Mapping threats to arctic bird populations. The effect of infectious organisms and pollution on bird health. IPY #172 BirdHealth

Project description

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Project summary

The arctic environment and its unique wildlife are currently being threatened at several levels; from climate change, from pollution and from infectious diseases. Health (infection levels and immune responsiveness) in wildlife is regulating population numbers through individual survival and reproduction. Little is known about the combined impact of infectious organisms and pollution on the health of arctic organisms. Due to the short arctic summer and limited food resources arctic birds typically have an exhausting breeding season were they rely upon accumulated body reserves for breeding. This leaves arctic animals very vulnerable to environmental stressors during breeding. This study proposes to (i) experimentally test how infectious organisms and (ii) how exposure from persistent organic pollutants (POPs) – both legacy and new compounds and selected heavy metals (HMs), affect the health, reproduction and survival of breeding female common eiders *Somateria mollissima.* Moreover, (iii) by comparing health and infectious organisms of eider populations from three areas differing in migration patterns (wintering and breeding areas) we will assess the potential large scale effects of avian migration and climatic zones for distribution of infectious organisms. Also, (iv) waterfowl is considered the main source of avian influenza (AI) viruses, and may thus constitute a possible source for infection with bird flu to humans. We will thus identify previous exposure to, and current infection of, the different AI viruses in eider females from different populations to establish which individuals are most susceptible and also the geographical distribution of AI in the arctic. The eider is the most numerous sea-duck with a wide circumpolar distribution. Northern eider populations have been declining in recent years without any clear explanation. The arctic breeding strategy is extreme in the eider as the female does not eat for ~30 days while incubating eggs. This study will quantify geographic variation in individual levels of POPs and HMs, and in the prevalence of selected pathogens. The effect of these stressors on parameters related to individual fitness like immune function, survival and reproduction will be assessed through individual health monitoring, experiments and large scale comparisons of different eider populations from different climatic zones with different pollution levels.

Principal objective

To understand how infectious organisms and pollution may affect the health, reproduction and survival of arctic bird populations.

<u>Sub goals</u>

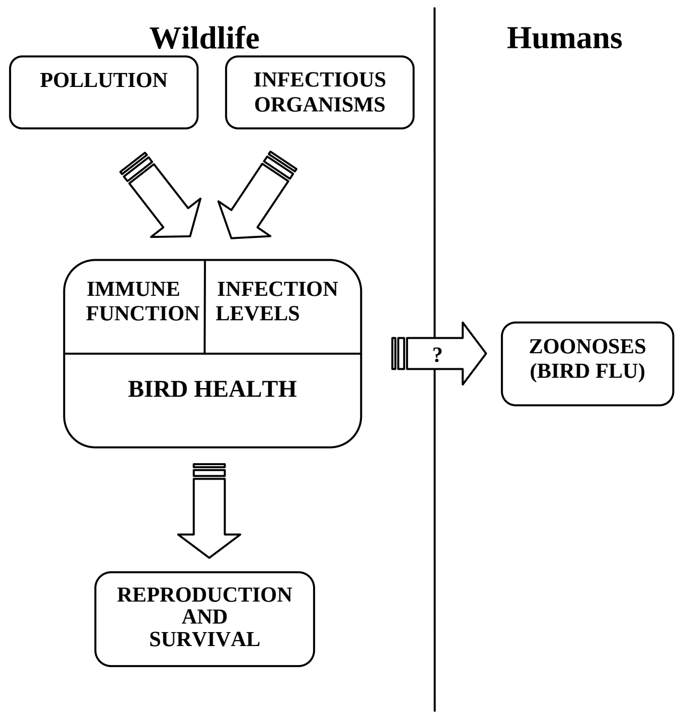
-To experimentally document how infectious organisms impact arctic bird populations

-To examine if the arctic breeding strategy (extreme use of accumulated body reserves) is vulnerable to environmental stressors like infectious organisms and POPs/HMs

-To map and understand the distribution and spread of infectious organisms including viruses such as internal parasites and avian influenza-viruses in arctic migrating and non-migrating eider populations

Introduction

The polar environment presents unique challenges for its wildlife. The arctic "summer" is very short and with temperatures often below freezing. Moreover, constant daylight in summer and complete darkness in winter further challenges the organisms breeding and living at high latitudes. Many arctic birds display what we term the "arctic breeding strategy" where the short breeding period and limited food resources forces them into depending upon stored body reserves for egg-production and incubation. The common eider *Somateria mollissima* is extreme in this arctic strategy as they do not eat for 30 days and thus loses 40% of their body mass during breeding (Parker & Holm 1990, Gabrielsen et al. 1991). This strategy leaves arctic animals very vulnerable to environmental stressors and diseases during breeding. For instance, human pollution is having a damaging effect on immune systems in wild birds (Grasman et al. 1996, Bustnes et al. 2004), which will reduce health of bird populations. These new threats may lead to increased infection levels and to higher prevalence of old and new infectious organisms (Sagerup et al. 2000, see Box 1). To experimentally reveal the impact of reduced immune defenses and increased parasite levels on fitness of individuals without adversely affecting the birds studied, one may experimentally *improve* the health of individuals by reducing parasite levels (e.g. Hanssen et al 2003a). Such experiments may quantify the strength of the relationship between parasite level/immune function and reproduction/survival of individuals and thus its effect on population trends (Hanssen 2003). Furthermore, reduced immune function may be especially detrimental for wintering waterfowl because both the number and intensity of infectious organisms is increasing when hosts (the birds) are gathered in larger concentrations. Thus, the combination of high densities and reduced immune function may increase the chances of epidemic outbreaks of usually "harmless" infectious organisms in wild populations of birds. Furthermore, these threats may not only have negative consequences for waterfowl populations. The waterbirds' highly social behavior during the non-breeding season and their association with water – an ideal medium for the survival and distribution of excreted viruses (e.g. Krauss et al. 2004) – makes waterfowl perhaps the prime host and vector for influenza viruses among birds (Fouchier et al 2000, 2004, 2005). A stress related reduction in immune system efficiency caused by human related activity such as pollution and climate change may increase the prevalence of influenza viruses. More vulnerable hosts will lead to a larger virus gene pool which may again lead to faster evolution of the viruses' virulence. Furthermore, more immobilized sick birds in wintering areas may increase contact between humans and sick/dead birds. This may also increase the chances of dangerous mutations appearing in the virus, mutations which may for instance increase the virus's ability to spread between humans. The current Asian/European/African outbreak of the H5N1 strains of avian flu and its considerable interest in the media, further amplify the need for better knowledge of how stressors influence the immune system and thus infections in water birds. This study will quantify geographic and individual variation in levels of POPs and HMs, and in the prevalence of pathogens and parasites. The effect of these stressors on parameters related to individual fitness like immune function, survival and reproduction will be assessed through individual health monitoring, experiments and large scale comparisons of three different eider populations with different migration patterns and with different pollution levels.



The study system

Populations of several northern sea ducks are declining, including populations of all 4 eider species (Somateria spp. and Polysticta stelleri; Kertell 1991, Stehn et al. 1993, Gratto-Trevor et al. 1998). Declines in common eider populations have been documented in Greenland, Hudson Bay, and Alaska (Robertson and Gilchrist 1998, Sudyam et al. 2000, Merkel 2004). In the White Sea area dead eider nestlings, heavily infected with helminths are recorded every year at the coast of the Kandalaksha Bay, however contaminant levels have never been studied in these birds. A large mass death (90% of all nestlings) was recorded in 1976-1977 (Bianki & Karpovich 1983). Reasons behind these population decreases vary, and many are unclear (besides parasite outbreaks, possible explanations have been human disturbance, overharvesting, and climatic events, Robertson and Gilchrist 1998, Suydam et al. 2000, Merkel 2004). The females of the common eider *Somateria mollissima* engage in an exhausting incubation period where they fast for 22-30 days which leads to a mass loss of more than 40% (Parker & Holm 1990). We will study common eiders from three populations, a Northern (Svalbard), an Eastern (White Sea) and a Western (Grindøya, Troms, North Norway) (Table 1). The White Sea population inhabits a heavily polluted area. The White Sea and Grindøya populations only migrate locally, whereas the Svalbard population migrates south to northern Norway during winter and partly mixes with the North Norway population during winter (Bustnes & Tertitsky 2000). The Grindøya colony has been investigated continuously since 1985 and the data base contains information on individual reproductive histories of females since their presumed first breeding. Also in Ny Ålesund and the White Sea eiders have been studied extensively for at least the last 10 years. Common eiders are capital breeders that distribute their accumulated body reserves to egg production and incubation (Erikstad et al. 1993, Erikstad & Tveraa 1995, Hanssen et al. 2003b). Eiders are susceptible to a wide range of gastrointestinal parasites such as nematodes and cestodes (Clark et al. 1958, Garden et al. 1964, Itamies et al. 1980, Warelius 1993). Previous studies in the Grindøya colony have uncovered that low-condition eiders are more vulnerable to costs of parasitism (Hanssen et al. 2003a) and more often down-regulate their immune system during breeding (Hanssen et al. 2003c, 2004, 2005).

> Box 1 Immunoecology and BirdHealth
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> Infectious organisms and their hosts are locked in an evolutionary arms-race dictated by the parasites dependence on their host's resources and the hosts wish to reduce the detrimental impact of the infectious organism. The host's weapon against infections is the immune system, however this weapon demands resources, resources which cold be used by the animal for other vital activities such as reproduction (e.g. Sheldon and Verhulst 1996, Hanssen et al 2004). This has lead to a delicate balance between the needs of the immune system and other vital physiological functions such as for example reproduction.

Approach and methods

Continued demographic measurements of colonies (2007-2009).

The colonies will be searched for nests from mid-May until mid-June in the seasons 2006-2009. A minimum of 70 breeding females will be captured in each colony and year (Norway, Svalbard and Russia) and blood and feces samples will be collected for later analysis in order to identify parasite species, avian influenza infection (previous and present) health status (immune function) and contaminant levels. In the White Sea area in addition to blood samples tissue samples will be available for parasitological, contaminant and biomarker analyses. All sampled females will be individually market with leg-rings and the study colonies will be intensely searched for marked birds in the seasons following the experiment 2008 and 2009 in order to estimate recapture rates and survival (Yoccoz et al. 2002). Female eiders show strong breeding site philopatry; 98% of re-sighted females repeatedly return to their birth colony (Baillie & Milne 1989; Swennen 1990) and even in cases of disturbance and reduced breeding success only 2.5% of the exposed females change breeding colony (Wakeley & Mendall 1976). Thus recapture rates are closely associated with survival.The biostatistical analyses will be done in cooperation with Professor Nigel Yoccoz at the University of Tromsø.

Experimental parasite removal

The experiment will be performed in the 2007 and 2008 breeding seasons in all three study populations. Five days after laying of the last egg females will be randomly assigned to two groups, one treatment group and one control group. The two groups will be randomized with regard to laying date and clutch size. The individuals in the treated group will be administered a 2ml (50 mg fenbendazole, ~ 26 mg/kg body mass) oral dose of 2,5 % PANACUR® (Hoechst Roussel Vet GmbH), active ingredient fenbendazole (a benzimidazole) (25 mg/ml). The drug is effective against various intestinal parasites in birds e.g., nematodes, lungworms and cestodes, (Norton et al. 1991, Yazwinski et al. 1992, Yazwinski et al. 1993) and may also be effective against acantocephala as another benzimidazole (albendazole) has been reported to cure acanthocephala infections in monkeys (Weber & Junge 2000). Additionally, no negative side effects of fenbendazole have been shown in domestic ducks (Short et al. 1988, Pedersoli et al. 1989). The control group was placebo treated with sterile water. This method has previously been conducted in one of the eider populations (Grindøya) and was not found to have any negative side-effects (Hanssen et al. 2003a)

Immunocompetence

All females in the experimental study will be captured and a blood sample will be collected. From this we will prepare a blood smear for differential leucocyte/erythrocyte counts. The level of white blood cells in common eiders have previously been found to correlate with reproductive costs and immunosuppression (Hanssen et al. 2003c, 2005). We will also freeze a small amount of blood plasma from which we will be determining individual levels of immunoglobulins. Total levels of immunoglobulin G and immunoglobulin M are found to be negatively affected with pollution levels (Sagerup et al. 2005).

Hormones

Thyroid hormones (thyroxin and triiodothyronine) in birds regulate growth, body weight, development of central nervous system, cell differentiation and maturation, hatching, molt and reproduction (McNabb, 2000). Furthermore, they are considered the key controllers of that part of the metabolic heat production (i.e. thermoregulation) that is necessary for the maintenance of high and constant body temperature (Merryman & Buckles 1998). Triiodothyronine (T-3) has been implicated in the control of the metabolic rate and is decreased during fasting in most bird species. Factors that influence thyroid functions include dietary iodine (I-) availability, activity, ambient temperature, photoperiod, body condition, seasonality, age and exposure to PCBs and several OC pesticides (McNabb 2000, Verreault et al. 2003). It has been shown that the T-3 levels are important in regulating heat production during fasting in common eiders (Criscuolo et al. 2003).

Ecotoxicology

The potential for POPs to adversely affect eiders have not been critically considered. In a recent analysis it was found that in incubating females levels of common POPs (PCBs, DDE and HCB) on average increased 3-4 times; max 7 times, during a two week period (Bustnes & Hanssen, unpublished data). This increase depends on the lipid metabolism during which lipophilic POPs are released into the blood. During late incubation, when eider female are weakened (e.g. Hanssen 2003a, 2005), such rapid build up of circulating POPs may affect the reproductive effort and survival probability. The ecotoxicological part of proposed project will include both field work and a complex of experimental and laboratory studies with application of a wide broad of chemical, biochemical, cytological, immunological and molecular methods. It will be conducted in close cooperation with other proposed to IPY projects (COPOL, MariClim etc.). To study changes in POP and HM dynamics in relation to seasonal lipid changes and levels of infectious organisms, parallel samples of Common Eider blood will be taken for POP, HM and biomarker analyses in three study areas seasonally. Blood samples collected from 3 populations of Common eiders will be analyzed for a wide range of legacy and new POPs, as well as for HM levels and parasite/contaminant load responses (list of analytes and biomarkers is given in the Appendix). In the White Sea area, eider's tissue samples will be available for parasitological, contaminant and biomarker analyses. We suggest to carry out the screening study (a wide set of contaminants) during the first year on ca. 10 individuals per site in order to select appropriate target analytes and to identify compounds of concern for each area for the following year's studies. Some of contaminant and biomarker analyses are planned in frame of the COPOL project, we will coordinate efforts to ensure that analyses are not duplicated for the same samples, but rather that the results are open to both projects. Complex of chemical and biomarker analyses will allow us to: (i) Assess exposure before nesting period and after – a period when accumulated contaminants are released (ii) Evaluate potential biological combined effects of total contaminant mixtures present in Common Eider tissues and levels of infectious organisms.

Parasitology

Gastrointestinal parasites are excellent pathogens with which to investigate the possible relationships between infectious disease, immune-function and fitness as they occur world-wide and can be detrimental to fitness in wild populations (Clayton & Moore 1997). In birds, gastrointestinal parasites are found in every species that has been investigated (Janovy 1997). Few studies have addressed the effects of these parasites on fitness in wild populations (Hudson 1986, Piersma et al. 2001, Hanssen et al. 2003a, Holmstad et al. 2005). Previously, the identification of intestinal parasites has been difficult without sacrificing the individual (Doster & Goater 1997). However, recently developed PCR-methods allows for identification of parasitic strains from fecal samples (Doster & Goater 1997, Gasser 1999). These methods in addition to counts of parasitic eggs from fecal samples will allow for identification of parasite levels as well as identification of the parasite species. Fecal samples and cloacal swabs will be collected from all available ringed breeding females in the two field seasons.

The distribution of blood parasites in wild arctic waterbirds have, to our knowledge, not been investigated before. We will therefore use molecular genetic methods to map the presence of and species strain of the blood parasites leucocytozoon, plasmodium and Haemoproteus (Hellgren et al. 2004, Waldenstrom et al. 2004).

The parasite Toxoplasma gondii is recently recognized as a widespread organism in wildlife of Svalbard. Barnacle goose in Svalbard showed a prevalence rate of around 7-8% (Prestrud et al., unpublished). There is another IPY project application , IPY #363; Epidemiology of Toxoplasma and Trichinella in wildlife of Svalbard, dealing specifically with Toxoplasma on Svalbard. The common eider is potentially important as a species for transmission of Toxoplasma. Common eider, at least of the Svalbard, White Sea and Troms populations, have not been studied with respect to Toxoplasma, and we are not aware of any published report on T. gondii in eider of any other population. T. gondii might show up as a key parasite for studies in relation to impacts of pollutants and health parameters aimed at being studied in the present project. Findings related to T. gondii in eider will obviously also be important as part of the companion project (IPY #363). The combined results from the projects will have the potential to give synergy effects in the form of new knowledge/publications which could not have been achieved from each project alone. Blood samples (serum) from eider (all three populations) will be assayed for antibody against *T. gondii* by established method (modified agglutination method, MAT).

Coccidia fauna of arctic birds and in particular of the common eider has hardly been studied up to now, apart from some reports of lethal renal coccidiosis caused by Eimeria somateriae or other unidentified Eimeria spp. (e.g. Skirnisson 1997). Cloacal swabs and feces samples will be taken to analyze for coccidial infections. We will distinguish the coccidia species infecting the birds, determine prevalence and estimate the intensity of infection with each coccidia species in birds because this may vary considerably e.g. Dolnik 1998). Different coccidia species as well as mixed infections may have different pathogenicity for their hosts, therefore it is important to distinguish the parasites up to species level. Molecular methods are still insensitive to determining mixed infections of blood haemosporidian (Apicomplexa) parasites (Valkiūnas 2006) which also may also be a case with intestinal coccidia species. Therefore traditional methods of microscope analysis will be used (in addition to molecular methods)

Avian influenza

Currently (March 2006) the highly pathogenic avian Influenza Virus (IV) subtype H5N1 are infecting populations of wild birds and poultry. It is probably being introduced into Western Europe by migratory birds.

Although some fear regarding this strain is justified it should be borne to mind that also less virulent IV subtypes constitute a potential health risk to humans. Dr Ron A M Fouchier at the Dept of Virology, University of Rotterdam, Netherlands will screen (i) serum samples for avian flu antibodies (a measure of previous infection) and (ii) cloacal swabs for present infections of avian influenza virus strains. The previous and present avian flu infections are primarily investigated to map geographical variation to evaluate infection routes, but will also give an indication on the birds' health.

Time frame

The project will have a time frame of 3 years, starting in January 2007 with the start of field work in the summer of 2007.

Relevance for the Norwegian IPY contribution

-The proposal will generate new knowledge of high scientific quality regarding the fundamental processes regulating population numbers and disease spread in light of climate change and its possible effect on distribution of parasites, their hosts and the movement (migration) of these.

-The proposal leans upon international collaborators from Sweden, Netherlands and with a large contribution from Russian collaborators. The projects' Norwegian and foreign scientists will also use Norwegian infrastructure in Ny Ålesund, Svalbard.

- A large part of the project will be devoted to recruitment of scientists through the postdoctoral position applied for.

- The project will generate large public interest because of its focus on spread of possible zoonoses like the avian influenza strains. Additionally, the focus on the strenuous breeding of arctic animals and their dependence on good wintering areas in Europe and vulnerability to pollution, will increase public awareness of the fact that the polar areas are not a distant and isolated area but actually a vulnerable neighbor which is affected by the actions of everyone living in the northern hemisphere.

Other relevant IPY Proposals

-IPY #172 BIRDHEALTH Health of arctic and Antarctic bird populations. Coordinating project, Maarten Loonen, Netherlands (Sveinn Are Hanssen is second contact for the international project)

> -Geographical and temporal variation in health issues in Arctic breeding birds (BirdHealth). M. Loonen, Arctic Center, University of Groningen, Netherlands: post doc position (3y) and technical assistent (2y)
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> -Contrasting breeding investments in a small arctic shorebird: trade-off between breeding effort and fighting disease? (BirdHealth) T. Piersma, Animal Ecology, University of Groningen: post-doc position
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> -Arctic breeding waterfowl as vectors for avian influenza viruses (BirdHealth) M. Klaassen, NIOO, Nieuwersluis: PhD student
>
> -Combining behaviour-based and epidemiological models to identify the role of Arctic breeding migratory waterfowl in the ecology of infectious diseases, notably Avian Influenza (BirdHealth) J. A. P. Heesterbeek, Veterinary Department, University of Utrecht: post-doc position

-The international COPOL initiative IPY#175 consists of two research pillars: 1) transport and fate of contaminants to and in Polar Regions, 2) food web transfer and contaminant status of higher organisms. The Norwegian contribution to COPOL focuses on the dynamic range of contaminants in polar marine ecosystems (Pillar 2), Coordinator Norwegian project Geir Wing Gabrielsen.

-Epidemiology of Toxoplasma and Trichinella in wildlife of Svalbard (IPY #363, sharing endorsement with IPY #186; Engaging communities in the monitoring of zoonoses, country food safety and wildlife health). K. Åsbakk, Norwegian School of Veterinary Science, Section of Arctic Veterinary Medicine, Tromsø, Norway: PhD student.

Organization and partners

The project is a collaboration between the ongoing eider studies at NINA dept. of Arctic Ecology, The Norwegian Polar Institute, Akvaplan-NIVA, the White Sea Biological Station (Zoological Institute, Russian Academy of Sciences), department of zoology/ecology at University of Tromsø and the Molecular Ecology & Immunoecology Group at Department of Animal Ecology, University of Lund, Sweden. NINA and dept. of Ecology/Zoology at University of Tromsø have been active in the eider studies in Norway for the last 16 years and eight MSci candidates and two PhDs have completed their education as part of these studies. In addition, the research manager (Hanssen) has completed his PhD thesis on immunoecology and reproductive biology of common eiders, and has recently been holding a post-doctoral position financed by the Norwegian Research Council (157904/V40) at dept. of Ecology/Zoology, Tromsø and Animal Ecology, Lund. He is currently (from July 2006) employed as a researcher at Norwegian Institute for Nature Research (NINA). He is also co-leader for the international coordinating IPY BirdHealth project, project leader Maarten Loonen, Netherlands.

Partners

The scientific team is partly composed of scientists from Norway and Russia who have been co-operating for several years, additionally the project will involve new partners from Sweden and the Netherlands. Scientists involved in this proposal have an experience in immunoecology, evolutionary biology, parasitology, virology and ecotoxicology fields.

<u>Norwegian partners:</u>

The Norwegian Institute for Nature Research (NINA, www.nina.no) established in 1988. NINA is Norway's leading institution for applied ecological research. NINA is responsible for long-term strategic research and commissioned applied research to facilitate the implementation of international conventions, decision-support systems and management tools, as well as to enhance public awareness and promote conflict resolution. The institute employs a staff of 152 and directs well-equipped laboratories and facilities at seven locations in Norway. NINA offers broad-based ecological expertise covering the genetic, population, species, ecosystem and landscape level, in terrestrial, freshwater, and coastal marine environments. NINA has long-term cooperation in parasitological studies with Russian colleagues.

Akvaplan-niva (Apn, www.akvaplan.niva.no) a private R&D institute specializing in the fields of marine biology, ecotoxicology and environmental monitoring. The Norwegian Institute for Water Research (NIVA) is main shareholder in Akvaplan-niva. Akvaplan-niva has it's headquarters in Tromsø, Norway and offices/representatives in France, Iceland, Spain, Russia, Scotland, Canada, Malaysia and Qatar.
Akvaplan-niva has many years experience working with uptake and transport of persistent organic contaminants in marine and freshwater food chains, ending with marine birds, marine mammals and humans. Akvaplan-niva has an extensive network of collaborators in Northwest-Russia. Since the beginning of 90th Apn has started co-operation with Murmansk Marine Biological Institute (MMBI, Murmansk), Zoological Institute (ZIN, St.Petersburg), Institute of Biology (IB, Petrozavodsk) of the Russian Academy of Science. In co-operation with Russian institutes Apn has so far carried out 10 joint scientific cruises in Russian and Norwegian waters. These cruises were mainly focused on studying the contamination levels in different (abiotic and biotic) components of the ecosystems of the Barents, Pechora, White and Kara Seas.

Norwegian Polar Institute (NP, www.npolar.no) is the central governmental institute for research, mapping, management and logistics in the Norwegian polar areas. NP is located at present in Tromsø, and Svalbard (research station in Ny-Ålesund). NP has conducted studies on the bioaccumulation and biomagnification of POPs in arctic pelagic food chains; several ecotoxicological studies with marine birds at Jan Mayen, Bear Island and Svalbard.

Norwegian Institute for Air Research (NILU, www.nilu.no). The institute was established in 1969 and is now an independent foundation. It has an experienced staff of scientists who are specialized in issues of

pollution research on a national as well international level. The branch in Tromsø focuses in particular on pollution in the Arctic and Barents regions.
NILU has advanced measuring techniques and analytical methods for organic and inorganic chemicals of air, water and biological samples. In September 1993 the laboratories were accredited according to the EN 45001 standard.

University of Tromsø, Institute for biology. The dept for zoology/ecology has been involved in eider studies at Grindøya for the last 15 years. Professor Ivar Folstad is a highly cited evolutionary ecologist/parasitologist and will be aiding the evolutionary aspect of the experiment and interpretation of results from this project. Professor N Yoccoz (www.ib.uit.no/~nigel) is a biostatistician. He has recently (2002-2006) been involved in a long term capture-mark-recapture study on common eiders financed by NFR (148071/V10). We will draw upon his expertise when estimating the eiders recapture and survival rates, an important response variable in relation to the experiment, pollution levels, immune function and infectious organisms.

Swedish partners:

Department of Animal Ecology, University of Lund, Sweden

The laboratory of the Molecular Ecology & Immunoecology Group in Lund, Sweden is modern and the researchers are highly competent. We plan to perform the ELISA assays and blood parasite analyses at these facilities. The Molecular Ecology and Immunoecology Group in Lund, where Hasselquist and Bensch are associate professors, has produced leading research using molecular genetic techniques to investigate diverse ecological problems. Moreover, the group's lab also has modern equipment for analyzing humoral immunocompetence using enzyme-linked immunosorbent assays (ELISA). Hasselquist and Bensch are currently involved in studies of Campylobacter in wild birds (screening, epidemiology, effects of infection on wild birds, and in screening of influenza in wild birds in Sweden (both prohects in cooperation with Bjorn Olsen and Jonas Waldenstrom).

Dutch partners:

Department of Virology, Erasmus medical centre (EMC)

The dept. Virology at EMC houses the Dutch WHO national influenza centre. EMC is coordinator of the EU framework 5 programme "NovaFlu", where novel vaccine candidates for pandemic IVs are designed and tested. One of Dr. Fouchier's activities in this programme is the generation of an avian IV database. In this programme, avian samples are collected through a large international network of ornithologists. After 2005, the database FP5 project will be continued in the NWO/WOTRO programme "Nivarec". As a fellow of the Royal Dutch Academy of Arts and Sciences from 2000-2005, Dr. Fouchier developed new methods to study determinants of IV zoonosis and pathogenesis, which will be invaluable for the current proposal. Fouchier is also one of 19 partners in the framework 6 programme coordinated action RiViGene (Risk Virus Gene database). The genetic data from IV isolates in the current proposal will be compared with available datasets, and correlated with biological properties of the IVs.

Russian partners: the principal collaborators are the White Sea Biological Station,(which will coordinate work with other Russian scientific institutes: MMBI and IB and Kandalaksha State Nature Reserve) and analytical Center of Environmental Chemistry SPA "Typhoon". The long-term monitoring data on Common Eiders, bentic communities and parasites accumulated in Kandalaksha Reserve, Zoological Institute and MMBI will be available for this study.

White Sea Biological Station (Zoological Institute, Russian Academy of Sciences, WSBS ZIN, www.zin.ru) is one of the oldest (founded in 1832) research institutes and leading institute in the field of zoology. Institute has two biological stations, one of them, the White Sea Biological Station was founded in

1949 and since then is conducting research on ecology and life cycles of marine invertebrates and fish, parasithology of invertebrates, fish and marine birds, adaptations of marine organisms to environmental factors.

Center of Environmental Chemistry SPA "Typhoon", Russian Federal Service on Hidrometheorology and Environmental Monitoring (CEC, Obninsk,
The CEC of "Typhoon" has been conducting scientific investigations on persistent organic pollutant (POPs) levels in the arctic ecosystems and participating in many international projects. The CEC has extensive experience in scientific collaboration with Akvaplan-niva on contaminant studies in marine birds and mammals from the Barents, White and Kara seas areas. The CEC has national accreditation and participating on regular basis in international intercalibration studies including QUASIMEME Program for sediments and biota, AMAP Ring Test for human blood etc.

Institute of Biology, Karelian Scientific Centre, Russian Academy of Sciences (IB, http:\\biology.krs.karelia.ru), founded in 1953 is a leading research institute in the field of genetics, biochemistry of marine and freshwater organisms.

Murmansk Marine Biological Institute, Kola Scientific Centre of the Russian Academy of Sciences (MMBI, www.mmbi.murman.ru) The main field of research: ecology of Arctic seas; evolution of marine ecosystems of the Arctic; environmental monitoring of the Barents, White, Pechora and Kara Seas; marine biology; ecology and parasithology of marine birds and mammals of the Barents-Kara Region; chemical pollution of Arctic ecosystems. MMBI have been conducting ecotoxicological studies since 1976. Contamination levels of heavy metals, oil and chlorinated hydrocarbons have been studied in bottom sediments and in different trophic level of marine organisms from the Arctic regions. Parasitological studies on effects of invasion on immunological and biochemical parameters in marine birds were conducted in the Barents Sea area. All studies will be coordinated with Kandalaksha State Nature Reserve, Russian Ministry of Nature Researches.

Dept of Protozoology, Russian Academy of Science (RAS) Olga Dolnik is a free partner of Dep. of Protozoology ,St Petersburg. Dep. of Protozoology was found in by an outstanding parasitolgist Prof. V. A. Dogiel who established the school of ecological parasitology in Russia. Ecological parasitology, host-parasite interactions between parasitic protozoa and their hosts as well as studies on morpho-functional organization of protozoa and their fauna fundamental research are the main directions of the research at the Department.

PUBLICATION

We will attend various conferences presenting results from this project. We plan to publish at least 4 articles in peer reviewed international scientific journals. E.g. (1) Effects of pop and heavy metals on the immunocompetence of eider females. (2) Patterns of migration and its consequence for distribution of infectious organisms in the arctic (3) Avian influenza; its distribution in arctic seaducks (4) the arctic breeding strategy; its vulnerability for human induced stressors. Additionally, with the cuurent and porabable future public interest in the Avian Influenza the results from our study should gain a great deal of public interest.

ETHICS

The capture of and experimentation on wild eider ducks will be performed under permits from the relevant Norwegian and Russian governmental authorities (Directorate for Nature Management/County Governor of Troms and the Norwegian Animal Research Authority in Norway)

Table 1

White Sea, Russia	Kongsfjorden, Svalbard	Tromsø, Norway
Population status		
Common Eider has a special role in the White Sea ecosystem - in some publications the White Sea is named as “Sea of Eiders”) (Bianki et al. 1993). These birds constitute a separate population which spends the entire year on the White Sea and winters in polynias. The main nesting sites are on the islands in Kandalaksha Bay and Onega Bay. The population in the protected areas is relatively stable. In the Onega Bay estimated that there were 5,000 pairs in more than 3,000 colonies (Anker-Nielsen et al. 2000).	The total number of breeding pairs in Kongsford in 1981-1987 was fluctuated between 1,000 and 3,400 depending on the sea-ice conditions in the fjord (Mehlum 1991). The population status of Common Eider in Svalbard is thought to have declined dramatically since the beginning of this century (Nordenhaug 1982).	Tromsøysund/Balsfjord area, ca. 2000 individuals, Grindøya largest colony, ca 400 pairs (Strann unpublished, Hanssen et al. 2003). The total population number in North-Norway has been estimated at 35 000-40 000 pairs. Norwegian coast eiders are resident in the breeding area all year or migrate locally (~25 km) (Bustnes & Tertitsky 2000)
Feeding		
The Common Eider is a typical benthophagous bird – 66% of the diet consists of blue mussels *Mytilus edulis*, but gastropods, echinoderms and crustaceans are also important and in the winter time it may use fish for feeding (Bianki et al. 1979).	In Svalbard, the autumn diet consisted of bivalves and the amphipod Gammarellus homari (Lydersen et al. 1989, Mehlum & Gabrielsen 1989)	Mussels and crustaceans e.g. *Littorina* sp., *Mytilus, Nucella* sp., *Gammaridea* (Soot-Ryen 1941)
Parasites		
Abundance and high diversity in food composition (59 species of coastal invertebrates) lead to heavy infection, especially of young birds with parasites. Dead neastlings, heavily infected with helminths are recorded every year at the coast of the Kandalaksha Bay. The large mass death was recorded in 1976-1977, when 90% of all nestlings were assumed to perish from helminthosis (Karpovich 1987). This corresponded to the years in which the maximum number of Common Eiders nesting in the Kandalaksha Bay was reported (Karpovich 1987). Following this a drastic decrease in the number of birds nesting in the Kandalaksha Bay took place. In 1993 an unusual mortality of common eider ducklings was observed in West-Iceland, the cause was assumed to be renal coccidiosis (Skirnisson 1997)		
Contaminant sources		
The main contaminant sources in this region are discharges and emissions from the mining, pulp and paper, metallurgy and oil industries, as well as from military activities (NEFCO-AMAP 2003).	No known local POP sources, main source –long-range atmospheric transport. However, there are elevated natural levels of petroleum hydrocarbons (Dahle et al. 2006) and metals (coal mining) in marine environment.	No known major local POP sources, main source – long-range atmospheric transport.
Contaminants		
Several surveys, conducted recently shown high levels of some legacy and new POPs in invertebrates, fish and seals from the White Sea (Muir et al. 2003, Savinova et al. 2005). No information exists on legacy and new POP levels and effects in marine birds from this area.	Existing information on legacy POPs in eiders from 90th (Daelemans 1994, Savinova et al. 1995) shown low-moderate levels, while high Cd and Hg levels were detected (Savinov et al. 2003). No data exist on “new contaminants” levels and effects in birds.	New data from 2005; levels of PCB, HCB and DDE increased in individuals during the incubation period (Bustnes & Hanssen unpublished)

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