International Polar Year 2007-2008
The Netherlands
(IPY•NL)

(Name and address of the main and co-applicant, project title and an executive summary (in English) are provided through the on-line electronic submission system and will be automatically inserted at the front of the application)

Is this application part of a *coordinating project proposal*? **X** Yes • No
If the above question is answered with "yes", please fill in the title of the coordinating project proposal.
Title coordinating project proposal: BIRDHEALTH Health of Arctic and Antarctic bird populations

Related international IPY 'Full proposal'
(submitted to ICSU-WMO Joint Committee for IPY)
Title: Bird Health
Lead contact (name, organisation, country): Dr. Maarten J.J.E. Loonen, Arctic Centre, University of Groningen, The Netherlands
ID No: 172
Website URL for more information: www.birdhealth.nl

Geographic area of interest for this (IPY•NL) application
• Antarctic **X** Arctic • Bipolar

1a. Further details of the applicant(s)

Main applicant Prof. Dr. T. Piersma
Gender: **X** Male • Female
Tenure Position: **X** Yes • No
Research School: Functional Ecology

Website URL:
http://www.rug.nl/biologie/onderzoek/onderzoekgroepen/dierOecologie/animalEcolmembers/piersmaIntro

Co-applicant Drs. J. Reneerkens
Gender: **X** Male • Female
Tenure Position: • Yes **X** No
Research School: Functional Ecology
Website URL:

1c. Does the local authority support your application? **X** Yes • No
(did you inform your superior and accepts your institute/university the conditions for support by NWO)

1d.Renewed application? • Yes **X** No
(in case of renewed application please summarize main changes under item 4**)** **Dossier nr:**

1e. Applying for: • PhD student **X**Postdoc • Research costs
(for PhD student please underline promotor in question 1f, composition of research group)

1f. Composition of the research group

Name and title	Specialization	Employment/Institute
PhD students		
D. Buehler	Ecological immunology	PhD student, University of Groningen
T. Compton	Tropical adaptations shellfish	PhD student, University of Groningen/ Royal NIOZ
E. Folmer	Spatial distribution shorebirds	PhD student, University of Groningen
P. van den Hout	Ecology of bird predation	PhD student, University of Groningen/ Royal NIOZ
C. Kraan	Spatial distribution shellfish	PhD student, University of Groningen/ Royal NIOZ
J. Leyrer	Tropical wintering shorebirds	PhD student, University of Groningen/ Royal NIOZ
J. Reneerkens	Shifts in preen wax composition	PhD student, University of Groningen/ Royal NIOZ
J. Schröder	Condition Black-tailed Godwits	PhD student, University of Groningen
Y. Verkuil	Population dynamics Ruff	PhD student, University of Groningen
W. Vahl	Interference competition waders	PhD student, University of Groningen/ Royal NIOZ
Post-docs		
Dr. C. Both	Avian population ecology	Post-doc, University of Groningen
Dr. M. Loonen	Arctic ecology, geese	University of Groningen, Arctic Centre
Dr. K. Matson	Ecological immunology	Post-doc, University of Groningen
Dr. I. Tieleman	Ecological immunology	Post-doc, University of Groningen
Dr. F. Vézina	Energetics and physiology	Post-doc, Royal NIOZ

2. Populaire samenvatting van de aanvraag (Nederlands)
(if granted, this description will be used for Dutch communication, also to non-specialists)

Vogels die op de hoognoordelijke toendra broeden geven veel energie uit aan warmte-huishouding en de productie en het uitbroeden van hun eieren. Het is bekend dat hun dagelijkse energie-uitgaven het theoretisch maximaal mogelijke benaderen of zelfs overschrijden. Het is des te verwonderlijk dat sommige vogelsoorten, die vanwege hun kleine omvang veel geproduceerde warmte aan hun koude omgeving verliezen, er bovendien een bijzonder broedsysteem op nahouden dat extra veel energie vergt. Sommige paartjes hoognoordelijk broedende Drieteenstrandlopers C*alidris alba* presteren het om, niet zoals gebruikelijk met zijn tweeën een nest met vier eieren uit te broeden, maar twee legsels te produceren waarvan het eerst gelegde door het mannetje wordt uitgebroed, en het tweede door het vrouwtje zelf. Dat heeft weliswaar het voordeel dat, als verder alles hetzelfde is, de kans op nageslacht de betreffende arctische zomer tweemaal zo groot is, het vergt daarentegen nog meer energie van beide ouders. Het vrouwtje moet immers tweemaal zoveel eieren produceren, en beide ouders zijn nu in hun eentje verantwoordelijk voor een heel nest met eieren. Om deze in hun eentje succesvol uit te broeden is er weinig tijd om het dagelijkse kostje insecten bij elkaar te scharrelen, want als de eieren niet bebroed worden koelen ze snel af. Paartjes Drieteenstrandlopers die samen een nest bebroeden hebben het dan makkelijker omdat ze de broedzorg delen.

Dergelijke topprestaties die deze zogenaamde ‘dubbel-leg’-strategie met zich meebrengt worden slechts door een (klein) deel van de broedpopulatie geleverd. Mogelijk zijn deze hoogkwalitatieve Drieteenstrandlopers alleen in staat om in hun eentje een heel legsel groot te brengen in relatief warme zomers met veel insecten als voedselbron en doordat ze (tijdelijk) bezuinigen op een ander energetisch dure eigenschap; het immuunsysteem. In de relatief ziektekiem-arme arctische omgeving kunnen ze zich dit waarschijnlijk veroorloven. Voor vogels die parasieten met zich meedragen uit de tropische overwinteringgebieden kan bezuinigen op het immuunsysteem echter gevaarlijk zijn. Dit contrast binnen een vogelsoort waarin een groep 'dubbel-leggers' veel meer energie kwijt is aan een waarschijnlijk tweemaal zo grote kans op het grootbrengen van nageslacht vergeleken met individuen die 'het rustiger aan doen' biedt allerlei onderzoeksmogelijkheden.

Wij willen graag onderzoeken waarom slechts enkele Drieteenstrandlopers in staat zijn twee broedsels per jaar groot te brengen, welke energetische consequenties dit heeft, hoeveel rek er in hun immuunsysteem zit en of de dubbel-leggers hier inderdaad op bezuinigen. Door de vogels te screenen op infecties met ectoparasieten, malaria en vogelgriep kunnen we een link leggen tussen investeringen in het immuunsysteem en infectiekans. Uiteindelijk willen we de gevolgen voor de overleving van 'enkel-leggers' en 'dubbel-leggers' en hun jongen bestuderen, om te begrijpen waarom er binnen een vogelsoort twee broedstrategieën kunnen bestaan.

Dit onderzoek past in lopende onderzoeksprojecten aan vergelijkende ecologische immunologie van 'zoetwater-' en 'zoutwater steltlopers' en een binnenkort uit te voeren project aan vergelijkende demografie van Drieteenstrandlopers op overwinteringlocaties op verschillende breedtegraden. De studie zal waarschijnlijk allerlei interessante inzichten opleveren over het functioneren van het immuunsysteem van arctisch broedende vogels en de kans op infecties voor deze vogels. Op grond van het laatste valt te beoordelen of arctische steltlopers tot de risicogroepen behoren wat betreft het verspreiden van gevaarlijke ziekten.

3a. Top 5 scientific publications of the applicants related to the proposed research

1. **Piersma, T**. 1997. Do global patterns of habitat use and migration strategies co-evolve with relative investments in immunocompetence due to spatial variation in parasite pressure? *Oikos* 80: 623-631.

2. Mendes, L., **T. Piersma,** M. Lecoq, B. Spaans and R.E. Ricklefs. 2005. Disease-limited distributions? Contrasts in the prevalence of avian malaria in shorebird species using marine and freshwater habitats. *Oikos* 109: 396-404.

3. Mendes, L. **T. Piersma**, D. Hasselquist, K.D. Matson and R.E. Ricklefs. 2006. Variation in the innate and acquired arms of the immune system among five shorebird species. *J. Exp. Biol.* 209: 284-291.

4. **Piersma, T.**, A. Lindström, R.H. Drent, I. Tulp, J. Jukema, R.I.G. Morrison, **J. Reneerkens**, H. Schekkerman and G.H. Visser. 2003. High daily energy expenditure of incubating shorebirds on High Arctic tundra: a circumpolar study. *Funct. Ecol.* 17: 356-362.

5. **Piersma, T.** 2002. Energetic bottlenecks and other design constraints in avian annual cycles. *Integr. Comp. Biol.* 42: 51-67.

3b. Other relevant publications (max 1 page for publications, min 10 pts)

By the applying research group:

Klaassen, M., A. Lindström, H. Meltofte and **T. Piersma**. 2001. Waders are not capital breeders. *Nature* 413: 794.

Krijgsveld, K.L., **J.W.H. Reneerkens**, G.D. McNett and R.E. Ricklefs. 2003. Time budgets and body temperatures of American Golden Plovers chicks in relation to ambient temperature. *Condor* 105: 268-278.

Piersma, T. 2003. "Coastal" versus "inland" shorebird species: interlinked fundamental dichotomies between their life- and demographic histories? *Wader Study Group Bull.* 100: 5-9.

Piersma, T., H. Meltofte, J. Jukema, **J. Reneerkens**, P. de Goeij and W. Ekster. A single-year comparison of two methods to map breeding Red Knot and Sanderling in High Arctic Greenland. Submitted to *Wader Study Bull.*

Reneerkens, J., **T. Piersma**, J. Jukema, P. de Goeij, A. Bol and H. Meltofte. 2005. Sex-ratio and body size of sandpiper chicks at Zackenberg, north-east Greenland in 2003. *Wader Study Group Bull.* 106: 12-16.

Reneerkens, J., R.I.G. Morrison, M. Ramenofsky, **T. Piersma** and J.C. Wingfield. 2002. Baseline and stress-induced levels of corticosterone during different life cycle substages in a shorebird on the High Arctic breeding grounds. *Physiol. Biochem. Zool.* 75: 200-208.

Reneerkens, J., T. Piersma and J.S. Sinninghe Damsté. 2002. Sandpipers (Scolopacidae) switch from mono- to diester preen waxes during courtship and incubation, but why? *Proc. Roy. Soc. Lond. B.* 269: 2135-2139.

Reneerkens, J., T. Piersma and J. S. Sinninghe Damsté. 2005. Switch to diester preen waxes may reduce avian nest predation by mammalian predators using olfactory cues. *J. Exp. Biol.* 208 : 4199-4202.

Other references with respect to the application:

Castro, G., J.P. Myers and R.E. Ricklefs. 1992. Ecology and energetics of Sanderlings migrating to four latitudes. *Ecology* 73: 833-844.

Gudmundsson, G.A. and A. Lindström. 1992. Spring migration of Sanderlings *Calidris alba* through SW Iceland: wherefrom and whereto? *Ardea* 80: 315-326.

Kirkwood, J.K. 1983. A limit to metabolizable energy intake in mammals and birds. *Comp. Biochem. Physiol.* 77A: 1-3.

Martin II, L.B., A. Scheuerlien and M. Wikelski. 2003. Immune activity elevates energy expenditure of house sparrows: a link between direct and indirect costs? *Proc. Roy. Soc. Lond. B.* 270: 153-158.

Meltofte, H. and T.B. Berg. 2004. *Zackenberg Ecological Research Operations. Biobasis: Conceptual design and sampling procedures of the biological programme of Zackenberg Basic, 7th edition.* National Environmental Research Institute, Department of Arctic Environment. 77p. (also on http://BioBasis.dmu.dk/).

Parmelee, D.F. and R.B. Payne. 1973. On multiple broods and the breeding strategy of arctic Sanderlings. *Ibis* 115: 218-226.

Sheldon, B.C. and S. Verhulst. 1996. Ecological immunology: costly parasite defences and trade-offs in evolutionary ecology. *Trends Ecol. Evol.* 11: 317-321

Schekkerman, H., I. Tulp, T. Piersma and G.H. Visser. 2003. Mechanisms promoting higher growth rates in arctic than temperate shorebirds. *Oecologia* 134: 332-342.

Schmid-Hempel, P. 2003. On the evolutionary ecology of specific immune defence. *Trends Ecol. Evol.* 18: 27-32.

Tieleman, B.I., J.B. Williams, R.E. Ricklefs & K.C. Klasing. 2005. Constitutive innate immunity is a component of the pace-of-life syndrome in tropical birds. *Proc. Roy. Soc. Lond. B.* 272: 1715-1720.

Tulp, I., H. Schekkerman, T. Piersma, J. Jukema, P. de Goeij and J. van de Kam. 1998. *Breeding waders at Sterlegova, Northern Taimyr, in 1994.* WIWO-report 61, Zeist.

4. Detailed description of research area and research plan
(max 4 pages, min 10 pts, including figures)
(Objectives, innovative aspects, history/background, scientific approach and research methodology)

General introduction

The Netherlands is tightly linked with the arctic tundra through the many waterbirds that reproduce here but spend the winter in, or migrate further south through, Western Europe. A large proportion of these birds consists of Arctic breeding shorebirds, birds that show spectacular behavioural and physiological adaptations to living in the Arctic. Among these are long non-stop migratory flights, high energy expenditures during incubation in the cold and an unparalleled fast growth of chicks. Recently, with the threat of diseases like avian influenza that possibly can be transmitted via migratory waterbirds the general public also shows interest in Arctic breeding waterbirds. To understand more about the possible risk of diseases for humans and animals, it is of importance to gain more knowledge about fundamental questions regarding how arctic-breeding birds fight infections. Here we propose a research program to monitor avian diseases, and investigate the functioning of the immune system in a High Arctic breeding shorebird that shows a fascinating contrast in reproductive investments between individual birds that either raise a family together or do it alone. Additionally, in collaboration with an existing and an upcoming research project in western Europe and in Africa on wintering shorebirds, the research proposed here may give insight in the possibility of transmittance of disease by arctic breeding shorebirds over long distances and elucidate possible seasonal changes in immune responses of shorebirds.

Ecological immunology

The reproductive period of shorebirds on the High Arctic breeding grounds is energetically demanding. Females devote large amounts of energy and nutrients in production of eggs that together weigh more than their own body weight, whereas males invest in expensive courtship displays. Daily energy expenditure of incubating shorebirds is about 50% higher on the arctic tundra than in temperate breeding areas (Piersma et al. 2003), whereas the food availability is probably not much higher in the Arctic compared with temperate areas (Tulp et al. 1998).

In the last decade, biologists began to realise that risk of disease and organism's immune defence are important selective forces that shape life histories. Piersma (1997, 2003) hypothesised that High Arctic birds invest less in their (innate and acquired) immune defence system. This lack of appropriate immune responses would then force High Arctic birds to live in relatively parasite-poor environments year-round, such as the Arctic and marine habitats (Piersma 1997, 2003). The relatively small investment in a costly immune defence might enable such birds to allocate more energy and/or nutrients into other highly demanding aspects of their life history.

Contrasting breeding strategies in an arctic bird species.

The presumed trade-off between immunocompetence and energy-demanding traits can well be studied in bird species that show clear inter-individual contrasts in energy expenditure during a breeding season. Sanderlings (*Calidris alba*) are a very suitable species for such studies because it is known to sometimes lay two clutches of eggs soon after each other, the first one which is being brooded by the male, while care of the second clutch is being taken by the female herself (Parmelee and Payne 1973). In contrast, other pairs of Sanderlings raise a single brood together.

We have strong indications that near Zackenberg, northeastern Greenland, part of the local breeding pairs of Sanderlings also produces two clutches within a breeding season. In a previous field season in 2003 we found 20 Sanderling nests of which 10 were being brooded by two different birds (molecularly sexed as a male and a female for each nest). In four cases, only one attending bird was encountered at repeated catches or visits at the nest. These latter are presumed 'double clutching birds' of which the partner was taking care of a second clutch. For six other nests it remained unclear how many different birds were attending it (Piersma et al. submitted).

Although the double-clutching strategy may yield a twice as large reproductive success in a given year, the costs may be high. Double-clutching females have to produce a second set of four eggs in a short period of time in early spring when insect food is still not very abundant. In addition, both double-clutching parents will have the care of a brood on their own. Incubation duties and subsequent chick guarding can therefore not be shared with a partner. To avoid unnecessary cooling of the eggs, double-clutching individuals have less time to find insect food to meet their daily energy requirements.

Daily energy expenditures of Sanderlings during incubation in the Arctic approach or even exceed the suggested sustainable maximum (Piersma et al 2003), due to the high thermoregulatory demands of the arctic weather conditions and the costs of incubation. Indeed, compared with measured daily energy expenditures on wintering grounds at four different latitudes (Castro et al. 1992), daily energy expenditures of breeding Sanderlings exceed those costs (Piersma et al. 2003) and are among the highest in the annual cycle. The double-clutch breeding strategy of Sanderlings, might push energy expenditures even more in the direction of, or above, the so-called 'metabolic ceiling' (Kirkwood 1983).

The double-clutching strategy in Sanderlings appears to be facultative (i.e. not all females lay a second clutch, Parmelee and Payne 1973), which suggests that there must be costs that constrain some individuals to incubate a clutch and raise the young without the help of a partner. Possibly, only Sanderlings in good condition can do so.

The fraction of double-clutching individuals in a local breeding population may depend on environmental conditions, such as food availability and weather conditions in the early arctic spring. Arctic shorebirds are 'income breeders' (Klaassen et al. 2001) and Sanderlings thus produce the two clutches from the local (insect) food source. A changing climate may affect insect abundance and consequently breeding strategies of birds. Because Sanderlings are faithful to their breeding location, we may discover whether annual variation in weather, insect abundance and body condition of the birds will lead to different breeding decisions.

A possible trade-off between immunocompetence and reproductive investments

Because breeding shorebirds in the Arctic already spend maximal amounts of energy, we think that they must economise on other energy demanding processes to increase breeding efforts and incubate on their own. We proposed that sandpipers bring about energy demanding adaptations to environmental challenges of arctic breeding seasons by economising on investments in the immune defence systems (Piersma 1997, 2003). Indeed, the (energetical or nutritional) costs of maintaining and using the immune system are high (Sheldon and Verhulst 1996, Schmid-Hempel 2003, Martin II et al. 2003) and it therefore makes sense to down-regulate such expensive processes when not immediately vital. We hypothesise that individuals that rear a clutch on their own ('double-clutching individuals') can do so by channeling less energy into immunocompetence. Only individuals that are not infected with parasites, for example picked up on the tropical wintering grounds, can afford to economise on immunocompetence and are expected to be able to raise a single brood on their own.

It has been suggested before that avian malaria, caused by blood parasites that are transmitted between vertebrate hosts by dipteran insects, was not found in High Arctic breeding shorebirds (Mendes et al 2005). Sanderlings breeding in Greenland, winter in West Africa (Gudmundsson and Lindström, 1992) where they forage on decaying organic material (pers. obs.), which is a possible source of infections (Mendes et al 2005). This would imply that during wintertime Sanderlings need to up-regulate their immune response or else run the risk of getting infected, which might lower their survival.

A possible trade-off between immunocompetence and risk of disease
Although temporally economising on immune function may enable arctic birds to allocate energy in costly behaviour and to invest in a second clutch, birds will also run a higher risk of infection when immunocompetence is down-regulated. Birds thus have to trade-off immunocompetence against risk of disease. The balance of this trade-off will differ seasonally and between individuals.

On the African wintering grounds, economising on immune defence may be dangerous if birds forage in parasite-rich environments. In the Arctic, that is presumed to be poor of parasites and their vectors (Piersma 1997, 2003), disease risk is probably lower. Migratory arctic shorebirds that carry parasites, for example picked up on the wintering grounds and not got rid of them at the start of the arctic breeding season, might not be able to temporally economise on their immune system.

With increasing temperatures in polar regions, the risk of disease might also increase in the Arctic and, everything else remaining equal, thereby change life history decisions of birds. In co-operation with partners within "BIRDHEALTH" we plan to screen many birds for ectoparasites, blood- and intestinal parasites as well as for viruses. This may yield insight in temporal and spatial variation in risk of infection.

Objectives
During three breeding seasons in northeast Greenland, in the well facilitated Danish research station Zackenberg, we plan to catch and individually colour-mark shorebirds, with a special attention to the most abundant Sanderlings of which the **energy expenditure** and **immune responses** in relation to their **breeding effort** will be studied. Re-sightings of colour-ringed shorebirds, which are faithful to the breeding grounds, in following years will be used to assess **survival** consequences of individual life history decisions. We have prior experience with the tundra near Zackenberg and possess blood samples of a group of Sanderlings (probably both single- and double-clutching) and have developed microsatelite genetic markers appropriate for paternity analysis.

The field work requires the catching of birds soon after arrival in early spring on the breeding grounds and intensively searching for territories and nests, such as we did in the field season of 2003 (Piersma et al submitted), to catch birds during incubation. Colour-marked birds will be followed intensively to learn about their breeding efforts (one or two clutches) and time invested in incubation and chick guarding relative to their partners. Small blood samples will be taken for DNA to molecularly sex adult and chicks (cf. Reneerkens et al. 2005) and for parentage analysis (using microsatelite genetic markers) afterwards, to find out which birds had one or two sets of offspring.

Energetic consequences of breeding together or alone will be measured using stable isotopes (doubly-labeled water; cf. Piersma et al. 2003). Non-invasive immunological assays that can be performed in the field as well as in the excellent laboratory facilities in the Zackenberg research station will be used to get information on the relative investments of birds in immune defence. The assays we plan to use involve the collection of small blood samples (for whole blood or plasma) that can be used to investigate both the innate and acquired immune responses. Furthermore, we would like to expand our set of blood samples of complete families to understand inheritance of the MHC-complex, the highly variable part of the genome that encodes for the immune system.

In close co-operation with other proposed research projects in the full proposal "BIRDHEALTH" we plan to screen birds for infections with ectoparasites, intestinal parasites, blood parasites (such as avian malaria) and viruses (e.g. avian influenza and West Nile Virus) to assess temporal and spatial variation in disease risk.

Re-sightings of colour-marked individuals (with coloured leg rings) during following years will allow us to estimate (annual) survival and correlate this to investments in immunocompetence or multiple broods, i.e. study the fitness repercussions of breeding decisions the year(s) before. Also, colour-ringed birds will help us at the breeding grounds to ascertain the attendance of one or two birds at nests without having to catch the birds. Automatic data-loggers in the vicinity of some nests of single- or double-clutching Sanderlings of which the attending birds will be applied with small transmitters will give exact time budgets of birds. Together with behavioural observations, the measured daily energy expenditures and detailed weather as well as insect data, can be used to estimate the energetic consequences and time costs of double-clutching individuals compared with pairs breeding a single clutch together. After hatch, the transmitters on adults will greatly help to track the roaming families (precocial chicks guarded by a parent), allowing us to study the fate and growth of the chicks, individually colourmark the chicks for survival analysis, and by applying the same immunological assays as used for the adult birds, investigate an expected trade-off between chick growth and immune system (Piersma et al. 1997).

In addition to the immune responses of individual birds we will gather data on other characteristics that may signal their health condition (amount of breeding plumage, body mass and fat stores, structural measurements). Fat stores of birds, another important index of birds' condition, can accurately and directly be estimated by use of the doubly-labeled water method which we hope to use to measure energy expenditure. Bird territories, insect abundance, phenology and weather data are intensively monitored at Zackenberg as part of the standard monitoring program since 1996 (Meltofte and Berg 2004).

The proposed study could nicely be combined with survival studies on Sanderlings of the same population on three different wintering areas in Ghana, Mauritania and The Netherlands (WOTRO project W01.83.2005.016). Sanderlings caught for these purposes can be subjected to the same field immunological assays as their breeding conspecifics. Although living in presumably parasite-poor marine environments in winter, we know that Sanderlings in Mauritania feed on dead fish material and other decaying organic material. This is the typical 'dirty' habitat of another sandpiper species, the Turnstone *Arenaria interpres*, that shows relative high immune responses compared with shorebird species that restrict themselves to 'clean', parasite-poor, marine environments (Mendes et al. 2005, 2006). It is possible that Sanderlings that reduce investments in their immune system during incubation in the High Arctic have to up-regulate immune defence during the winter to withstand infections in parasite-rich environments. Measuring immune responses of Sanderlings both in the Arctic where birds are time- and energy restricted, as well as in the tropical and temperate wintering areas allows studying seasonal variation in immune responses in this species.

5. Timetable of the project and working program:

2007: January-April: preparation of the field work
May-July: fieldwork
August-December: laboratory work and writing scientific articles
2008: January-April: preparation of the field work
May-July: fieldwork
August-December: laboratory work and writing scientific articles
2009: January-April: preparation of the field work
May-July: last field season
August-December: laboratory work and writing scientific articles

6. Affiliation with (inter)national research programmes
(This should include an explicit description of existing and planned co-operation)

Dr. B.I. Tieleman (RUG): immunology & life histories.
Dr. K.D. Matson (RUG): immunological techniques.
Drs. Spaans, Drs. Hooijmeijer & Prof. Dr. Piersma (NIOZ/RUG): comparative demography of shorebirds in The Netherlands & Mauritania.
PhD-position (NIOZ) by WOTRO-funding: demography of Sanderlings in Netherlands, Mauritania and Ghana.
Prof. Dr. A. J. Baker (University of Toronto and Royal Ontario Museum): genetics of MHC-complex and parentage analysis.

7. Societal significance
Motivation of the relevant policy aspects, such as:.
- Political / societal significance in a national and international context
- Urgency for international and/or national policy
(These are important for the evaluation of the proposal, because of the funding by several ministries.)

The monitoring of Arctic breeding shorebirds for diseases will yield relevant information on whether arctic breeding shorebirds may be potential distributors of dangerous diseases, such as avian influenza. Knowledge on the immune defence of arctic birds will give important insights in the relative investments of birds into immune defence to fight such diseases.

The project will also give insights in the interplay between weather, insect abundance and the breeding strategies of arctic shorebirds and will show how arctic birds adapt to a globally changing climate.

Knowledge of the Major Histability (MHC) Complex, the genetic blueprint of the immune defence, will help us understand how flexible migratory arctic birds are to fight diseases. Genetic bottlenecks (inbreeding) due to habitat loss both in the Arctic as in the marine wintering grounds of birds may limit birds' ability to appropriately react to diseases. Understanding birds' disease risk and immune response in a globally changing environment is important for nature conservation, sustainable development and for health issues for humans and animals.

8. Legal requirements
For fieldwork to Antarctica additional information is needed for an initial assessment whether or not the applicant will have to apply for a permit under the 'Wet bescherming Antarctica'.

Do you plan to visit Antarctica, South of 60°S? O Yes **X No**
If the above question is answered with "yes" please fill in the separate 'WBA-IPY' form for details

Has been complied with the law and legal requirements with respect to the proposed Research, such as 'Wet op Dierproeven' and 'DNA-recombinant legislation?
x Yes • No

Specific permits for the project need to be requested based on detailed descriptions of experimental tests.

9a. Requested budget from ALW

		2006	2007	2008	2009	2010
Personnel (mm)			12	12	12	
Research costs (k€)						
	Equipment		85			
	Consumables		22	2	2	
	Fieldwork		47	47	47	
	Education, Outreach & Communication			**p.m.**		
	Coordination*					
Shiptime NIOZ-MRF (in days)		XXXXXXXX				XXXXXXXX

* Costs for coordination can only be requested if main applicant is lead contact of the related IPY "Full proposal". If this is a subproject of a coordinating project proposal, the coordination costs can only be requested in the application form of the coordinating project.

9b. Explanation and/or remarks to the proposed budget:
(Personell, equipment, consumables, fieldwork, EOC, coordination and Shiptime NIOZ-MRF)
(Education, Outreach & Communication (EOC) plan must be included here)

Fieldwork needs to be done by a small group of people; personnel costs for a post-doc only are included here. The budget for fieldwork includes the travelling to/from and the costs for accommodation at Zackenberg research station for a stay of 2½ month for four people (prices for researchers after the price list 2006 at www.zackenberg.dk/).

Equipment: Highest cost for the equipment are the costs for the new generation transmitters developed in collaboration with technicians at Cornell University, Ithaca (ca. 80.000 €), next to the required hematocrit centrifuge, spotting telescope and bird catching equipment.
Consumables: stable isotopes (doubly labeled water), including analysis, cost ca. 20.000 €. Blood sampling equipment and materials for the immune response assays cost ca. 2.000 € per year.

The Workshop plan ***Northward Bound*** conveyed in the Bird Health proposal for 2008 is warmly endorsed by our group.

P.m.: We have made detailed plans with Musch & Tinbergen Film Company (Bussum) on a documentary film on the life cycle of High Arctic breeding shorebirds such as

Sanderlings and Red Knots, with Zackenberg as the focal location. It is expected that the making of such a film will cost ca. 180.000 €.

10. Financial assistance from (an)other source(s)

Although this project is nicely embedded in a constellation of related projects with affiliations to many of the world's best experts, so far this does not entail any financial commitments. We rely on this proposal to secure the necessary funds.

The proposed collaboration with existing and upcoming projects on Sanderlings in Africa and Europe will be paid by those projects.

11. Relation research program university, large institutions, research schools, etc.

The Post-doc will work within the Animal Ecology Group, a department within the Centre for Ecological and Evolutionary Studies of the University of Groningen. This person, next to bonding with members of the Arctic Centre at the University of Groningen, will maintain close contacts with the shorebird ecologists at the Royal Netherlands Institute for Sea Research (NIOZ). The work will be embedded in the national Dutch research school *FUNCTIONAL ECOLOGY*, which will ease participation of other undergraduate and graduate students within the program of work.

As will have become clear, the proposed research will also be connected to a whole network of studies on coastal shorebirds (in Europe and Africa, through a WOTRO and other ongoing projects, mainly of NIOZ), a growing research team within the Animal Ecology Group in Groningen (and lead by Dr. Irene Tieleman, Rosalin Franklin scholar at the University of Groningen) focussing on immunocompetence related organismal features regarding life history, and international collaborative work on the comparative genetics of High Arctic and lower latitude breeding shorebirds (especially through the co-operation with Prof. Allan Baker's team at Toronto).

If granted, the proposed Postdoc project will further stimulate the continuing co-operation of Prof. Dr. T. Piersma with Dr. H. Meltofte (Manager of the BioBasis monitoring programme at the Zackenberg Research Station in Northeast Greenland, Danish Polar Centre) on Arctic shorebird ecology.

(No signatures required for electronic submission)