human skull bones (Storå 2000:66) which indicates that some ritual activities may have taken place there. However, due to the excavation in test pits alone, the larger context of these finds is not known. Like other Pitted Ware sites on Åland, Källsveden probably represents a year-round occupation site (Nuñez & Storå 1997). Two radiocarbon dates exist from Källsveden: 2820±70 BP, Ua-10690 (cattle bone) (about 1210–820 cal BC), 3370±70 BP, Ua 11464 (pig bone) (about 1880–1500 cal BC) (Storå 2000:61).

Åsgårda 34.20 II (Saltvik)

During the Stone Age, Åsgårda was located on an island in the central part of the Åland Archipelago (Fig. 1A). The site complex was excavated in 1991–1993 by J. Storå (ÅM 651 and ÅM 662, ÅM 672). Two trenches, excavated in 1991 and 1992, comprise an area of 21 m². The documentation and collecting of finds were made in 5 cm technical layers and 1 m² squares. Most of the pottery at Åsgårda can be classified to the older and later Pitted Ware styles (Storå 2000:68). Bones were found scattered in the cultural layer, although some concentration of bones could be observed (Storå 1995 [unpubl.], 2000:68–69). Practically all bones originate from the area of the later occupation phase. The upper part of the cultural layer was disturbed by ploughing and some of the finds from the uppermost layers may be quite recent.

Bird bones from both excavation seasons were identified for the present study, and they represent the later Pitted Ware occupation (NISP=99, Paper IV). Bird bones are scarce compared to seal bones at Åsgårda. Bird bones were identified in only 60 find numbers of a total of 1968 find numbers which included bones. The uppermost layers of the excavation area in 1991 contained many bones, but most of the bones from 1992 were found in the middle and lower parts of the stratigraphy. Bird bones were scattered evenly in the excavation area. Almost half of the bird bones in the 1991 material and 11% of the bones in the 1992 material are burnt.

Three fragments of seal tooth pendants were found at Åsgårda (Storå 2005) and may derive from disturbed burials. No human bones were recovered at Åsgårda, but 32 fragments of clay figurines connected to the later Pitted Ware phase on Åland were found (Storå 2000; Fagerholm-Sjöblom 2003:60–61; Stenbäck 2003:211). The figurines have been connected, for example, to shamanism (Nuñez 1986; Fagerholm-Sjöblom 2003:60–61) or to changes in the relationship between people and animals, especially seals, between older and later occupation phases (Storå 2002; Stenbäck 2003:211). Halinen (1999:175) has connected these broken clay figurines to burial rites. Three radiocarbon dates from Åsgårda provided the results 3725±65 BP, Ua-10689 (cattle bone) (about 2339–1939 cal BC), 3710±80 BP, Ua-11460 (sheep bone) (about 2397–1889 cal BC) and 2665±60 BP, Ua-4929 (cattle tooth) (976–670 cal BC) (Storå 2000:61).

Otterböte (Kökar)

Otterböte is situated on the Island of Kökar, in the eastern part of the Åland Archipelago. It represents a period, the Bronze Age, which is not within the central chronological scope of this work. However, I wanted to include it here because it is a special part of the prehistory of the area and is interesting from the point of view of bird utilization.

Excavations at Otterböte in 1946 (Mats Dreijer) and 1950 (C.F. Meinander) revealed a small dewelling site, consistíng of hut rings and refuse heaps (Meinander 1954, Gustavsson 1997:4). During these field seasons, an area of 620 m² was excavated, and nine hut rings, four refuse heaps and several hearths were investigated and documented (Meinander 1954; Gustavsson 1997). The find material consisted of lithics, pottery sherds and more than 10 kg of animal bones (seals, birds and few domestic animals) (Gustavsson 1997:23–24). The bone material from the 1950 excavation (ÅM 200), all unburnt specimens, was identified by A. Forstén (1977). In the re-analysis of the bird bones, I was able to identify two taxa not mentioned by Forstén, the greater black-backed gull (*Larus marinus*) or the herring gull (*Larus argentatus*) and the black guillemot (*Cepphus grylle*) (NISP=73, Paper II). However, the specimen, identified as a potential hobby (*Falco subbutteo*) by Forstén (1977) was not found in the material. Bones from 1950 were poorly documented in the field and a large number of them do not have information about the find spot (Gustavsson 1997:44).

The site was originally interpreted as a seal hunting station (Meinander 1954). A recent investigation has suggested a very long-distance hunting journey for Otterböte

occupants (Gustavsson 1997). Based on pottery of the Rusticated Ware type and other archaeological data, Gustavsson (1997) suggests that Otterböte occupants came from the area of the Lusatian culture in northern Poland. A few textile-impressed vessels at Otterböte may be of local production. It seems that Otterböte represents Bronze Age culture which never spread into the northern parts of the Baltic Sea area. Several radiocarbon dates from Otterböte date it to about 2600–3100 BP or 1200–900 cal BC (Gustavsson 1997:40).

Gotland, Sweden

Ajvide settlement area (Eksta)

Ajvide is located on the western coast of Gotland (Fig. 1C). In the Middle Neolithic, the site was situated on a bay that was protected by a small island (Burenhult 2002). Large excavation were performed at Ajvide during the 1980s, 1990s and 2000s by various archaeologists. The settlement has three occupation phases, dating to the Mesolithic, Neolithic (older and later phase of the Middle Neolithic, the main occupation at Ajvide) and Bronze Age (Österholm 1989:95; Lindqvist 1997). Three areas with Middle Neolithic Pitted Ware culture finds have been distinguished; C, D-upper and D-lower (Burenhult 2002; Storå 2002). The Middle Neolithic occupation phase, dated to 3100–2300 cal BC, consists of both settlement remains and burials (Burenhult 1997b). The faunal material included in the present study derives from the area D-upper, dated to about 3100–2700 cal BC (Burenhult 2002) (NISP=679, Paper III). It was taken from a very large bone collection consisting mainly of mammal and fish bones.

The Ajvide settlement area has been excavated by using technical layers (Burenhult 1997c). Finds were recovered in 10 cm sections within one square meter units and sieved with 7 mm mesh (Storå 2002:389). The upper parts of the cultural layer in the D-upper area have been damaged by modern agriculture and later burials have disturbed the stratigraphy in some places (Burenhult 1997c). A transgression layer of about 5–15 cm separates the upper and lower (later and older) levels of the cultural layer (Österholm 1989, Storå 2002:6). The majority of bird bones were found in the middle parts of the stratigraphy, under the transgression layer (Fig. 2B, Tables 1–2 in Paper III).

Archaeological data indicates that various activities have taken place in the Ajvide area (Burenhult 1997d, 2002, Österholm 2002). The settlement activities at Ajvide date to the Mesolithic and the earlier Middle Neolithic, while the area was used as a cemetery in the later Middle Neolithic phase. The very thick cultural layer and the uniformity of find material indicates that the Pitted Ware occupation phase was very intensive but lasted only 150–200 years (Burenhult 2002:32). Few features, except burials and postholes, were discovered in the cultural layer, and no special areas for slaughtering animals have been recognized in the settlement area (Storå 2002:392, Paper III). However, a special area covering about 100 m², probably used for butchering seals, was

recovered inside the settlement area (Österholm 1989, 2002). This area, consisting of a very thick and hard layer of black soil was located in the upper layers of the stratigraphy and is apparently contemporary with the burials (Österholm 1989, 2002).

Ajvide burials (Eksta)

More than 70 graves have been recovered in the area D-upper at Ajvide. The material discussed in this study comes from 17 graves which were found during the excavations seasons 1983, 1986 and 1992–1998 (Paper V). The graves have been excavated and documented in a manner that the whole grave was exposed before any find was removed (Burenhult 1997c, 2002). The osteological analysis of the skeletons was already started in the field. The graves were measured and documented with Total Station (Burenhult 1997c:50, 2002). The graves had been dug down through the earlier occupation cultural layer. They are slightly later than the settlement material (D-upper), dating to 4120–3720 BP (about 2900–3200 cal BC) (Burenhult 2002; Possnert 2002, see also the discussion about calibration of the reservoir effect in Eriksson 2004:21–23). However, the burials are contemporary with the occupation in the D-lower area where only a few bird bones were found. It is not known if there was a permanent settlement at Ajvide during the period the burial ground was in use (Burenhult 2002). All Ajvide graves, except three, included remains of one or more skeletons. Most of the dead were laid on their back although some were in a flexed position. Burials are, in general, richly adorned and furnished with a variety of grave goods. The most typical grave goods are animal tooth pendants, bird bone beads, lithics, amber artifacts and *Dentalium*-shells (Burenhult 2002).

The distribution of bird bones in burials was elucidated from the illustrations and the find catalogue presented by Burenhult (2002). The locations of most bird finds are shown in these illustrations.

Stora Förvar (Island of Stora Karlsö)

The island of Stora Karlsö is located at about a 7 km distance from Ajvide, off the west coast of Gotland (Fig. 1C). The site was excavated by Lars Kolmodin and Hjalmar Stolpe in 1888–1893. The results were published by Rydh (1931) and Schnittger & Rydh (1940). Excavations on Stora Karlsö in 1888 have a special place in the history of Swedish archaeological research because it was the first time that Stone Age materials were ever found in exavations in Sweden (Janzon 1974:1).

The cave of Stora Förvar has been frequented by humans from the Mesolithic until historical times (Lindqvist & Possnert 1997). It was most likely always used as storage for catches of seals, fishes and birds while the campsite was situated somewhere nearby the cave (Knape & Ericson 1983; Ericson & Knape 1990). The material for this study derives from parcel layers 5 to 11, most of which can be dated to the Middle Neolithic (Lindqvist & Possnert 1997) (NISP=434, Paper IV). Bird bones are clearly more common (4.4 % of all specimens) in the Middle Neolithic layers of Stora Förvar material than in Mesolithic layers (Lindqvist 1997:95). However, the share of fish

is low in Middle Neolithic layers. According to Lindqvist (1997), this may indicate that fowling was more important than fishing for people inhabiting the island of Stora Karlsö during the Middle Neolithic. It is also possible that fish were processed in some other place on the island.

Ire (Hangvar)

The Pitted Ware culture site of Ire is located on the north-western coast of Gotland (Fig. 1C). The site was excavated in 1956–1960 by Greta Arwidsson (Janzon 1974:8–9). Material from the settlement area of all excavation seasons is discussed in this study and it was analyzed by Jan Ekman (1974), Anders Hegert (1982 [unpubl.]), and Maria Landin (1981 [unpubl.]) (NISP=76, Paper IV). Bone material is mostly unburnt but highly fragmented (Ekman 1974:212). Arwidsson's excavations followed horizontal layers and the material was sieved (Janzon 1974:8–9). A major part of the cultural layer was disturbed due to sand workings and agricultural activities. A large cemetery area with well-preserved skeletal remains was recovered in the settlement area. Clear similarities with Ajvide burials in finds and burial manners have been observed at Ire (Janzon 1974). Layers from the settlement and graves are partly mixed (Ekman 1974).

Hemmor (När)

The Pitted ware culture site of Hemmor was located on a Peninsula on the eastern coast of Gotland (Fig. 1C). The site was excavated by Oskar Vilhelm Wennersten in 1903, by Paul Wallin and Helene Martinsson-Wallin in 1983, and by Åsa Hedemark, Christoffer Samuelsson and Niklas Ytterberg in 1999 (Wallin & Martinsson-Wallin 1996; Hedemark *et al.* 2000). In this study, only bird bones from Wennersten's excavation (NISP=8, Paper IV) are discussed because species identifications of birds from other excavations were not available. However, a material from the 1983 excavation (Storå 2001) is included. Wallin and Martinsson-Wallin (1996) report that fish comprises 81.3 %, pig 17.7%, seal 1% and birds only 0.4% of the identified bones from the 1983 sample. This is well in accordance with the 1903 material identified by L. Hedell (Nihlén 1927:66).

During the excavation in 1903, remains of possible dwelling depressions, hearths and burials were recovered (Nihlén 1927:66; Wallin & Martinsson-Wallin 1996:10). Typical settlement finds at Hemmor are pottery of the older Pitted Ware, harpoons, hooks and points of bone, and stone flakes. The loose human bones, already observed during agricultural activities before the first excavation, belong to the destroyed burials (Hedemark *et al.* 2000:18). Three of the almost undamaged graves have been identified and published (Janzon 1974:258–260). Two awls made from long bones of indeterminate birds were found in the loose soil in the adult burial (Janzon 1974:258). The bone beads found in the settlement layers (Wallin & Martinsson-Wallin 1996:10) probably also came from burials.

Gullrum (Näs)

The site was located on a bay on the south-western coast of Gotland (Fig. 1C). It was excavated in 1890–1893 and 1899 by a school headmaster Hans Hansson (Nihlén 1927:102, Janzon 1974:1). Data of the bird finds for this study were taken from the publication of Nihlén (1927:102) (NISP not available, Paper IV). The total area excavated at Gullrum was 1000 m². In his excavation method, Hansson mainly followed that adopted from Kolmodin's and Stolpe's excavation on Stora Karlsö (Janzon 1974:2). The area was divided into parcels which were documented in 1 x 1 m squares. The soil was sieved and plan drawings at a 1:20 scale, with each find marked with a cross, were produced. Like other Pitted Ware sites on Gotland, Gullrum also contains both settlement and burial remains (Nihlén 1927:100; Janzon 1974:254–256).

Visby (Visby)

Pitted Ware Culture site Visby is situated on the west coast of Gotland (Fig. 1C). It was excavated by Nils Lithberg in 1905, O.V. Wennersten and Johan Fardelin in 1909–1910, John Nihlén in 1924–1926, Erik B. Lundberg and Lars Bergström in 1936–1937 and Pernilla Flyg and Anders Olsson in 1983 (Nihlén 1927:229; Janzon 1974:5; Wallin & Eriksson 1985 [unpubl.]). Partly disturbed Stone Age layers were recovered under the medieval town in the late 19th and early 20th century (Wallin & Eriksson 1985). The bird bone material discussed here derives from excavations in 1924–1926 (Nihlén 1927:128) and 1983 (Wallin & Eriksson 1985) (NISP=6, Paper IV). These excavations were conducted in squares of 0.5–1.5 m and followed natural layers. Soil was sieved with both coarse and fine mesh (Janzon 1974:5; Wallin & Eriksson 1985:2).

The stratigraphy is partly mixed due to the Pitted Ware culture burials (Janzon 1974:5–6). A detailed description of the partially disturbed burials has been given by Janzon (1974: 291–334). The graves have quantities of grave goods, and for example, bird bone beads, similar to those found in Ajvide burials, are present in many of them (Paper V). Moreover, the bird bone beads found in the settlement materials (Nihlén 1927:125) most likely derive from the disturbed burials.

Saaremaa, Estonia

Kõnnu

The site was situated on the southern coast of a relatively large island (Fig. 1D). The Kõnnu site was originally discovered when a gravel pit was established (Jaanits 1979). It was excavated in 1977–1978 by Vello Lõugas and Lembit Jaanits. In 1980, the rest of the site was destroyed by cultivation. In the years 1979–1985, finds were collected from the soil that was removed with a bulldozer (Lõugas 1997a:15). The find material consisted of Early Neolithic Narva Ware type pottery, lithics and bones (Jaanits 1979). The bird bone sample (NISP=10, Paper IV) derives from the material collected in 1980–1985 (Lõugas 1997a:15). Contextual or taphonomic investigation of Kõnnu

material is not possible, but it is likely that all bird bones derive from the Early Neolithic. Some areas excavated in 1977–1978 were mixed with Neolithic burials (Jaanits 1979; Lõugas 1997a:16 and App. IIB), and it is not excluded that some of the animal bones discussed here derive from these burials. Kõnnu was probably a hunting camp for seals and other fur bearing animals, and used mainly in spring (Lõugas 1997b:7).

Naakamäe

The Middle Neolithic site of Naakamäe was located on the southern coast of a relatively large island (Fig. 1D). It was excavated by L. Jaanits in 1958, 1959 and 1962. The bird bones derive from the excavation seasons 1958 and 1962 (NISP=62, Paper IV). The pottery represents Middle Neolithic Typical Comb Ware and Late Neolithic Late Comb Ware (Jaanits *et al.* 1982:72, 85). One Stone Age burial has been recovered at Naakamäe (Jaanits *et al.* 1082:83). The material derives from somewhat mixed cultural layers, disturbed during modern road building. The taphonomic history of the bone materials has not been studied in detail. The appearence of the bird bones from Naakamäe is homogeneous (e.g., level of preservation or color) and no clear indications of mixing were observed. Based on the archaeological material, Naakamäe has been interpreted as seal hunters' seasonal camp. Animal bones indicate occupation at least during autumn but it is possible that the site was used throughout the year (Lõugas 1997b:8, Kriiska 2001).

Loona

Late Neolithic Loona was located on the western coast of a relatively large Stone Age island (Fig. 1D). The site was excavated by A. Kustin in 1956 and L. Jaanits in 1957–1959. The material analyzed for this study derives from the years 1956, 1958 and 1959. Most of the bone material, including birds (NISP=272, Paper IV) came from the Late Neolithic cultural layers. The pottery represents Late Neolithic types (Late Comb Ware, Corded Ware) and Early Metal Period (Textile Ware) (Lõugas 1997a:16; Kriiska 2001). The Stone Age cultural layers were mixed with Bronze Age burials which complicates the dating of the material (Jaanits *et al.* 1982:84; Lõugas 1997a:16–17).

The appearence and preservation of the bird bones in the Loona material is not homogeneous . For example, bones of domestic chicken which definitely do not belong to the Neolithic have a different color than other bones. Chicken bones have lighter colour than other birds and their surface is better preserved than other bird bones. The chicken bones probably derive from Bronze Age burials. A detailed contextual study could give more information on the depositional history of faunal materials from Naakamäe and Loona but this has not been done here. Loona has been interpreted as a seasonal sealing camp (Jaanits *et al.* 1982; Lõugas 1997b:7–8). However, like Naakamäe, Loona could also have offered the possibility for permanent settlement (Lõugas 1997a; Kriiska 2003:27). Two radiocarbon dates from animal bone in Loona gave results 4270±75 BP (Ua–4824) (about 3100–2700 cal BC) and 4050±80 BP (Ua-4825) (about 2900–2460 cal BC) (Kriiska 2003:21)

Hiiumaa, Estonia

Kõpu I

In the Stone Age, the Kõpu Peninsula was a small island of only 5 km² surface (Fig. 1D). Sites on the Kõpu Peninsula (Kõpu I-XI) were excavated by Aivar Kriiska in 1994–1995. An area of 32 m in length and 1 m in width was opened at Kõpu I in 1994 (Lõugas *et al.* 1996b). Soil was sieved by 1 and 2 mm hand sieves which have enabled the recovery of very small fragments (Moora & Lõugas 1995:477–478). The archaeological data support long term occupation in the Kõpu area, but only material from the Early Neolithic occupation phase, Kõpu I (Narva Ware) will be discussed here (NISP=182, Paper IV). Bird bones are unburnt but, like other animal bones, very badly preserved. Archaeological data indicate that Kõpu I was most likely a seasonal (seal) hunting station, probably used in the early spring (Moora & Lõugas 1995:479; Lõugas *et al.* 1996a:206; Kriiska & Lõugas 1999). Radiocarbon dates from Kõpu I yielded 5330±90 BP (TA-1493) (about 4337–3981 cal BC), 5698±70 BP (Tin 1901) (about 4708–4370 cal BC) (Lõugas *et al.* 1996b:204).

Zvejnieki, Latvia

Zvejnieki burials

During the Stone Age occupation, Zvejnieki was an island in Palaeolake Burtnieks (Eberhards 2006:34) (Fig. 1B). A total of 317 burials were uncovered and documented during the excavations in 1965, 1966, 1968, 1972 and 1979 by F. Zagorskis (Zagorskis 1987, 2004). Two settlement phases, Mesolithic Zvejnieki II and Neolithic Zvejnieki I, were observed close to the cemetery area (Zagorskis, 1987; 2004; Zagorska 2006a). The Mesolithic settlement was excavated almost entirely during the years 1971–1975, 1977 and 1978 (Zagorska 2006a). The total excavated cemetery area exceeds 4200 m² (Zagorska 2006a). Fifteen of the excavated burials have bird remains and will be discussed here (Paper V). Burials date to the Late Mesolithic and Early or Middle Neolithic of the Latvian Stone Age chronology but the burial area was used from the Middle Mesolithic to the Late Neolithic, about 7200–2800 cal BC. The oldest burial including bird remains (no. 154) dates to 7730±70 BP, Ua-3644 (6686–6445 cal BC) and the latest (no. 282) to 5100±65 BP, Ua-3645 (4040–3713 cal BC) (Zagorska 2006b; about the calibration of the reservoir effect, see Eriksson *et al.* 2003:15–17).

All bird remains (except burials 225, 282 and 209) in graves were identified by me at the Latvian Academy, Institute of History. The placement of bird bones in the graves was later gathered from the descriptions and drawings published by Zagorskis (1987, 2004). Some of the bird bones found in the find inventory at Latvian Academy, Institute of History have not been mentioned in Zagorskis' publication (2004). In order to investigate whether such bird bones belonged to the burial or not, some of them were radiocarbon dated (Mannermaa *et al.* 2007).

3. Methods

Some notes about the interpretation of archaeologial bird remains

A detailed and qualified analysis is the basis of osteoarchaeological interpretation. In order to make reliable identifications, large and representative reference collections of modern skeletons are needed. Knowledge of the deposition history and the preservation of bone samples are also important issues. The different preservation of organic materials at sites, excavation techniques or the size of the excavated area affects the quality of the data. A larger and better preserved bone sample will yield more identified species than small and fragmented samples (Mannermaa 2004:36–37). This means that quantitative data on assemblages have to be interpreted with caution, and even more so when assemblages from many sites are compared with each other. The detailed study of the taphonomical aspects and the source criticism is always relevant in osteoarchaeology, and even more so when studying poorly preserved materials, or materials from several sites with different states of preservation or archaeological documentation. As mentioned earlier, excavation methods and the size of the excavated area affect the sample size and its representativeness. Despite its importance, a detailed taphonomical description and interpretation of bird bone materials have not been done here.

The contexts of animal bones may be difficult to interpret, for example, in mixed or disturbed cultural layers. Marks of filleting and fresh fractures indicating marrow extraction on mammal bones indicate utilization of animals as food (e.g., Binford 1978; Tagliacozzo & Gala 2002; Outram 2002). However, bird bones are often more difficult to interpret. If the bone material is very fragmented, even the simplest osteological methods, like counting the MNI (Minimum Number of Individuals), are impractical (Anderson 1998). In large and well-preserved bird bone assemblages (e.g., Cassoli & Tagliacozzo 1995) it may be possible to investigate human utilization patterns by studying marks on bones. However, cutmarks are relatively rarely encountered on bird bones (Steadman *et al.* 2002). Fragile bird bones are easily broken by, e.g., trampling and it may be difficult to see any patterns in the breakage. Element distribution patterns have often been used for interpreting bird carcass treatment and separating natural deposits from human deposits (e.g., Mourer-Chauviré 1983; Livingston 1989; Higgins 1999; Bovy 2002). The food remains of birds of prey may sometimes represent a very similar anatomical distribution to human consumption (Bramwell *et al.* 1987). At sites near sea-shores some of the bones may derive from naturally washed out carcasses (e.g., Ericson 1987a).

The burning of bones has often been interpreted as an indication of cooking and eating (e.g., Zeiler & Clason 1993; Serjeantson 1997). However, burning may also be connected to other activities, such as waste disposal and rituals (e.g., Richter 2005; Cain 2005).

Identification

Bird bones were analyzed morphologically by comparing them with modern bird skeletons. Identification of species is based on the morphological comparative method with modern skeletal material, but also a number of identification guides were used (Bacher 1962 [unpubl.]; Woelfle 1967 [unpubl.]; Tomek & Bochenski 2001). Collections at following institutions were used for analysis: the Natural History Museum at the University of Helsinki (Papers I, II and IV), the Swedish Museum of Natural History (Papers III and IV), and the Zoological Museum at the University of Copenhagen (Paper IV). The bird reference collections of the two last mentioned museums are extensive and highly suitable for archaeological bone analyses. The bird skeleton collection at the Natural History Museum at the University of Helsinki was not originally made for bone identification purpose, and as such, it was not comprehensive when I started the analysis. The preparation of a separate bird skeleton collection for bone identification purposes by the scholars at the Museum since 2003 has improved the situation markedly. Selected reference material from the Finnish Museum of Natural History was used for analyzing bird bones from the Ajvide burials in Visby and the Zvejnieki burials in Riga (Paper V). These portable reference collections were extensive but not fully comprehensive, which may affect the level to which identification was possible.

All specimens were identified to element, side and to the nearest possible taxonomic level. Identification of species which are taxonomically close to each other is difficult and sometimes impossible. More than two individual reference skeletons, including females and males of each closely related bird species and genera are needed for the identification. The variation in morphology between individuals of the same species may be extensive and the species specific differences cannot necessarily be recognized if only one individual is available. This has led to the uncertain identifications (supplied with a question mark), or alternative identifications (e.g., *Melanitta* sp. or *Mergus* sp.). The problem of identification concerns especially burnt materials. For example, the two largest grebes, the red-necked grebe (*Podiceps grisegena*) and the great crested grebe (*Podiceps cristatus*), or the willow grouse (*Lagopus lagopus*) and the rock ptarmigan (*Lagopus mutus*) cannot be distinguished in burnt material and only occasionally in unburnt material.

Complete bone specimens were measured to the nearest 1 mm or 0.1 mm according to Cohen & Serjeantson (1996) and these were sometimes used as an aid in identifying unburnt duck bones.

All bones from young or juvenile birds were documented. Young and juvenile bones have unfused epiphyses and a smaller size than adult individuals, or a visible line of fusion and almost the size of adult individuals. The bone surface in young and juvenile individuals is rough. The presence of medullary bone (Simkiss 1967; Dacke *et al.* 1993) was studied with the naked eye and with the help of a binocular microscope. Medullary bone was investigated only in bones that were already broken.

Depositional history

The origin of the material was investigated from the skeletal element distribution (Papers I and III). The general over-representation of wings in natural deposits has been suggested in earlier studies (Livingston 1989; Higgins 1999), but this cannot be used as an obvious method for separating natural from human deposits (see, e.g., Bovy 2002).

Natural deposits typically show pronounced breakage of long and slender bones (like the humerus, ulna, tibiotarsus) compared to shorter and more robust bones (like the coracoid, femur) (e.g., Ericson 1987a; Higgins 1999; Bovy 2002).

Fresh or dry breaks in bones may indicate both human activities and the depositional history. For example, marrow extraction or artifact production by humans is usually indicated by fresh fractures (e.g., Outram 2005). A detailed fracture analysis was performed for the Ajvide settlement material in order to identify dry or fresh breaks on the bird bones and to investigate their depositional history (Paper III). The criteria for the identification of fracture patterns follow those described by Binford (1978), Haynes (1983), Johnson (1985), Lyman (1994) and Outram (2001). The parameters used are the color and texture of fractures, the fracture angle and fracture outline. Every specimen in the Ajvide settlement material received a fracture score according to these parameters (see Table 3 in Paper III).

Surface modifications can yield information on a number of factors which affected the bones before or after deposition. Natural modifications on bones were studied systematically from the Ajvide settlement material. Parameters used in the investigation of natural modifications were the color of the specimen, degree of weathering and the degree of abrasion (see Table 4 in Paper III).

When studying unmodified animal bones in burials, it is necessary to know whether they were intended as grave goods. Applicable methods for excluding potential natural deposits are the human modification of bones and the location of bird bones in the grave in relation to the human remains. The location of bird bones in burials was investigated from the illustrations and the find catalogue of burials at Ajvide in Burenhult (2002) and at Zvejnieki in Zagorskis (1987, 2004). The radiocarbon dating of human and bird bone was used in the investigation of the depositional history of bird bones in some of the burials at Zvejnieki (Paper V; Mannermaa *et al.* 2007).

Treatment of bird carcasses and utilization of birds

Sometimes the treatment of bird carcasses – butchering, preparation for food, preparation for manufacturing artifacts, etc. – leaves traces on bones. All potential marks of human modification, such as butchering marks, polishing and traces of burning on bones, were documented (Papers I, II, III , V). Marks were identified by the naked eye and a magnifying glass. Most marks were also examined with a binocular microscope using 10–40x magnification.

Sometimes, the burning of bones can be interpreted as evidence of food preparation and eating. Fire may also be used in warming the grease or marrow inside the medullary cavity. The burning of animal carcasses or their parts may also be connected to ritual activities (e.g., Ingold 1986:268; Richter 2005). Using burning as an indication of cooking for the purpose of eating would warrant a detailed quantitative and qualitative investigation. Due to lack of data, the burning of bird bones is not used as a direct indication of eating here.

Bone breakage studies and skeletal element distribution can yield information about how animals were treated and utilized. Such information is, e.g., transportation and butchering of carcasses, consumption patterns, marrow extraction and other activities like craftsmanship or ritual behavior (e.g., Binford 1978; Outram 2001). Several aspects of human behavior, like sharing of food, food prohibitions and other social aspects are reflected in the treatment of animal carcasses (e.g., Bunn 1993; Marshall 1993; Grant 2002; Politis & Saunders 2002; Lupo 2006). Activities connected to these aspects may cause bias in the taxonomic or element composition of faunal material, but they are often difficult or impossible to investigate. In this study, skeletal element distribution was used in order to investigate the pattern of human exploitation of birds at Ajvide (Paper III).

Different factors affecting the selective survival of bird bones are related to the physical properties of the bones (Ericson 1987a; Livingston 1989; Lyman 1994:446–445; Higgins 1999), damage from scavenging animals or human processing and consumption (Bovy 2002). These factors are important to take into account when single bone samples are interpreted, or samples from different areas compared. However, a detailed taphonomic study of bird bone materials has not been conducted here.

The find contexts of bird bones and the general features of the other archaeological data were investigated in order to interpret bird utilization. The exceptions are Finnish sites –the detailed investigation of the function and the character of all sites is not possible. In addition, the general low numbers of bird bones found at Finnish sites does not give a real basis for their contextual interpretations.

Hunting seasons

The hunting seasons was studied based on the presence of young birds and the medullary bone (Papers I, II, III). Although it is not known whether the routes of migratory birds were the same during the Stone Age as they are today, knowledge of contem-

porary migration is used here in order to estimate the season of capture. However, the presence of one or two bones from migratory species, which is the case at many Finnish sites, does not provide a real basis for identifying the occupation season. It is not impossible that birds were caught during the summer but the stored meat was consumed in the autumn or winter.

Use of ethnographic sources

Many osteoarchaeological methods are based on analogies with known phenomena, and analogies have been traditionally used in zooarchaeology. For example, morphological methods of bone identification are based on analogy with modern specimens. Analogy from modern cultures was the basis for the invention of methods like bone fracture analyses and animal utility indices (Binford 1978; Reitz & Wing 1999:213–221; Outram 2001). Anthropological data from modern hunter-gatherer groups may be successfully used as aid to understanding different aspects in the relationship between human and animals in prehistory (e.g., Ingold 1986; Willis 1990; Politis & Saunders 2002; Lupo 2006). However, people's relationship with animals and ideas about them reflect a marked diversity of cultural traditions. Ethnographic analogies can be used as supplementary information which help interpretation, but they cannot give direct explanations of the archaeological phenomena (e.g., Wylie 1985; Marciniak 1999:305–309; Parker Pearson 1999:34–35) (Paper V).

Few archaeological finds of weapons, traps or other tools used in fowling exist in northern Europe. Historical literature about fowling methods in northern Europe is vast and comprehensive (e.g., Ekman 1910; Itkonen 1948; Storå 1968), and can help in the investigation of prehistoric fowling methods which are otherwise difficult to study. Such data are discussed here in places but not described in depth (Paper II).

The known meanings or beliefs connected to birds, as well as other animals in historical times in northern Europe, are diversified and extremely interesting. However, in this study, the use of this data in interpration has been limited to only a couple of aspects. I have decided this because otherwise an entirely different approach would have been necessary. The known behavior of modern hunter-gatherer groups are used for generating concepts for which roles and significances birds may have had in human burials, but not for directly explaining the archaeological data (Paper V).

4. Results

4.1. What can find contexts say about the uses of birds?

The distribution of bones in excavation areas may yield information about the character of the site or the treatment of animals. The site could be used, for example, for fur and hide processing, food preparation, or ritual uses of animals. Detailed contextual investigations of Finnish sites were not performed for the present study. Sometimes, concentrations of animal bones (e.g., in hearths or refuse pits) can be observed at Finnish Stone Age sites (e.g., Sätös in Outokumpu and Yli-Ii Kuuselankangas) (Karjalainen 1996, 2002; Halinen *et al.* 1998:38; Heinäaho-Miettunen 2006). The small amount of archaeological finds at Finnish sites has been interpreted as an indication of short-term habitation (Karjalainen 2002). As described in Paper II, it is typical for Finnish assemblages to contain only a few fragments of bird bones. The contexts of occasional bird bones at dwelling sites can hardly provide a basis for a horizontal or vertical interpretation of utilization pattern.

At Jettböle I, all unburnt bird bones were concentrated in an area of about 4 m^2 (northern area) and 3 m^2 (southern area). Occasional bird bones were also found in the eastern concentration area. There are no marked distinctions between taxonomic or body part representation of birds among these areas (Figs. 4 and 5). The southern area contains slightly more burnt bird bones than the northern one. This area includes the remains of a hearth which probably explains the higher amount of burnt bones. The similarity of bird treatment in the three areas is interesting because the anatomical representation of seal bones indicates a different handling of body parts in these areas (Götherström *et al.* 2002). The northern area has been interpreted as a special activity place, most likely used for butchering animals. The southern area includes the remains of a hut or house construction with a hearth (Storå 2001, Götherström *et al.* 2002). It seems that complete skeletons of the same bird species were treated in both activity areas. The same bird species are also present in the eastern activity area, although birds are much scarcer there.

Practically all bird bones at Glamilders were found among rectangular stone enclosures. These stone enclosures can be interpreted as hearths and probable remains of domestic structures (see Storå 2000:65). Because all bird bones from Glamilders are burnt, it is evident that they have been thrown into the fire in the hearths. A plausible explanation is that animal bones represent refuse from household activities, for example, preparation of food, skinning, removing feathers, etc. The bird bone material is very homogeneous and most likely has a common depositional history. The color of

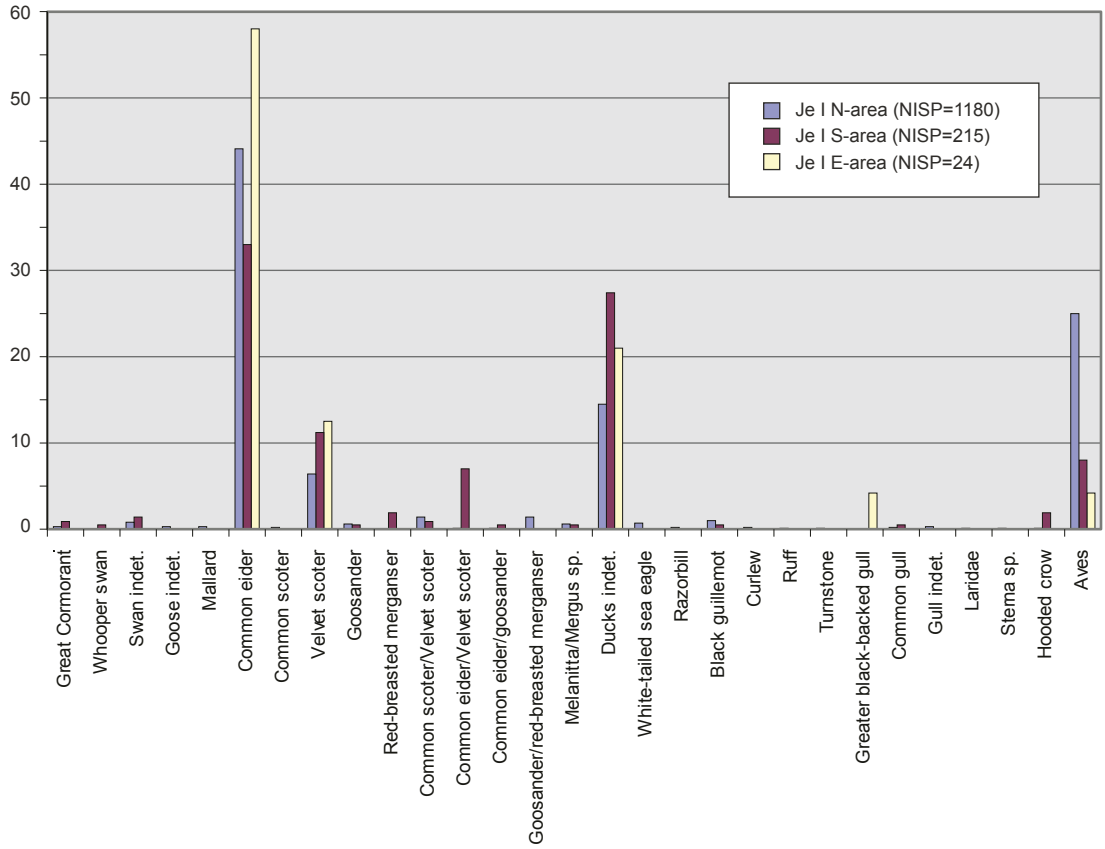

Fig. 4. *Distribution of bird taxa (NISP%) in different areas at Jettböle I.*

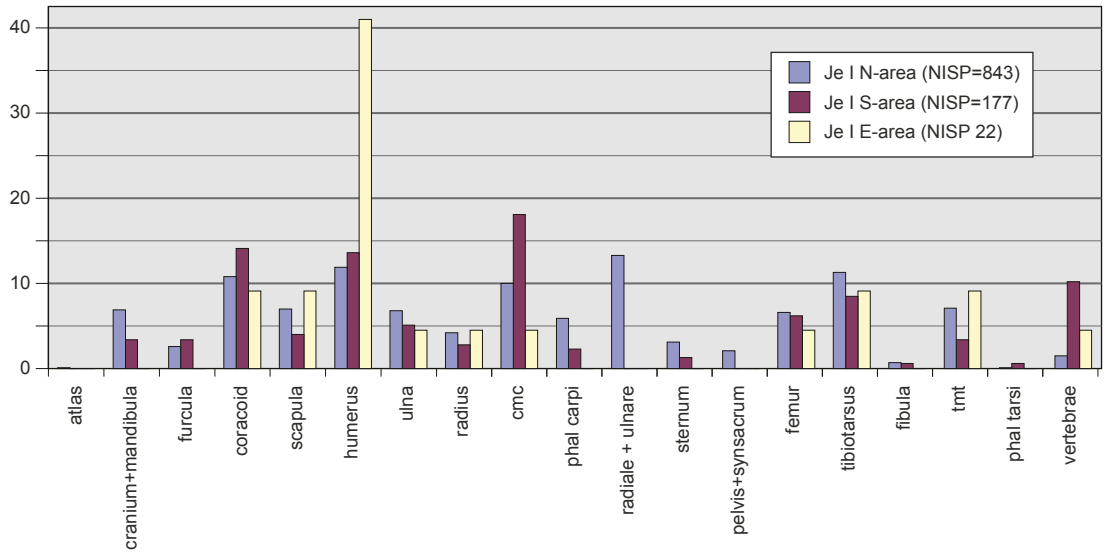

Fig. 5. *Anatomical element distribution of all bird species (NISP%) in different areas at Jettböle I.*

the burnt bones is white or grey and no differences exist in the appearance of bones found inside and outside the hearths. The color of the bird bones from Glamilders differs significantly from those from the Finnish mainland. The Finnish burnt material is typically white inside but there is a brown or yellowish layer on the surface of a fragment. The reason for the color differences may be the type of the soil where the material was deposited.

The contexts of bird bones at Middle Neolithic Jettböle I and Glamilders indicate the different characters of the sites and bone materials. The Glamilders material seems to represent household waste that was discarded by throwing into the fire, while the Jettböle I material rather represents butchering activities at a hunting camp. The differences most likely reflect how the animals were used but also the methods of waste disposal. I agree with Stenbäck (2003:202) in his argument that people who used Jettböle I had their permanent settlement elsewhere. It is of importance that all parts of bird skeletons have been found at Jettböle I and Glamilders. However, differences in the shares of individual elements are remarkable. They may reflect human activities but presumably also the different element survival of unburnt bones at Jettböle I and burnt bones at Glamilders.

Bird bones were scattered relatively evenly in the excavation area at Åsgårda. This does not indicate special activities for the treatment or utilization of birds. The concentration of animal bones in two test pits at Källsveden indicates a special accumulation, but it is not possible to interpret these concentrations further. Many of the bones were charred or burnt, which suggests that bones originated from a hearth. Human bones found in the same concentration with animal bones at Källsveden, Jettböle I and Åsgårda may refer to some kind of ritual treatment of human and animal remains (see Götherström *et al.* 2002).

The distribution of bird bones in the Ajvide settlement area reveals that bones were deposited in the cultural layer without any specific pattern (Paper III). The taxonomic composition of birds is also rather similar in different areas of Ajvide (main area and test area 1), and it is not possible to see any special features in the treatment or utilization of birds. In general, the spatial distribution of bird bones follows the general patterns of all faunal bones (see Storå 2002).

Lack of data prohibits a closer investigation of the find contexts at other Gotlandic sites. Bone material from the cave Stora Förvar indicates activities connected to the treatment and probable storage of birds and other animals. The relatively high share of birds indicates intensive fowling on Stora Karlsö. However, the very small amount of bird bones compared to mammal and fish bones at other Gotlandic Middle Neolithic sites (Ajvide, Ire, Hemmor, Gullrum and Visby) indicates low utilization of birds.

The find contexts of bird bones are essential when the roles of birds in burials practices are investigated (Paper V). In most cases, it is possible to say, both during the excavation and by reading the excavation documents, which bones belong to the grave entity and which could have been deposited naturally. However, the interpretation is not always unambiguous. For example, by using the radiocarbon dating method, my

collegues and I were able to exclude four unmodified bird bones from the grave goods in Zvejnieki graves (nos. 154, 165, 170, 256), which were previously interpreted as part of the burial entity (Paper V; Mannermaa *et al.* 2007).

4.2. On breakage pattern and skeletal element distribution

A detailed fracture analysis was carried out from the Ajvide material in order to study the depositional history of bird bones (Paper III). The high level of bird bone fragmentation and the breakage patterns observed at Ajvide does not reflect a human utilization pattern, but is rather connected to the post-depositional fragmentation and the long occupation history of the site. The older settlement area at Ajvide was later used as burial ground and for other activities. These later activities have increased the levels of trampling, and resulted in the breakage of bones from the older occupation phase. Burning, carnivore gnawing and post-depositional attrition have had some influence in the fragmentation pattern at Ajvide. Trampling, caused by intensive human activities, will produce a similar breakage pattern of bird bones as is recognized in natural deposits. Hollow birds bones with relatively thin cortical walls are especially vulnerable and prone to breakage due to trampling.

Another important result of our study is that the anatomical distribution of bird bones from the Ajvide settlement resembles a natural deposit to some degree (Paper III). Elements from wings are most abundant while the vertebrae, ribs and digits seem to be under-represented. I would prefer to interpret this as the result of the selective handling of bird carcasses by humans at the site rather than an indication of natural deposition. Complete bird carcasses were brought to the site, but the refuse disposal pattern was different for different body parts.

No detailed study of bird bone fracture patterns has been conducted at Jettböle I. The investigation of the depositional history of Jettböle material is not of primary interest because the uneven distribution of bird bones in the excavated area indicates human activity (Paper I). A preliminary investigation of the fracture patterns reveals that bird bones show some degree of breakage but also a relatively high degree of completeness. It has been suggested that the high level of breakage of pottery at Jettböle I might be caused by repeated and intensive human activity (trampling) and not necessarily by the ritual breaking of pots (Stenbäck 2003). The breakage pattern of Jettböle I bird bones most likely has a similar explanation.

It is not possible to discuss the skeletal element distribution for all bird species here. The skeletal element distribution of all bones in the family Anatidae (excluding whooper swan) shows a clear dominance of wing elements at selected sites (Fig. 6). The number of radii is pronounced at Jettböle I. This indicates very good preservation conditions because the radius is usually considered to have a low resistance against destructive agents (Ericson 1987a). The number of ulnae is pronounced at Naakamäe and Loona. Wing bones – humerus, radius and carpometacarpus – are common at

all sites. The coracoid (shoulder) is also common at all sites. The high number of coracoids is certainly in part due to the robustness of the bone (Tagliacozzo & Gala 2002:124). It seems that the robustness of coracoids helps them to survive during burning, as indicated by the high proportion of coracoids in burnt materials from Finland and Glamilders. The other reason may be that these bones are numerous because they are involved in activities connected to meat removal (from breast) and to separating wings and feathers for other uses.

The proportion of femora is not high in any of the assemblages, but it is especially low in the burnt Finnish material. Usually, the share of femora is low in natural assemblages (Ericson 1987a). However, I think that the relatively low proportion of femora implicates butchering patterns and other activities that took place at the site. It is also possible that the density and other physical structures of femur makes it more vulnerable to burning and that femora are not preserved as well as other elements in burnt assemblages (see Livingston 1989, Gumiński 2005:126). Differences in element distribution may also be affected by differences in excavation and documentation methods. The distribution pattern of bones from Glamilders and Finnish Neolithic sites resemble each other. This is due to the similar quality of material and taphonomic factors – both assemblages consist of burnt bones.

In this study material, the skeletal element distribution is most even at Ajvide. The two most representative assemblages in this study, Ajvide and Jettböle I, indicate that at least ducks were transported to the settlement site as complete carcasses. Practically all parts of the skeleton are also present at other investigated sites, with Naakamäe as an exception. At Naakamäe, bird carcasses were perhaps handled at the kill sites and only selected parts, i.e., breast parts, wings and upper legs, were brought to the site. Birds are relatively small animals and easy to carry to the settlement without any butchering at the kill site. Thus, all parts of bones are to be found at sites and not only the parts that were utilized. Bird carcasses were used for various purposes, and elements from meaty parts and non-meaty parts are present. It would have been interesting to compare the skeletal element distribution of birds at Ajvide and Stora Karlsö as the different characters of these sites might be seen in the material compsition. Such a study could not be carried out because of the lack of anatomical data from the Stora Förvar material.

Most of the eagle bones in my study material derive from legs (tarsometatarsus, phalanges tarsi) although occasional wing bones and vertebrae are present. This is clearly different than the element distribution of ducks. While ducks were likely used for various purposes, the skeletal element distribution of bones of the birds of prey indicates that they were used for some special purpose. I find it likely that birds of prey were hunted particularly for their claws and feathers (see also Gumiński 2005:139). However, there are also exceptions to this in archaeological materials. For example, the white-tailed sea eagle was represented by only the bones from the shoulders (coracoidii and scapulae) (MNI=3) in the burials at Yuzhniy Oleniy ostrov (Mannermaa *et al.*, forthcoming).

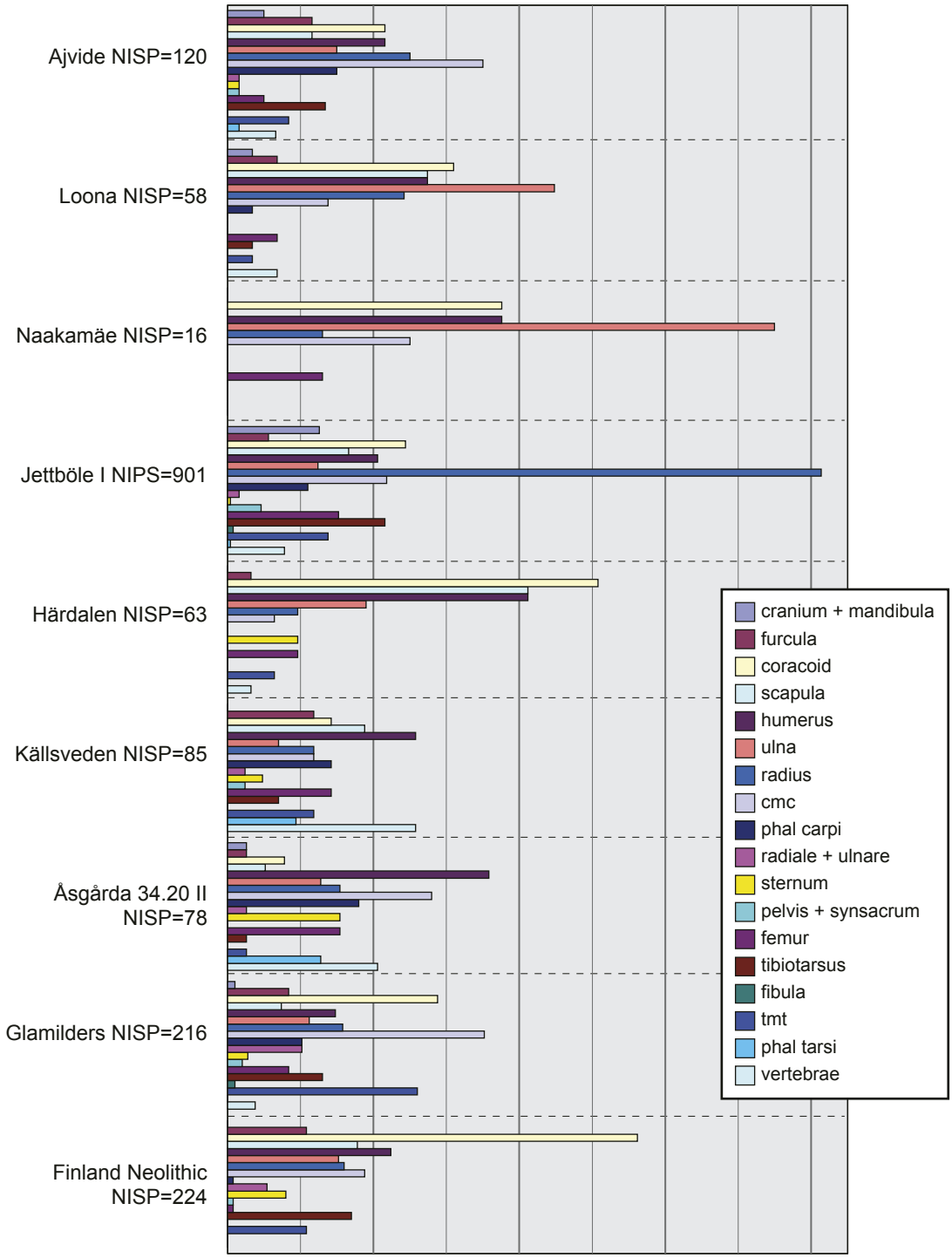

Fig. 6. *Anatomical element distribution (NISP %) of species of Anatidae (excluding* Cygnus *sp.) at selected sites and in the Finnish Neolithic.*

4.3. Bird taxa

Ducks, auks and grouse are the most common bird taxa in the material of this study (see Tables 2–3). However, grouse are not present on the large islands, with Saaremaa as an exception. All identified species are well in accordance with the ecological settings of the areas. In the following, I present the identified bird taxa in order of their prevalence.

Ducks

Ducks are the most common birds at the sites of this study. The importance of ducks is pronounced in coastal areas and especially for Middle Neolithic Åland. Small and medium-sized ducks such as the genera *Anas, Aythya* and *Mergus* were commonly hunted at Finnish sites. Preference for medium-sized ducks and the mallard (*Anas platyrhynchos*) in particular is evident throughout prehistory in northern Europe (e.g., Ericson & Tyrberg 2004, Gumiński 2005).

In fowling, Pitted Ware groups on Åland were specialized in hunting common eiders (*Somateria mollissima*) (Papers I and IV) (Fig.7). This seems to be unique in the Baltic Sea area. The value of the common eider was probably in its relatively large size, and its ubiquity and behavior (see also Ericson 1987b). It was probably easy to catch with available methods as eiders feed in relatively shallow water and the female trusts

Fig. 7. *Common eiders (*Somateria mollissima*) in display. Watercolor painting by Jari Kostet. Reproduced courtesy of Jari Kostet.*

in protective coloring during the incubation period. The rocky archipelago was suitable for the mating and breeding of the common eider. It is also usually among the first migratory species to appear in the Åland Archipelago. Meat of common eiders was eaten and bones were used in making tools (Papers II, III). Probably feathers and down were taken and used for different purposes. The hunting period of common eiders was probably longer than that of many other bird species.

The common eider is the most commonly identified duck species at the Ajvide settlement, and practically the only bird hunted at the Bronze Age hunting camp of Otterböte on Kökar. The common eider is present but not numerous at other sites on Gotland, Saaremaa, Hiiumaa and the Finnish coast. The reason for the scarcity of common eiders in these areas may be that the species was not as numerous there as they are in the Åland Archipelago during the breeding period.

Medium-sized ducks are also the most common birds in the burials at Zvejnieki, and most of the bird bone beads in the Ajvide burials were made of duck bones (Paper V).

Grouse

Grouse species (the willow grouse, the black grouse *Tetrao tetrix* and the capercaillie *Tetrao urogallus*) dominate at several Mesolithic and Neolithic inland sites in Finland (Paper II). Species in this group are present in all parts of Finland and at both inland and coastal sites, although they are more common at inland sites than at coastal sites. The willow grouse is the most common gallinaceus bird at Neolithic and Mesolithic sites in Finland, followed by the capercaillie and the black grouse. The rock ptarmigan has not been identified in Finland. Bones of the willow grouse and the rock ptarmigan are morphologically very similar and cannot be separated in burnt material. It is likely that some of the willow grouse identified in material from Lapland may in fact derive from the rock ptarmigan. Occasional hazel grouse (*Bonasa bonasia*) bones have been identified in Neolithic contexts in continental Finland (Paper II).

All grouse species are absent in materials from Åland, Gotland and Hiiumaa, but the black grouse is numerous and the capercaillie present on Saaremaa. One specimen from a black grouse has been identified on Stora Karlsö. Even though the presence of (breeding) willow grouse in the Finnish Stone Age Archipelago is indicated at several Finnish Neolithic sites, this and other Tetraonidae-species seem to have been absent on Åland and Gotland in the Middle Neolithic (or, alternatively, they were not hunted) (Papers I, II, III, IV). The apparent rarity of the hazel grouse on Finnish mainland and on islands before the end of the Neolithic may be due to the scarcity of spruce forests, the main environment of hazel grouse.

Auks

Auks are common at Ajvide and in Stora Förvar, but rare at other sites (Papers I, II, III, IV). The most common species are the razorbill (*Alca torda*) and the black guillemot (*Cepphus grylle*), followed by the guillemot (*Uria aalge*). The reason for the intensive utilization of auks at Ajvide is the nearby location of the rocky cliff island of Stora Karlsö. Today the island is the most important breeding area in the Baltic for razorbills and guillemots (Durinck *et al.* 1994:100–102). Auks were not hunted intensively in other places because they were not common. Special breeding and habitat demands affect the distribution of razorbills and guillemots in the Baltic Sea area. Interestingly enough, auks are almost completely absent in Ajvide burials – only two beads found in the Ajvide burials derive from auks (Paper V).

Divers

Divers (*Gavia* sp.) are relatively commonly identified at Finnish inland Stone Age sites, but they are rare on the large islands (Papers II, IV). Both red-throated divers (*Gavia stellata*) and black-throated divers (*Gavia arctica*) have been identified in Finland. The commonness of divers at inland sites indicates that they were typically hunted by the lakes in the breeding period or in the late summer when they prepare for the autumn transit. However, a number of finds in coastal Finland probably indicate the hunting of divers during the migration period. Another possibility is that they were hunted in the lake area and brought to the coastal sites. Divers identified at Naakamäe, Loona, Ajvide and Stora Karlsö also probably represent individuals hunted during the migration period (Paper IV). Fennoscandian and Baltic breeders are also found during the winter in the coastal areas of the Southern Baltic (Cramp *et al.* 1986) which means that some of the Gotlandic diver finds may be from wintering bird individuals.

Bones from the red-throated diver were placed in the burial 7 (male) at Ajvide. Toe bones from unspecified diver were found in the grave area of burial 164 at Zvejnieki, but according to the radiocarbon date, they do not belong to the burial (Paper V; Mannermaa *et al.* 2007).

Grebes

Grebes (*Podiceps* sp.) are relatively commonly identified at Finnish sites, especially the Neolithic sites. Species are rarely identified, but according to the size and morphology, most of the specimens belong to the red-necked grebe or great crested grebe. The slavonian grebe (*Podiceps auritus*) was identified at the site of Yli-Ii Kuuselankangas in northern Finland (Paper II). Grebes are absent in material from the Åland and rare on Gotland. Saaremaa is a special case due to the large amount of grebes (the red-necked grebe or the great crested grebe) at Naakamäe (Paper IV). The abundance of a suitable environment for grebes, shallow and vegetated bays, may be the reason for the abundancy of grebes on Saarenmaa. This has enabled their effective hunting at Naakamäe.

Geese and swans

Geese (*Anser* sp. and/or *Branta* sp.) are relatively numerous at Ajvide and Loona but rare at other sites. The low representation of geese in refuse faunas is surprising. Geese are relatively large birds and could be hunted *en masse* during migration. One reason for the low representation may be that many goose species are much more timid and watchful than other duck species, which could have made them difficult to catch.

Swan (*Cygnus* sp.) bones are present at several sites in Finland, Åland, Gotland and Saaremaa, but only in very low numbers (Papers I, II, III, IV). The exception is Stora Förvar where swan bones are numerous. Only some of the swan bones in Finland, Åland, Gotland and Saaremaa could be identified as to species, but it is likely that most of them belong to the whooper swan. Most of the identified swan bones in Finland derive from Mesolithic sites (Paper II). It is possible that some ideological attitude may have restricted the hunting of whooper swans (Paper II, Paper V). Swans depicted in the Neolithic rock art in the Lake Onega region have been interpreted as totems, symbols of the soul or messangers between humans and the spirit world (Ernits 1992, Lahelma 2008a). A special relationship between swans and people is also indicated in the use of swan motifs in the pottery decoration in Middle Neolithic Finland and Russia (e.g., Pesonen 1996; Poikalainen 1999). Hence, it is interesting that swans are absent in graves at Zvejnieki and scarce at Ajvide (Paper V).

Birds of prey (including owls)

Eagles (white-tailed sea eagle or golden eagle *Aquila chrysaetos*) are relatively often present at coastal and inland sites in Finland and on the large islands (Papers II, IV). Only the white-tailed sea eagle has been identified on Åland, Gotland and Saaremaa. Other birds of prey are the osprey (*Pandion haliaetus*), the Tengmalm's owl (*Aegolius funereus*), the red kite (*Milvus milvus*), the rough-legged buzzard (*Buteo lagopus*) and the western honey buzzard (*Pernis apivorus*) (Gotland), and the northern goshawk (*Accipiter gentilis*) (Gotland and Saaremaa). All species, except the white-tailed sea eagle, are represented by occasional bones. I suspect that hunting of these species was not intensive or at least not very successful, or carcasses were not treated or disposed at the settlement sites. There is no evidence for eagle hunting methods in prehistory. They were probably shot with a bow and arrow in the nests, or caught with traps. Chicks may have been collected from the nests and fed and raised in captivity. Evidence of keeping adult white-tailed sea eagles in captivity exists from the Early Iron Age site of Ust' Poluisk in northwestern Siberia (Potapova & Panteleyev 1999:133–135). None of the eagle bones of this study or in graves at Yuzhniy Oleniy ostrov (Mannermaa *et al.*, forthcoming) show evidence of being captive birds.

Birds of prey have not been identified at all in burials in Zvejnieki and Ajvide (Paper V). An owl leg bone which was found in burial 256 at Zvejnieki does not belong to the burial according to the radiocarbon dates (Mannermaa *et al.* 2007).

Other taxa

The high number of identified bones of the great cormorant (*Phalacrocorax carbo*) at Ajvide and Stora Förvar indicates that this bird was relatively intensively utilized at these sites (Papers III, IV). It is likely that people at Ajvide went to Stora Karlsö to hunt cormorants. The great cormorant is also abundant in Ajvide burials and the settlements of Jettböle I and Naakamäe (Papers I, IV).

Common crane is present in Ajvide settlement and burial material but absent at all other sites. Gulls (*Larus* sp.) are numerous at Jettböle I, Loona and Ajvide but otherwise they are rare. Waders from the families Scolopaciidae and Charadriidae have been identified relatively often at Jettböle I, Ajvide and commonly on Åland and Gotland, but in other areas they are rare. Unspecified plovers (*Pluvialis* sp.) are relatively numerous at Ajvide which indicates that the bird had some economic importance. The Eurasian woodcock (*Scolopax rusticola*) is present in Finland, Åland and Gotland, but numerous only on Saaremaa (Loona). Bones from the Eurasian woodcock were found together with bones of the common goldeneye (*Bucephala clangula*) and European elk in eastern Finland, in connection with underwater excavations underneath red-ochre rock paintings (Paper II). One of the woodcock bones has been radiocarbon dated (AMS) to 3275+-35 BP (Hela-1434), or about 1610–1500 cal BC (beginning of Early Metal Period) (Lahelma 2008b). The painting cannot be dated, but it could well date to the Early Metal Period. It is likely that the bones were deposited on the lake bottom during some ritual act connected with the use of the rock painting site (Lahelma 2008b).

Species in the family of crows are not numerous in the assemblages of this study. The hooded crow (*Corvus corone*) is relatively common in bird material at Ajvide and Stora Förvar. An interesting example of the importance of birds from the crow family is the presence of the jay (*Garrulus glandarius*) in three Middle Neolithic burials at Zvejnieki. Unmodified wing bones from jays are rare examples of the symbolic, ritual and probably social importance of birds in prehistoric northern Europe (Paper V). A bone of a jay was also identified in the settlement material from Ajvide, but it is impossible to say anything about its use(s).

The utilization of waders is reflected in the settlement material from Gotland, Saaremaa and Åland, even though only a few species can be identified. The turnstone (*Arenaria interpres*), the ruff (*Philomagus pugnax*), the Palearctic oystercatcher (*Haematopus ostralegus*), and an indeterminate stint (*Calidris* sp.) were identified on Åland. The western curlew (*Numenius arquata*) was identified on Åland and Gotland, and the whimbrel (*Numenius phaeopus*) on Gotland. The utilization of waders is also indicated in Ajvide burials where many of the tubular bone beads are made of wader bones.

Occasional finds of the European nightjar (*Caprimulgus europaeus*) from Finland and Gotland, the water rail (*Rallus aquaticus*) and an indeterminate tern (*Sterna* sp.) from Åland, and the corncrake (*Crex crex*), the Eurasian cuckoo (*Cuculus canorus*), the wood pigeon (*Columba palumbus*) and the common redstart (*Phoenicurus phoeni-*

curus) from Gotland are interesting additions, but it is unlikely tht these species were economically important.

Finds of the gannet (*Morus bassanus*) and the great auk (*Alca impennis*), found at Ajvide and Stora Förvar are interesting from the faunal historical point of view. Probably neither of the species bred in the Baltic Sea (Aaris-Sørensen 1988; Ericson & Tyrberg 2004). The specimens identified on Gotland represent occasional visitors to the area. How these species were hunted is not known, but they may have been caught by opportunity. On the other hand, it is not impossible that they represent birds or parts of birds transported from other areas. The nearest known breeding areas of the gannet are today located in the North Atlantic (western Norway, northern Britain) (Cramp *et al.* 1986). The great auk is now extinct, but during historical times, the known breeding areas were located in the eastern Atlantic (Freethy 1987:28–39; Serjeantson 2001). Finds of great auks are known from Mesolithic and Neolithic sites in Denmark (Aaris-Sørensen 1988).

Many bird species presently breeding in Fennoscandia, the Baltic area and the large Baltic Sea Islands are not present in the prehistoric bone assemblages discussed in this study. The interesting feature in all samples is the almost total absence of small forest songbirds, like tits (Paridae) and warblers (Sylviidae). It is possible that this is due to taphonomic factors – the poor preservation of small bones – or the rough methods used in excavating and collecting (mainly, the lack of sieving). The presence of thrushes (Turdidae) in the well-preserved Ajvide material may support these explanations. However, I believe that the more probable explanation is that small song birds were not hunted.

Comparison of bird taxa in settlements and burials

The investigated burial and settlements material from Ajvide are not of the same age. The burials are slightly more recent than the settlement site. Thus, due to the chronological difference, a direct interpretation of the use of birds in the settlement and in burials is not possible. However, some observations can be made. It seems that cormorants had a specific role in both the death rituals and in the everyday life (subsistence?) at Ajvide. The clearest difference in the burial and settlement material from Ajvide is in the share of auks. Auks have a clear dominance among the birds from the settlement material, but they are almost totally absent in the burial material. This indicates that auks were strongly connected to the economy and did not have a place in the death ideology (Paper V).

Bird bones are so scarce at the Zvejnieki dwelling sites that only a few comparisons can be made with the grave material (Eriksson *et al.* 2003, Lõugas 2006). Ten bird bones were identified in the Mesolithic settlement Zvejnieki II (Lõugas 2006:77). Among these were bones of an indeterminate small diving duck (*Aythya* sp.) and two awls made of bones from a black-throated diver and an indeterminate grebe (Mannermaa 2006). Bird bones have not been found in the Neolithic settlement Zvejnieki I. It

is notable that grebes are present in the Mesolithic settlement but they are not present in the Mesolithic burials (Paper V; Mannermaa *et al.* 2007).

The context of the bird bones in graves at Vaateranta in Taipalsaari is not clear, and it is not possible to interpret them further. However, it seems that burnt bird bones were part of the graves (Paper II).

It has been suggested that animals used in Stone Age burial rituals were different from those connected with daily life (see Eriksson *et al.* 2003, Eriksson 2004:156). The osteological materials and the stable isotopes of human bones in the Mesolithic and Neolithic Zvejnieki reveal that the economy was mainly based on freshwater fish (Eriksson *et al.* 2003). However, fish are very seldom present in Zvejnieki burials. Instead, animals from burials suggest a strong utilization of mammals such as the European elk, fox (*Vulpes vulpes*), pine marten (*Martes martes*), badger (*Meles meles*) and seals (Zagorska & Lõugas 2000). Another example of the differences between the economy and ritual comes from Finland and Russia. Depictions of animals in rock art or pottery decoration in Finland and western Russia do not reflect the composition of the refuse faunas from settlements sites. The most commonly utilized prey species were not depicted in the prehistoric artistic expressions (Pesonen 1996:12). It is interesting that ordinary and common bird species were used in the mortuary practices at Ajvide and Zvejnieki. All bird species present in burials could have been caught nearby and they seem to be typical of the local environments.

4.4. Chronological aspects

I have earlier divided the Finnish bird bone finds according to periods and locations coastal or inland (Paper II). In order to more precisely investigate chronological traits in fowling in the Finnish Stone Age, I have here further divided the Neolithic material into early, middle and late phases. The distribution of bird taxa (unspecified Aves excluded) in these periods is presented in Fig. 3. The Late Neolithic is not presented in the figure because only one site could be connected to this phase. The fowling pattern is rather similar at all Mesolithic sites. All of them have species of Tetraonidae and ducks, or both of them (Paper II: Fig. 5). A clear difference at coastal and inland Mesolithic sites is that divers are present only in assemblages from inland sites. This indicates the hunting of divers during the breeding period and the occupation of the inland sites at least in summer.

The identified bird taxa from the Neolithic material are clearly more diverse than those from the Mesolithic. The number of sites and the number of identified specimens affect the number of identified taxa, but reasons for higher taxonomic variation may also reflect fowling intensity. The highest number of bird bone specimens and bird taxa were identified at coastal Middle Neolithic sites. The higher productivity of the Baltic Sea during the Litorina phase in the Early and Middle Neolithic (Ericson 1989; Nuñez 1996; see also Okkonen 2003:221) may have led to larger bird popula-

tions and to more intensive fowling on the coast. Ducks are common at all coastal sites in this study and the mallard is the most common bird species at Finnish coastal sites.

My study of the taxonomic distribution of bird specimens at the Finnish Mesolithic, Early Neolithic and Middle Neolithic sites indicates an increasing intensity of fowling and variation in species during the Early and Middle Neolithic periods. This trend at Finnish sites is further supported by the high number of identified bird taxa on Middle Neolithic Åland and Gotland (Ajvide, Stora Förvar) (Paper IV). On Åland, the proportion of bird bones is high in the older Pitted Ware phase, but it is significantly lower in later phase. This indicates some shift in the economy in the later part of the Middle Neolithic. A shift in the economic base is perhaps supported by the fact that the grey seal (*Halichoerus grypus*) has been identified only in the later Pitted Ware bone materials (Storå 2000:69). The amount of domestic animal bones is also higher in the later phase Pitted Ware sites (Storå 2000:71–72).

The Otterböte site represents a seasonal long-distance hunting camp and is about thousand years later than the Pitted Ware sites on Åland (Gustavsson 1997). However, similarly to the Pitted Ware people, the common eider was also the most important bird species for people visiting Otterböte.

The composition of the bird finds in prehistoric Finland and Åland resembles very much the modern game bird inventory (Paper II, Mannermaa 2004). The common eider and velvet scoter were, until recent hunting regulation, the most numerous game birds on Åland, and the mallard, the green-winged teal (*Anas crecca*), the garganey (*Anas querquedula*) and Tetraonidae-species on the Finnish mainland (see Table 3 in Mannermaa 2004). The same bird species that are hunted with modern weapons were also caught with prehistoric fowling methods.

4.5. Birds as resource

Subsistence

Food was definitely one of the most important ways of utilizing birds. Marks from butchering and filleting indicate that meat from whooper swans and common eiders was consumed at Ålandic sites and common eiders, guillemots, divers, whooper swans, and lesser black-backed gulls/herring gulls at Ajvide (Papers I, III). Cutmarks observed on bones from these species can be connected to filleting and slicing (Tagliacozzo & Gala 2002). Cutmarks on the distal end of a humerus from a white-tailed sea eagle at Loona and on a burnt ulna of unspecified duck from Rääkkylä Vihi I in eastern Finland can be connected to the separation of meat (Paper II). Six specimens at Ajvide indicate marks from disarticulation (the greylag goose [*Anser anser*], the whimbrel, the great cormorant, the mew gull, and an indeterminate auk). These marks

may be connected to flesh removal (Paper III). Butchering marks were, in most cases, found on bones from shoulders and proximal wings, which indicates that meat from the breast was separated.

Filleting and slicing marks are direct indications of the utilization of bird flesh as food, but, in my study material, such marks are limited to a few bird species. However, all bird species are palatable. The relatively high representation of velvet scoters at sites on Åland, auks and ducks at Ajvide, grebes at Naakamäe on Saaremaa and grouses, capercaillies and ducks on the Finnish mainland indicates that these species were eaten.

Bird meat was definitely eaten, but also other parts of birds, e.g., the liver, is palatable. Fat from bird bones may also have been eaten (e.g., Saint-Germain 2005). One distal femur of an indeterminate diver from Källsveden is split and burnt around the cutting area. This may indicate heating and extraction of bone marrow or grease. Diver bones are greasy and the femur is one of the bones in the bird skeleton that includes the highest amount of fat and bone marrow (Higgins 1999:1453).

Eggs were probably an important source of nutrition in summer but they are not present in the archaeological data due to taphonomical reasons. Eggshells have usually not been found in archaeological assemblages (but see Keepax 1981; Eastham & Gwynn 1997). Eggs may have been important because they can be stored for winter food. Fresh eggs can be kept easily for several months without any kind of preservative (Fenton 1978:512).

Tools and implements

Bird bones are naturally hollow and as such can be used as tools without much modification. However, the archaeological data for using bird bones as raw material for artifacts and tools is not abundant. I believe that this is mainly caused by poor preservation and the fact that the use of bird bones as tools, and the methods of working birds bones have not been investigated in such detail as has been done with the bones of large mammals (e.g., David 2003, 2005). Awls and points are the only tools made of bird bone found in the Stone Age in the Baltic Sea area. Two awls made of the tibiotarsus of the common eider and the humerus of the great cormorant were found at Jettböle I (Fig. 8). Four points made of indeterminate bird bones were found in a male burial at Zvejnieki (Paper I, Paper V). Unfinished tools or cut bones are present in

Fig. 8. *Awl made from humerus of the great cormorant (*Phalacrocorax carbo*) from Jettböle I. Length 13.3 cm. Middle Neolithic Period. Photo Kristiina Mannermaa.*

Fig. 9. *Worked humerus from a swan, probably a whooper swan (*Cygnus cygnus*), from Korpilahti in Vuoksenranta (Antrea net find). Length 18.8. cm. Mesolithic Period. Photo Ritva Bäckman, National Board of Antiques.*

materials from Åland and Gotland (Papers I, III). For example, the cut and polished common eider ulna from Härdalen (ÅM 649:180) is probably an unfinished or broken part of an awl. Two burnt pieces of artifacts were found in settlements on mainland Finland (duck ulna at Rääkkylä Vihi I in eastern Finland and duck radius at Hiitteenharju in Harjavalta in western Finland), but it is impossible to say anything about the type of artifacts of which they have been a part (Paper II). A worked swan humerus in the Antrea net find complex (Vuoksenranta in Karelia) may be an unfinished tool, arrowhead or musical instrument, but the function of this much discussed item remains uncertain (Paper II, see also Leisiö 1983; Mannermaa 2005) (Fig. 9).

Use of skins, feathers and bones in paraphernalia, decoration and raw material

Few indications about prehistoric uses of feathers exist. Feathers need very special depositional circumstances for preservation. The removal of feathers does not necessarily leave marks on bones (Politis & Saunders 2002:126). It is likely that feathers and pens were widely used, e.g., in paraphernalia and decoration in prehistory, like they were used in other periods or areas (e.g., McGovern-Wilson 2005). It seems that (parts of) jay wings were used in the decoration of burial dresses at Middle Neolithic Zvejnieki (Paper V). The blue feathers of the jay were perhaps considered beautiful and/or the jay may have been a totem animal for these people. It is possible that the blue color had special symbolic significance for this group (Paper V; Mannermaa 2006).

Many of the bird species found at archaeological sites, like male mallards, have brightly colored feathers. These may have been used for clothing decoration but also may have had other significances, e.g., connected to color symbolism (e.g., Wasilewska 1991; Jones & MacGregor 2002; Jackson & Scott 2003:555). Other uses may have been for fletching arrows, sealing up or insulating hut walls and clothing, decorating pottery, or making bird calls (Potapova & Panteleyev 1999:135; Clark 1948:129–130; Žul'nikov 2006:30). In the Neolithic, feathers were used as pottery temper in eastern Finland (Huurre 1984:46). The feathers of eagles and other birds of prey may have been favored for arrows. This could be an important reason for their hunting. Practi-

cally all eagle bones at the studied sites derive from legs and wings which supports the idea that wings were sought for feathers.

In historical times, bird skins have been the raw material for many kinds of articles, like quivers and pouches. For example, the skin of the black-throated diver was used for headgear and saltbags among the Saami (Itkonen 1948; Kielatis 2000). Archaeological evidence for the use of bird skins does not, however, exist in the Baltic Sea area.

Bird bones were manufactured in to beads or amulets at Ajvide and pendants at Zvejnieki (Paper V). Most of the beads are made of the radius and ulna of water birds, but also humerus and tibiotarsus were used. Bird bone beads quite similar to those from Ajvide have been found in the Middle Neolithic burials at Tamula in southern Estonia (see Appendix 2) and Neolithic Dudka in northwest Poland (Jaanits 1957; Tomek & Gumiński 2003; Gumiński 2005:125). All pendants derive from medium-sized or small ducks. The perforations in the specimens from one burial (190) are pointed on one side, which indicates that they have been hanging for a long time (Mannermaa 2006). The location of bird bone beads and pendants in graves in respect to human skeleton suggests that these were decorations on the coat or shirt of the deceased, or ornaments that were worn on the head, neck or breast. However, other practical and symbolic significances may have been connected to the decoration. For example, organizing parts of various species, or the sound made by free-hanging artifacts may have been important.

Tarsometatarsi (lower leg bones) from the great cormorant, crane and unspecified birds were made into artifacts (pendants?) found in some of the Ajvide burials (Paper V). Similar items made of common eider bones were also found in burials at Ire (Janzon 1974). The find contexts indicate that tarsometatarsi pendants were probably hung around the neck or sewn on headgear or hats. This type of artifact is unique to Middle Neolithic Gotland.

4.6. Birds in burial practices

Bones from ducks were used for making pendants and beads, and used in decoration. However, it is well known that artifacts may also hold social and ideological meanings. The detailed investigation of bird bone beads from Ajvide burials indicated that beads mainly appear in pairs of exactly similar form, length and breadth (Paper V). In many cases, pairs were made from left and right side elements of the same individual. Making two similar beads may be connected to dualistic symbolism, also seen in the appearance of double-edged amber beads at Ajvide (Burenhult 2002:63). Dual or pair symbolism has earlier been observed in other archaeological contexts as well as ethnographic data (Ernits 1992; Runcis 2002; Loze 2003:53; Žuľnikov 2006:46–56). Dualism has been associated, for example, in the Neolithic burial contexts in western Sweden, with the idea of the world order and the need to maintain balance and har-

mony (Runcis 2002). Additionally, all tarsometatarsus artifacts, found in three Ajvide burials, appear in pairs (left and right side elements), which may be associated with pair symbolism.

A striking emphasis on wetland birds – and ducks in particular – and on wings (the ability to fly?) is evident in burials at Ajvide and Zvejnieki. With the exception of the jay, all identified bird remains in Ajvide and Zvejnieki burials belong to waterbirds. Even the bone beads in Middle Neolithic graves were, in most cases, made of wing elements from waterbirds (Paper V).

Bird bone pendants and other artifacts as well as modified bird bones in graves likely indicate that some symbolic and ideological meanings were connected to these birds. It is possible that many bird species were predominantly important because of other than material values. Archaeological data suggests that at least the red-throated diver, the common crane, the great cormorant, the whooper swan and the common eider were somehow important in the ideology of the people at Middle Neolithic Ajvide, and the mallard, unspecified *Aythya* sp. and the jay at Mesolithic and Neolithic Zvejnieki. A clay figurine probably representing a swimming diver was found in a Typical Combed Ware settlement site in eastern Finland (Paper II, Karjalainen 1997). It probably had some spiritual function (see, e.g., Pesonen 2000). Bird figurines are also known from burials at Ajvide and Zvejnieki and Tamula in southern Estonia (Paper V). A burnt wing bone fragment from the European nightjar on the western coast of Finland may originate from decoration or some ritual activity (Paper II). It is possible that the buzzing sound of this nocturnal bird had some special significance for the people.

5. Discussion

5.1. Main factors affecting bird utilization

Location of the site and the availability of breeding birds and land mammals

The general dominance of duck bones at coastal sites and grouse and divers at inland sites seems to be typical for all cultural periods in Finland. Good examples are Vepsänkangas in Ylikiiminki (Ostrobothnia), where various ducks species and divers have been identified, and Hyrynsalmi Koppeloniemi (northeastern Finland), where divers, grebes and species of Tetraonidae (willow grouse, black grouse and capercaillie) were identified. Vepsänkangas and Koppeloniemi represent Early Neolithic Sär I Ware but Vepsänkangas was situated on the inner archipelago and Koppeloniemi by an inland lake.

Local topography is important in affecting the availability of breeding birds in coastal areas. This is clearly seen in the Åland sites or Ylikiiminki Vepsänkangas. The location of the sites in the sheltered shallow archipelagos was suitable for the hunting of breeding waterbirds.

Fowling was specialized and selective on the Åland Islands (Paper I). The Finnish bone material also indicates selective fowling: almost exclusively ducks, divers, grebes and grouse were hunted, and, for example, gulls and waders are not represented in the material. At Ajvide, people caught mainly waterbirds (auks and ducks) but species living in forested areas were also hunted. Fowling seems to have been rather extensive but at the same time selective at Ajvide (Paper III). Bird bone material is scarce compared to mammal bones in all Gotlandic sites except the cave Stora Förvar on the island of Stora Karlsö (Paper V). Based on the small amount of bird bones at Gotlandic sites, it can be concluded that, according to the osteological material, birds did not have any significant role in the economy of the people at Hemmor, Gullrum and Visby. However, unmodified bird bones or artifacts made of them are found in graves at these sites indicating that birds were hunted and utilized.

The availability of land mammals seems to affect fowling intensity. Continents and large islands could sustain a higher diversity of land mammals than small, isolated islands. The hunting of birds might have been most important at inland sites when food was otherwise scarce, such as during winter. On Gotland and Saaremaa, the most important game animals were seals, but people also hunted a variety of land mammals (feral pigs/wild boar, arctic hare, etc.). On these islands, the need for utilizing bird

resources was less acute. Birds were eaten alongside of seals and fish, the two primary sources of food (Rowley-Conwy & Storå 1997; Olson *et al.* 2002; Outram 2005). The situation was the opposite in the Åland Archipelago where the arctic hare was the only medium-sized mammal that lived there permanently. Fishing at Jettböle I has not been investigated, but it is probable that fish were a very important food supply, available in all seasons.

Mobility, seasons and settlement patterns

Some food sources were available in all seasons (e.g., local birds, pike *Esox lucius* or the European elk in Finland), while most were available or easy to catch only during a particular season(s). Seals may be counted as a seasonally exploited resource on Gotland, Åland, Saaremaa and Hiiumaa (Lõugas 1997b; Storå 2000, Storå 2001), and definitely migratory birds and fish (Papers I, III). Nuts, berries and other plants were also seasonally available. Migratory birds have contributed to the diet of prehistoric people in summer during breeding (perhaps mostly eggs and young individuals) and molting periods. The summertime, a period when the largest amount bird fauna is present in breeding areas, was not the most crucial period of prehistoric subsistence because also other sources of food, like fish and other animals, berries and nuts, were available. Stored food (e.g., meat of mammals, fish and birds, eggs, berries) can secure the food supply in the autumn and winter. The economic importance of birds was probably pronounced in all areas during the spring when the flocks of migratory birds arrive (see also Nuñez & Okkonen 1999, Okkonen 2003:222).

According to this study, medium-sized ducks, auks, divers, (grebes) were the most commonly hunted birds at coastal sites and medium-sized ducks, grouse, grebes and divers at inland sites. Cormorants have not been identified at all on the coast of the Finnish mainland or other Finnish sites, which is surprising in the light of their commonness on Åland and Gotland. The reason for the hunting of these species in particular is probably their way of gathering in large flocks or colonies during breeding, migration or wintering periods. The year-round abundancy and relatively easy trapping of willow grouse, black grouse and capercaillies in winter may have made these species important on the Finnish mainland when other food resources were limited (Paper II). The small amount of geese bones in the archaeological material points to a minor utilization of geese. The idea about the economic importance of geese and swans for prehistoric cultures, for example, at sites at the mouths of the large rivers in Ostrobothnia (e.g., Okkonen 2003:222) does not gain support. The reasons for the rarity of geese in Stone Age materials may be their rarity in the Stone Age: perhaps geese have spread in northern Europe in large quantities only later, along with the spread of agriculture in their breeding and wintering areas. Hunting restrictions could also have affected the utilization of geese.

In large mainland areas, like Fennoscandia, many prehistoric hunter-gatherer groups moved according to the season and the movements of prey (e.g., Zvelebil 1981;

Broadbent 1979; Forsberg 1985; Siiriäinen 1987). For example, investigations of Neolithic dwelling depressions by the large rivers that run into the Gulf of Bothnia indicate that winter sites (although year-round occupation of these sites is also possible, see, e.g., Pesonen 2002:27) were located at the river mouths and the summer time was spent in inland (Kotivuori 2002:157 [unpubl.]). Large flocks of migratory birds at the river mouths become available when the ice begun to melt in late winter or early spring. If seal hunting was the main reason for the Neolithic occupation of coastal Ostrobothnia and the Kemijoki river in late winter and early spring, as suggested by, e.g., Kotivuori (2002 [unpubl.]), then the arrival of migratory birds must have been an important reason for occupying these sites in spring and early summer.

Bones of birds are generally scarce in Finnish samples and it is often difficult to use bird bone material in the determination of the occupation season. The possibility of storing bird meat and using bird bones in artifact production has to be taken into account when interpreting occasional bird bones in prehistoric samples.

Ice conditions have an essential role in determining the arrival and departure of migratory waterbirds. Many birds identified in the prehistoric bone materials from Gotland and Åland may winter in the area today, but this was probably not the case in the Stone Age. Storå (2002:398) has investigated age profiles of ringed seals and harp seals at Ajvide. Both species need ice for breeding. Very young individuals of these species are present which indicates that ice regularly formed in the area around Ajvide. Waterbirds need open water throughout the year. The areas around the Middle Neolithic Gotland (and the northern parts of Baltic Sea) were perhaps not as frequently as today suitable for wintering waterbirds. However, significant annual changes in ice formation in the Baltic Sea may have occurred and suitable circumstances for seal breeding did not necessarily prevail every year in these areas. In such years, when the ice did not form, seal hunters had to follow the ice towards the north, or use other sources of food, e.g., fish and wintering birds. Annual fluctuations in the climate had an impact on peoples' choices of fowling pattern. Seals and birds were mostly a seasonal resource but utilized intensively in late winter, early spring and summer. At Ajvide and Jettböle I, the main seal hunting season was earlier than the main fowling season, but the principal fowling season may have coincided with the main fishing season (Papers I and III).

It is not surprising that grouse were caught and utilized in Finnish inland areas. It has been suggested that many of the Neolithic house and hut remains are connected to permanent settlements (Karjalainen 1999; Pesonen 2002:27; Leskinen 2002:169). Such settlements would have been suitable for trapping and other forms of hunting the local birds. Then it would be only logical that grouse have contributed to the winter economy of these populations.

Hunting of breeding, wintering and migrating birds

The birds identified in this study indicate that people caught mainly breeding birds. The specialization on breeding birds is evident in material from Åland and Gotland, but this tendency can be seen in other material as well (Papers I, II, III, IV). This is logical in the light of the fact that the majority of bird species observed in the study area today are migratory birds. The presence of bones from young birds and the presence of medullary bone inside some of the long bones are direct indicators of the utilization of breeding birds (Papers I, III, IV).

Wintering waterbirds were caught in open water areas in the southern part of the Baltic Sea (Paper III). Archaeological data suggests that wintering birds were hunted near sealing camps on Saaremaa and Hiiumaa (Paper IV). Wintering (or migrating) birds were extensively hunted in the southern parts of the research area (Gotland).

The third fowling period indicated by the material covers the spring and autumn transits. The specialized hunting of birds on migration is hard to show, and rarely indicated in the material. Many of the migratory birds, which today pass Åland and Gotland in autumn and spring, like the red-throated diver, the black-throated diver, the long-tailed duck and the common scoter, are only occasionally identified in the bone assemblages from these islands. The specialized hunting of migrating (or wintering) grebes was practiced at seasonal hunting camps on Saaremaa. Long-tailed ducks (*Clangula hyemalis*) from Åland and Saaremaa indicate hunting during winter or migration period. The red-necked grebes identified in Stora Förvar probably also derive from wintering or migrating birds (Ericson & Tyrberg 2004:57).

Bird species at coastal seasonal sites on Saaremaa (Kõnnu, Naakamäe and Loona) are different from other islands (Paper IV). Mostly long-tailed ducks were identified at Kõnnu, which indicates the hunting of wintering or migrating birds on the open sea. The goosander and red-breasted merganser are also present in the Kõnnu material which is a further indication of spring hunting. At Naakamäe, grebes are clearly more common than ducks. The great crested grebe and red-necked grebe are breeders and migrants in Estonia, but, in mild winters, may also winter in coastal areas (Leibak *et al.* 1994:29–30). The scarcity of ducks at Naakamäe may suggest that grebe hunting took place in autumn, winter or spring. Hunting breeding grebes in their easily recognizable floating nests would be the easiest way to capture them, and this possibility cannot be excluded. However, suitable breeding enviroment for grebes may not have existed on Saaremaa in the Stone Age. Thus, it is not possible to determine the grebe hunting season on Saaremaa.

It is interesting that the majority of bird bones at Küdrukula on the northeast coast of Estonia belong to long-tailed ducks (Lõugas *et al.* 1996a). This clearly indicates autumn/winter occupation at the site, and most probably the hunting of long-tailed ducks during their autumn or spring transit (Leibak *et al.* 1994:64). Today long-tailed ducks breed along the coast of Arctic Ocean and in the northern Scandinavian uplands, and winter offshore along the southern Baltic Sea (Cramp *et al.* 1986:627–628).

The concentration of ducks in the coastal Neolithic (winter?) settlements in Ostrobothnia may indicate the hunting of birds during the migration periods (Pesonen 2002:27; Kotivuori 2002:157,162 [unpubl.]; Mannermaa 2004:39). Long-tailed ducks are present in coastal Mesolithic and Neolithic sites in southern Finland (Paper II). They were probably caught in early spring or late autumn. Long-tailed ducks at Finnish coastal sites may also indicate breeding – it is not impossible that long-tailed ducks bred in southern parts of Finland during the Stone Age.

The abundancy of grouse in the bird bone materials from Finnish inland sites with house structures is not surprising. According to Pesonen (2002:27), many hut or house structures in inland sites (Lake Saimaa area) are likely remains of year-round occupation (see also Leskinen 2002:169). It can be concluded that during winters, the food supplies were based on stored food and the available animal resources, like pike and some other fish species, the European elk, the beaver, the arctic hare and grouse.

Hunting restrictions, taboos and other cultural factors

Among many historical hunter-gatherers, animals are comprehended as endowed with a soul or spirit much like that of humans (Karsten 1955:114; Jordan 2003:101). Such ideas may have affected or even directed the uses of birds in prehistory. The ideological qualities of some birds may have been more important than their material ones. For example, the impressive sight and sheer power of eagles and the diving and fishing ability of divers and cormorants may have been appreciated. Certain birds were perhaps prestigious, a sign of good hunter. Some birds may have been loaded with qualities which restricted or prohibited their economic utilization. Hunting restrictions and taboos may have regulated which species were hunted and how carcasses were treated and consumed. Prehistoric hunter-gatherers may well have had their own – perhaps very detailed – taxonomic divisions of birds, which cannot be understood today. All these aspects have affected the formation of the relationships between birds and people.

The absence or rarity of some bird species in the archaeological materials may indicate that these species were not (regularly) hunted. For example, nocturnal birds, like owls are rare but they are also difficult to catch. However, it seems strange to me why common cranes and whooper swans are so scarce (Paper II). Both species are large birds and could provide a good amount of meat. The bones and feathers are strong and good for making tools and other implements. Swan bones are occasionally found in sites from Finland, Åland, Saaremaa and Gotland (Papers I, II, III, IV). The common crane has been identified in the Ajvide settlement material. Swan and common crane bones were found in some of the Ajvide burials but both of them are absent in burials at Zvejnieki (Paper V). The rarity of these species in the archaeological data may be the result of hunting restrictions or taboos. It also is possible that common cranes and swans were caught, but not brought to the settlements. Special animals may have been treated and consumed at sacrificial sites or offering places at some dis-

tance from the settlements. For example, the Saami in Inari took bird bones, in particular the skull, the synsacrum and the sternum, to the forest where they were placed in a structure resembling a reindeer antler (Itkonen 1948: 372). A Mesolithic site at Aggersund in Denmark (Møhl, 1978) could perhaps be a special area for specialized hunting and treatment of swans. Perhaps a more likely sacrificial context for swan comes also from Denmark. Remains of a woman and a complete whooper swan were recovered in a Neolithic bog deposit at Østrup Mose near a contemporary settlement site (Koch 1998).

Finds of swans from other places in the Baltic Sea area are also relatively scarce, which supports the idea that some common ideological or practical reason for their rarity may have existed (Gumiński 2005:125–26). Pesonen (1996:13) has suggested that the ritual character of whooper swans spread in Finland in the Neolithic, perhaps in connection with the spread of the Comb Ware culture from western Russia. Whooper swan bones in the Late Mesolithic burials at Yuzhniy Oleniy ostrov indicate some special character of whooper swans (Mannermaa *et al.* forthcoming), and could support Pesonen's idea.

5.2. On fowling methods

Direct evidence for fowling methods does not exist in the northern Baltic Sea area. Several arrowhead types from the Stone Age were suitable for fowling (Paper II). The most probable fowling methods in prehistory were shooting with arrows, spears and slings and active or passive catching with different kind of snares, traps and nets. The ability to get close to a flock of birds must have been important in all kinds of active fowling. Small arrowheads like those found in Ylikiiminki Vepsänkangas (Slettnes-type), may well have been used in fowling. One archaeological find from Finland may be considered as indirect evidence of hunting birds with arrows. A transverse flint arrowhead, typical of the southern Scandinavian Mesolithic and Neolithic, was found at the Neolithic Sperrings site in southern Finland (Europaeus 1922). The origin of this single find is uncertain, but one theory is that it was shot into a migratory bird that was later caught in Finland (see Edgren 1993:71).

The arrow type used for fowling among historical tribes in Siberia was a wooden double-pointed arrowhead (Vilkuna 1950), and similar examples have been found in Stone Age contexts in western Russia (Oshibkina 1988; Zhilin & Matiskainen 2003). Shooting birds with arrows is indicated by finds from other areas. Archaeological finds from northern Norway (Metal Period, about 800 BC- AD 300) and historical sources indicate that birds in flocks were hunted with throwing spears constructed of long bone arrows (Solberg 1911; Olsen 1994:117–118). In summer, breeding and especially molting birds would be relatively easy to hit with spears or a bow and arrow. For waterbirds, the molt of wing feathers is connected to the loss of flying ability for a period of several weeks. The presence of breeding and nesting birds may sometimes

enable coincidental catches, made during other daily activities. Sporadic finds of species other than ducks on Åland, for example, waders and corvids, may represent secondary catches (Paper II).

Decoys and birdcalls may have been important aids in fowling. Potential archaeological evidence for using birdcalls exists from Ajvide burials. Polished shaft parts of the long bones of swans and ducks found in some of the Middle Neolithic burials might have been used as birdcalls (Lund 1988) (Paper V). If they are birdcalls, they were likely used for waterbird hunting (see also Burenhult 1997c). Whistles aided the hunting of black guillemots, for example, in Greenland in historical times (Holtved 1962:80). In Finland, birdcalls made of pens have been traditionally used for attracting hazel grouse (Leisiö 1983:88–89). There is no direct prehistoric evidence for trapping grouse species during the wintertime, but this must have been the easiest way to get them in large numbers.

Resting waterbirds were perhaps shot with a bow and arrow during the night, even though such evidence does not exist. Using decoys and shooting, e.g., common eiders and goosanders from boats during the night was common on the Åland Islands during historical times (Bergman 1975:98–99). Cormorants were caught during the night by the Inuits in Alaska (Nunivaks) and Greenland (Holtved 1962:81; Pratt 1990). On the Orkney Islands, waterbirds were caught with snares while they were sleeping (Fenton 1978:510).

The high number of bones from auks at Ajvide indicates that people specifically went to Stora Karlsö to catch auks in the large colonies (Fig. 10). The hunting of auks probably included a fairly organized system and expeditions over long stretches of

Fig. 10. *Guillemot (*Uria aalge*) colony on Stora Karlsö, Gotland. Photo Antti Halkka.*

water (Paper III). The most effective ways of catching guillemots and razorbills was probably to climb up and down the cliffs and take breeding birds from nests using bare hands or with hooks or nets. At the same time, eggs or chicks were probably collected. The practice of descending and ascending cliff faces by means of skin ropes in association with large throw-nets to catch seabirds is a traditional method among the Nunivaks in southwestern Alaska (Pratt 1990). The same method was used for catching birds and taking their eggs on Orkney (Fenton 1978). Bones of young black guillemots identified in material from Jettböle I and Ajvide suggest that these were probably taken from the nesting holes (Papers I, III).

Bones from young individuals and bones showing pathological changes found in material from Ajvide, Åland and the Finnish mainland indicate that people took advantage of weak individuals (Papers I, II, III). In general, birds were not an easy catch for prehistoric hunters. Getting close to a flock of birds by skulking and waiting may not be easy for everyone. Some people were more skilled fowlers than others, depending on personal characteristics and hunting experience. Achievements in fowling may have affected individual status and the social hierarchy inside the group in a similar way as hunters of large game (e.g., Hawkes *et al.* 2001:695).

The hunting of birds during migration (for example, divers and long-tailed ducks) warranted special methods. Flocks of resting ducks may have been hunted in great masses during migration, but it was probably not easy to get close to them. The easiest way is to slowly approach resting and feeding birds in open water and catch them with nets or arrows. The hunting of migratory birds has probably partly coincided with sealing on the spring ice. The MNI for common eider is relatively high at Jettböle I and might indicate mass hunting (e.g., hunting with nets, see Dahlström 1938; Storå 1968:162–274) (Paper I). However, the MNIs for other ducks at Jettböle I and all ducks at Ajvide are relatively small and do not indicate mass hunting. In fact, there is no clear evidence for the mass hunting of migratory birds in any of the samples of this study. The mass hunting, e.g., of geese has been important in historical times (e.g. Itkonen 1948: 32–34), but not evidenced in archaeology.

5.3. Culture- and ecology-based differences in fowling

Two aspects have been seen to have had major impacts on the economies of prehistoric hunter-gatherers. One is the role of ecological factors, for example, climate, flora and fauna, in determining the available sources of food. The other is the role of cultural factors, e.g., choices, settlement patterns, food storage traditions, ideology or social factors (e.g., Fiore & Zangrando 2006). Both aspects are important in shaping the identity and the way of life, including food procurement. Both are also somehow dependent on each other. The environment imposes both limits and opportunities, but people, with their learned and traditional cultural mechanisms, have adapted to life in their particular environments.

Although Pitted Ware sites on Åland and Gotland have the same cultural background, the people seem to have developed quite different cultural systems. The Pitted Ware culture on Åland is a good example of a culture whose way of life was shaped by the archipelago environment. A small land area compared to the surrounding sea area was an important factor affecting the economy and ideology. The limited terrestrial food sources forced people to rely more heavily upon marine species (seals, fish, birds). The topography of the archipelago with shallow water and solitary places for nesting was suitable for diverse breeding waterbirds. This resource was utilized intensively during the spring and summer (Paper II).

Ajvide and other Pitted Ware sites on Gotland also represent Neolithic communities which had adapted to the local environment and could use the available resources intensively. If a variety of food sources were present, such as during summers, it was possible to choose those sources that were most appreciated. There are indications that people were also able to disregard some animals due to ideological reasons. Stable carbon and nitrogen isotope studies on human bones from Västerbjers, a Pitted Ware site on the western coast of Gotland, indicate that feral pigs (or wild boars) were not eaten (Eriksson 2004:28). It seems that pigs were brought from the mainland but they do not morphologically represent the domesticated form (Eriksson 2004:28). The pig was a ritual animal and its uses were restricted to things other than food, or the meat was eaten only at certain ritual events. This indicates that the food resources available to people at Västerbjers, and probably also other Middle Neolithic sites on Gotland, were so plentiful that people were able to exclude pigs and perhaps some other animals from their diet.

It has been suggested that people at Ajvide did not suffer from dietary stress in any season of the year (Outram 2005:42). This might affect fowling in two alternative ways. First, because the food supply was guaranteed (with e.g. sealing, fishing, land mammal hunting), it was possible to limit fowling principally to the species that were considered most delicious or in other ways valuable (auks, ducks). The other alternative is that because eating pork meat was forbidden or restricted, it was necessary to obtain food by fowling in the summertime. Considering the low number of bird bones compared to mammal and fish bones at Ajvide, the first explanation seems the more likely one (Paper III). It is, however, important to remember the possibility that birds were eaten in the hunting camps but not brought in large quantaties to the settlement.

5.4. The relationship between birds and people

Animism, the worship of natural places, animals and plants as living (and perhaps sacred or spiritual) beings was part of many historical native cultures (Harvey 2005). In animistic ideologies, animals, plants and natural objects like stones or features in the landscape have souls and they may have been perceived as totems, spirit helpers or guardians (e.g., Karsten 1955; Ingold 1986, 2000). A totem animal is a member

of the group, and a specific unity exists between a human and his/her totem animal (Ingold 2000:115). For example, from ethnographic data, we know that parts of the golden eagle, a totem animal and a spirit helper, were fastened to the shaman's dress among some Siberian tribes (Lönnquist 1986:84; Siikala 2002:44). Few indications of bird totemism exist from prehistoric contexts. The whooper swan may have been a totem animal for the Neolithic groups in the Lake Onega region as it is so commonly found in rock art depictions (Ernits 1992; Poikalainen 1999:714, but see an alternative interpretation in Lahelma 2008a and 2008b). The white-tailed sea eagle may have been a totem animal in Neolithic Orkney because complete carcasses of this species were placed in tombs (Hedges 1984, but see also Jones 1998). Based on the finds of wing bones in three Middle Neolithic burials at Zvejnieki, I suggest that the jay was a totem animal for these people (Paper V).

Birds, like other animals, may have been emblematic of social relations among prehistoric people (see, e.g., Ingold 1986; Tilley 1991; Jones & Richards 2003; Fowler 2004), but they may also have been emblematic of themselves. Qualities of animals appreciated by people living close to nature need not necessarily have to be seen in relation to the human qualities.

Waterbirds, mainly ducks, are the most commonly identified species at all sites of this study, and especially at shore sites (excluding some sites in Finland) (Papers I, II, III, IV). It is not at all surprising that waterbirds were important for people who lived their life near the sea or a lake. Archaeological material indicates that the sea (and seals) has occupied a central place in the ideology of Pitted Ware groups on Åland. The same can be said about Pitted Ware groups on Gotland, although a terrestrial component in the ideology, for example, pig ritualism, was also important (Eriksson 2003). Water as an ecological milieu, with its fauna, flora and the whole system, was essential in both economic and ideological ways in Middle Neolithic Åland and Gotland. Of course, to live near a freshwater source was essential everywhere during all periods.

Waterbirds, like whooper swan, ducks and divers, were central components in the belief systems and world conception of circumboreal and Uralic communities (Ingold 1986; Napolskikh 1992). The abilities to fly and dive are central in the tripartite universe of sky, earth and underworld of the circumboreal belief systems and the symbolic role of some waterbirds (Karsten 1955; Ingold 1986; Napolskikh 1992; Zvelebil 1993; Hansen & Olsen 2004). Prehistoric burial material from northern Europe indicates similarities in attitudes to birds among the Stone Age and modern hunter-gatherers and reindeer herders (Paper V). Most of the bird finds at Ajvide and the Zvejnieki burials derive from wings of waterbirds. A wing bone from the capercaillie in a Middle Neolithic burial at Tamula and a wing bone from the golden eagle in another Tamula burial are possible indications of the common wing symbolism (Jaanits *et al.* 1982, see also Jaanits 1957, 1961). A distal wing bone from a capercaillie was also found in a grave at Dudka in northeast Poland (Gumiński 2005:124). Crane humeri were found in the Early Metal Period cemetery at Bolshoi Oleniy ostrov on the

Kola Peninsula (Mannermaa 2006 [unpubl.]), but the connection of bones to a specific grave is uncertain (Anton Murashkin, pers. comm. 2007). One example comes from a later period but underlines the importance of the ability to fly. In the Iron Age sacrificial site at Mortensnes (northern Norway), bird bones were placed around the sacrificial stone (bauta), together with other "flying" bones (reindeer antlers) (Nordvi 1907:81 [unpubl.]; Bjørnar Olsen, pers. comm. 2006).

Images of waterbirds were associated with the journey of the soul or spirit to the afterworld among Siberian forager tribes (e.g., Chernetsov 1963). My interpretation of burial materials from Ajvide and Zvejnieki provides some indications about the perception certain waterbirds as transporters or messengers (Paper V). Such indications are the finds of two ducks near the hands of a young male at Zvejnieki or the two wing bones of the red-throated diver found in an assemblage near the right hand of the deceased at Ajvide. Bird figurines in burials at Ajvide and Zvejnieki could also be representations of similar ideology (Paper V). This kind of interpretation may also be connected to the bird figurine and the two crane wing bones near the hands of a child in Early Neolithic burial VII at Tamula I (see Appendix 1; Jaanits *et al.* 1982; Kriiska *et al.* 2007), and the placing of a newborn baby above a wing of a whooper swan at the Late Mesolithic site of Vedbæk Bøgebakken (Albrethsen & Brinch Petersen 1976).

Some special power was perhaps associated with birds of prey and their wings and claws. This may be the reason for putting parts (both wings and legs) of at least fourteen ospreys in Late Mesolithic burials at Yuzhniy Oleniy ostrov (Mannermaa *et al.*, manuscript). However, the shoulder bones of three white-tailed sea eagles found in the burials at Yuzhniy Oleniy ostrov may indicate that meat was consumed or offered during the funeral (Mannermaa *et al.*, forthcoming). Birds of prey are clearly important in Yuzhniy Oleniy ostrov burials, but interesting enough, no parts of birds of prey were identified in Ajvide or Zvejnieki burials (Paper V).

Birds can be source of inspiration and even part of the ideology. The relationship between birds and humans in prehistory may even have contained religious aspects, but they can also be seen through the more general concept of how humans perceived themselves as part of nature and as one of the animal species. The attitude of prehistoric hunter-gatherers to animals and nature was different from that of ours. Common feelings shared by modern and prehistoric people may be the pleasure associated with bird song or the joy in seeing a rare or a beautiful bird. Some bird species had such important qualities that complete carcasses or parts were put in burials. It is uncertain why unmodified parts of birds were placed in a grave, but probably it was believed that these birds or their body parts had powers that could help the deceased on the journey to the afterlife (Paper V). The skeletal element distribution of birds (mostly non-meaty, distal wing bones) at Ajvide and Zvejnieki indicates that bird remains were not food offerings.

It is important to consider the relationship between humans and animals in prehistory as mutual affiliation. From historical examples, we know that humans have not only taken advantage of birds but also helped them in many ways. It is well known

that some modern activities, e.g., agriculture, have improved the living conditions of some bird species. Gulls, ravens, crows, etc. are attracted to dumping places, and half-tamed mallards and mute swans winter regularly in urbanized areas. Hunter-gatherers may have practiced smaller scale activities which had their effect on the local environment, including behaviour of local bird populations. Mutual relationships between people and birds may have included, for example, the making of suitable breeding structures for common goldeneyes and goosanders. There might have been attempts to improve the living conditions of some birds by killing birds of prey. Some species, like eagles and cormorants, may have been caught and killed because they competed for the same prey as people (Pettersson 2002). Prehistoric hunters-gatherers were naturalists that knew and understood their environment. For example, ducks may have been fed and tamed long before domestication took place (e.g., Coy 1988). People may also have changed the environment (to the advantage or disadvantage of some birds and other animals) without conscious intentions.

5.5. The importance of birds for the prehistoric cultures in the Baltic Sea region

The study of bird bones in selected sites in the circum-Baltic area indicates significant differences in the importance of birds in the economies of different cultures. The material used in this study shows that fowling was widely practiced and a significant part of the economy in parts of Finland and in the Middle Neolithic Åland Islands and especially in the earlier part of this period (older phase of the Middle Neolithic).

The economic importance of animals is only one part of the large and complex human-animal relationship. This study has provided new evidence for the significance of birds in the ideology of the prehistoric peoples of the Baltic Sea area (Paper V). It is probable that many bird species did not have economic importance, but instead were ideologically or socially important. Hence, it is evident that animal bone materials at archaeological sites cannot be interpreted only in terms of the meat or raw materials they would produce. The commonness of a bird species in the archaeological material does not necessarily indicate its social or ideological importance for the culture.

Bird bones are hollow and usually have thin cortical layer, a structure that makes them more sensitive to post-depositional destructive activities than mammal bones. For the same reasons bird bones are usually less tolerant of trampling and burning than mammal remains. These reasons may be responsible for the lower preservation or the lower degree of specific identifications of bones from birds compared to those from mammals. Even though bird bones are scarce at sites, this does not say that birds would not have had any significance for prehistoric cultures. The number of identified specimens really does not tell the whole truth.

In spite of the suspected high taphonomic loss of bird bones, they are usually found, though often in low proportions, in prehistoric materials. The interpretation of bird

bones at archaeological sites should be done alongside other archaeological data. When interpreting prehistoric fowling, it is important not to look only at the bone material but to make a detailed investigation of other ecological factors, like the topography, palaeoecology, etc. The results of this study emphasize the fact that the importance of fowling seems to vary a lot depending on the location and the topography of the site, occupation season, mobility, other means of subsistence, ideology, etc.

The investigation and recognition of the ritual uses of birds is often difficult. As long as we cannot define the character of the occupation site, we do not know what kinds of activities may have taken place there. Some of the bone material from sites which have been identified as settlements or hunting camps, may well also be connected with some ritual or other social activities not connected to practical subsistence activities. Sometimes, the detailed study of the contexts of bone materials can shed light on these different kinds of uses of animals. Well contextualized animal bones in graves can be used for studying burial practices and rituals, ideology, clothing and decoration. The last part of this study is an example of how such things can be investigated through a detailed analysis and interpretation of bird bone materials.

6. Conclusions

1. Despite their often low numbers in bone materials from prehistoric sites, birds had economic and ideological importance for prehistoric cultures in northern Baltic Sea area.
2. Fowling has been most important in coastal areas. The breeding period was the main fowling period in the Baltic Sea area during the Stone Age.
3. In Finland, the economic importance of waterbirds (mainly ducks) and grouse species are pronounced locally and during particular seasons. The scarce bone material indicates the more prominent role of fowling at coastal sites than at inland sites.
4. Butchering marks indicate that at least divers, swans, ducks, auks and some gulls were hunted for food. The commonness of grouse species in the Finnish Neolithic, Mesolithic and Early Metal Period is conclusive evidence of their use as food.
5. Fowling was a significant part of the economy on the Middle Neolithic Åland Islands and especially in the earlier part of this period (older phase of the Middle Neolithic).
6. The importance of birds in the food economy depends on several factors. The most important are the location of the site (coastal/inland), the topography of the surroundings of the site, the availability of land mammals, and the season of occupation. Cultural choices and traditions are also important.
7. The skeletal element distribution of birds indicates that complete bird carcasses have usually been brought to the sites. However, butchering, food sharing, transportation, different economic, social or ritual uses, and different ways of disposal affect the assemblage composition.
8. Of all studied sites, auks have been economically important only at the Ajvide settlement site on Gotland.
9. Some species, for example, the jay had a special social or ideological place in Middle Neolithic Zvejnieki.
10. The abundance of waterbirds and wing bones in northern European burials indicates some common idea about waterbirds (perhaps as messengers or spirit helpers) in the Stone Age burial practices.
11. Fracture analysis is a relevant method for studying the taphonomy and deposition history of bird bones.

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Appendix 1.

Radiocarbon (AMS) dates of humans and birds from the burials at Zvejnieki (northern Latvia), Tamula I (southern Estonia) and Yuzhniy Oleniy ostrov (Karelia, western Russia).

LM=Late Mesolithic, EN= Early Neolithic,
MN=Middle Neolithic, LN= Late Neolithic.

Locality	Burial no	Lab.no.	Date BP	$\delta^{13}C$	Sample	Period	Source
Zvejnieki	170	Hela 1313	10435±75	–21.4	Aves sp.	–	Mannermaa *et al.* 2007
Zvejnieki	170	Oxa-5969	8150±80	–21.8	Human	MM	Zagorska 1997
Zvejnieki	154	Hela-1372	10610±75	–19.0	Anatidae	–	Mannermaa *et al.* 2007
Zvejnieki	154	Ua-3644	7730±70	–22.3	Human	MM	Zagorska 2006
Zvejnieki	83	Hela-1210	6785±50	–23.4	Human	LM	Mannermaa *et al.* 2007
Zvejnieki	92	Hela-1211	6510±50	–22.8	Human	LM/EN	Mannermaa *et al.* 2007
Zvejnieki	93	Hela-1212	6840±55	–23.8	Human	LM	Mannermaa *et al.* 2007
Zvejnieki	256	Hela-1213	5320±45	–23.2	Human	MN	Mannermaa *et al.* 2007
Zvejnieki	256	Hela-1214	4480±45	–21.3	Strigiformes	LN	Mannermaa *et al.* 2007
Zvejnieki	164	Hela-1215	5770±55	–17,6	*Gavia* sp.	EN	Mannermaa *et al.* 2007
Zvejniek	164	Ua-15544	5230 95	–24.0	Human	MN	Eriksson *et al.* 2003
Zvejnieki	165	Ua-19812	5480±100	–18.8	Human	MN	Eriksson *et al.* 2003
Zvejnieki	165	Hela-1216	5250±55	–21.1	*Garrulus glandarius*	MN	Mannermaa *et al.* 2007
Zvejnieki	165	Hela-1217	10690±80	–17.6	Anatidae		Mannermaa *et al.* 2007
Tamula I	VII	Hela-1335	5760±45	–27.1	Human	EN	This study
Tamula I	VIII	Hela-1336	5370±45	–25.8	Human	MN	This study
Tamula I	XIX	Hela-1337	4925±40	–25.0	Human	MN	This study
Y. Oleniy ostrov	56	Hela-1374	7570 ± 60	–21,4	*Pandion haliaetus*	LM	This study
Y. Oleniy ostrov	125	Hela-1375	7950 ± 60	–18,1	*Gavia arctica*	LM	This study

Appendix 2.

The English, Latin, Finnish, Estonian and Swedish names of birds species mentioned in this study.

English	Latin	Finnish	Estonian	Swedish
Black-throated diver	*Gavia arctica*	kuikka	järvekaur	storlom
Red-throated diver	*Gavia stellata*	kaakkuri	punakurk-kaur	smålom
Great crested grebe	*Podiceps cristatus*	silkkiuikku	tuttpütt	skäggdopping
Red-necked grebe	*Podiceps grisegena*	härkälintu	hallpõsk-pütt	gråhakedopping
Slavonian grebe	*Podiceps auritus*	mustakurkku-uikku	sarvikpütt	svarthakedopping
Gannet	*Sula bassana*	suula	suula	havssula
Great cormorant	*Phalacrocorax carbo*	merimetso	kormoran	storskarv
Whooper swan	*Cygnus cygnus*	laulujoutsen	laululuik	sångsvan
Mute swan	*Cygnus olor*	kyhmyjoutsen	kühmnokk-luik	knölsvan
European wigeon	*Anas penelope*	haapana	viupart	bläsand
Green-winged teal	*Anas crecca*	tavi	piilpart	kricka
Mallard	*Anas platyrhynchos*	sinisorsa	sinikael-part	gräsand
Tufted duck	*Aythya fuligula*	tukkasotka	tuttvart	vigg
Common eider	*Somateria mollissima*	haahka	hahk	ejder
Long-tailed duck	*Clangula hyemalis*	alli	aul	alfågel
Common scoter	*Melanitta nigra*	mustalintu	mustvaeras	sjöorre
Velvet scoter	*Melanitta fusca*	pilkkasiipi	tõmmuvaeras	svärta
Common goldeneye	*Bucephala clangula*	telkkä	sõtkas	knipa
Red-breasted merganser	*Mergus serrator*	tukkakoskelo	rohukoskel	småskrake
Goosander	*Mergus merganser*	isokoskelo	jääkoskel	storskrake
Osprey	*Pandion haliaetus*	kalasääski	kalakotkas	fiskgjuse
Western honey buzzard	*Pernis apivorus*	mehiläishaukka	herilaseviu	bivråk
Red kite	*Milvus milvus*	isohaarahaukka	puna-harksaba	glada
White-tailed sea eagle	*Haliaeetus albicilla*	merikotka	merikotkas	havsörn
Rough-legged buzzard	*Buteo lagopus*	piekana	karvasjalg-viu	fjällvråk
Northern goshawk	*Accipiter gentilis*	kanahaukka	kanakull	duvhök
Golden eagle	*Aquila chrysaetos*	maakotka	kaljukotkas	kungsörn
Peregrine falcon	*Falco peregrinus*	muuttohaukka	rabapistrik	pilgrimsfalk
Willow grouse	*Lagopus lagopus*	riekko	rabapüü	dalripa
Rock ptarmigan	*Lagopus mutus*	kiiruna	lumepüü	fjällripa
Black grouse	*Tetrao tetrix*	teeri	teder	orre
Western capercaillie	*Tetrao urogallus*	metso	metsis	tjäder
Hazel grouse	*Bonasus bonasa*	pyy	laanepüü	järpe
Common crane	*Grus grus*	kurki	sookurg	trana
Palearctic oystercatcher	*Haematus ostralegus*	meriharakka	merisk	strandskata
Ruddy turnstone	*Arenaria interpres*	karikukko	kivirullija	roskarl
Eurasian woodcock	*Scolopax rusticola*	lehtokurppa	metskurvits	morkulla
Western curlew	*Numenius arquata*	kuovi	suurkoovitaja	storspov
Whimbrel	*Numenius phaeopus*	pikkukuovi	väikekoovitaja	småspov
Ruff	*Philomachus pugnax*	suokukko	tutkas	brushane
Corncrake	*Crex crex*	ruisrääkkä	rukkirääk	kornknarr
Water rail	*Rallus aquaticus*	luhtakana	rooruik	vattenrall
Tengmalm's owl	*Aegolius funereus*	helmipöllö	karvasjalg-kakk	pärluggla
European nightjar	*Caprimulgus europaeus*	kehrääjä	öösorr	spinnare
Eurasian skylark	*Alauda arvensis*	kiuru	põldlõoke	lärka
Common redstart	*Phoenicurus phoenicurus*	leppälintu	aed-lepalind	rödstjärt
Eurasian cuckoo	*Cuculus canorus*	käki	kägu	gök
Arctic skua	*Stercorarius parasiticus*	merikihu	söödikänn	labbe
Common gull	*Larus canus*	kalalokki	kalakajakas	fiskmås
Greater black-backed gull	*Larus marinus*	merilokki	merikajakas	havstrut
Lesser black-backed gull	*Larus fuscus*	naurulokki	tõmmukajakas	silltrut
Herring gull	*Larus argentatus*	harmaalokki	hõbekajakas	gråtrot
Great auk	*Alca impennis*	siivetön ruokki	hiidalk	garfågel
Common guillemot	*Uria aalge*	etelänkiisla	lõunatirk	sillgrissla
Black guillemot	*Cepphus grylle*	riskilä	krüüsel	tobisgrissla
Razorbill	*Alca torda*	ruokki	alk	tordmule
Jay	*Garrulus glandarius*	närhi	pasknäär	nötskrika
Hooded crow	*Corvus corone*	varis	vares	kråka
Raven	*Corvus corax*	korppi	ronk	korp