Project information

Project title

Multi-stress relationships in seabird populations: interactions between natural stressors and environmental contaminants

Year

2013/2014

Project leader

Jan O. Bustnes, NINA

Participants

- Leader: Jan Ove Bustnes, NINA
- Participant: : Geir Wing Gabrielsen, NPI
- Participant: Børge Moe, NINA
- Participant: Bård Jørgen Bårdsen, NINA
- Participant: Sveinn Are Hanssen, NINA
- Participant: Dorte Herzke, NILU
- Participant: Kjetil Sagerup, APN
- Participant: Jacques Godfroid, NVH
- Participant: Olivier Chastel, Chizé, France

Flagship

Hazardous substances, Theme: The impact of climate change on trensport and fate of contaminants in the Arctic

Funding Source

Fram Centre

Summary of Results

Seabirds are among the species most vulnerable to bio-magnifying environmental contaminants, and the main objective of this project is to document concentrations, distributions and effects of different environmental contaminants in northern seabird populations. Special focus is on how environmental contaminants may function in concert with other natural and anthropogenic stressors; i.e. a multi-stress perspective.

In 2013 the project was extended to include all projects studying arctic seabirds in the Flagship, to achieve a more integrated approach. At present, the project studies different seabird species both at Svalbard and on the Norwegian mainland. Prime species of interest are the common eider, the kittiwake, the glaucous gull, the northern fulmars and the great skua. These species represent different food chains (benthic, pelagic and more scavenging). In 2013 new data have been collected for kittiwake, eiders and glaucous gulls from Kongsfjorden at Svalbard.

PAHs might affect benthic feeding birds and a study have shown that a reduction of PAH emissions into a North Norwegian fjord resulted in reproductive improvement in a population of **common eiders**. Both hatchability and survival of the chicks after hatching was much higher after PAH emissions stopped. The results have been published in Bustnes (2013).

For **kittiwakes** data have been collected from a Kongsfjord study colony in 2013, for the 7'th year in a row. In 2013 one paper has been published showing that mercury is involved in disrupting the ability to modulate the reproductive effort in kittiwakes (Tartu et al. 2013). Hormonal changes have also been documented in kittiwakes with increasing levels of POPs (Tartu et al. submitted). In addition, all blood samples from kittiwakes collected between 2007 and 2011 (5 years) are being subject to data analysis and writing of a paper is under way (Bustnes et al. in prep). This analysis focuses on the environmental and biological factors that influence the concentrations of POPs in live kittiwakes, and thus the potential effects of POPs. We have found that the great annual variation in legacy POPs in kittiwakes. For example, there seems to be a declining trend for PCBs between 2007 and 2010, but strong increase in 2011. Also, HCB levels were increasing over the years, parallel to increasing levels in air at Ny Ålesund. It also turned out that DDE levels was highest in kittiwakes when they arrived from their winter quarters, and the dropped over the season. Statistical analyses will be completed soon and it has been demonstrated great impact of year and period of the year on the POP burdens of kittiwakes. A study from Ny Ålesund has also been published showing that the bright colors of kittiwake soft tissue are related to POP concentrations (Blevin et al. 2014).

For **glaucous gulls**, data on the migrations and POPs have been continued in Kongsfjorden. In addition, a survival analysis has been carried out for glaucous gulls from Bjørnøya showing that pollution have a potentially dramatic population effect. This has been published in Erikstad et al. (2013). Moreover, concentrations of organochlorine (OC) contaminants and histomorphology of liver, kidney, and thyroid tissues were studied in adult and subadult glaucous gulls from Svalbard. The histological findings were similar to those of controlled laboratory studies and OC-contaminated wildlife and the data of this study therefore suggest that OC exposure may be a co-factor in the development of organ alterations in glaucous gulls. Results have been published in Sonne et al. (2013). Moreover two MSc students have studied the connection between PFAS and thyroid hormones in glaucous gulls and documented strong relationships. WP2 has also started two new master student projects this year. The students at NTNU, Department of Biology and Norwegian Polar institute continue the ongoing work of detecting levels of POPs and their endocrine effects in glaucous gulls. Fieldwork and sampling has been during the summer. The samples are at the moment under analyses. The establishment of the IFN-gamma qPCR protocol for glaucous gulls and seals is in progress. Most of the method is established, but there are some small adjustments to be made before results could be read. The mouse model was established within the Fram center flagship project last year and has resulted in publications and one dissertation.

For the **great skua**, the Flagship money has enabled continuous work using data from the NFR funded SKUA project. The main results in 2013 have been that perfluorinated compounds (PFCs) in skuas are relatively low compared to glaucous gulls at Bjørnøya (Leat et al. 2013a). Another finding is that wintering areas may be of great importance for levels of POPs in breeding skuas, both with regard to levels and compositions (Leat et al. 2013b). In addition, wintering areas of the mothers also seems to be important for POPs concentrations and compositions in growing chicks even as late as 20 days after hatching (Bourgeon et al. 2013). The great skua seems to be a species in which POPs are strongly involved in multi-stress relationships; *i.e.* in stressed populations there are strong impacts of even low POP levels in stressed populations (Bustnes et al. in MS). Finally relationships between organohalogen contaminants and blood plasma clinical-chemical parameters have been examined (Sonne et al. 2013a).

Using a meta-analysis approach, the variations in cytochrome P450 (CYP) 1A-like enzyme induction based on ethoxyresorufin O-deethylase activity (EROD) and selected physiological variables (retinoids and thyroid hormones) have been investigated in in **northern fulmar** breeding in three differentially OC-exposed populations: The analysis illustrated that OC exposure (mainly PCBs and dioxins/furans) may be associated with modulation of the thyroid and retinoid homeostasis (Verreault et al. 2013).

Finally new screening studies also confirm the existence of new compounds in the Arctic food chains including chlorinated paraffins (Hezke et al. 2013), suggesting increasing stress on arctic seabirds.

Published Results/Planned Publications

1. Blévin, P., Tartu, S., Angelier, F., Leclaire, S., Bustnes, J.O., Moe, B., Herzke, D., Gabrielsen, G.W. & Chastel, O. 2014. Integument coloration in relation to persistent organic pollutants and body condition in arctic breeding black-legged kittiwakes (*Rissa tridactyla*). *Science of the Total Environment* 470-471: 248-254.

2. Bourgeon, S., Leat, E.H.K., Furness, R.W., Borgå, K., Hanssen, S.A., & Bustnes, J.O. Dietary versus maternal sources of organochlorines in top predator seabird chicks: an experimental approach. *Environmental Science & Technology* 47: 5963-5970.

3. Bustnes J.O. 2013. Reproductive recovery of a common eider *Somateria mollissima* population following a reduction in discharges of polycyclic aromatic hydrocarbons (PAHs). *Bulletin of Environmental Contamination and Toxicology* 91:202–207.

4. Erikstad, K. E., Sandvik, T., Reinertsen, T. K., Bustnes, J. O. & Strøm, H. 2013. Persistent organic pollution in a high-arctic top predator: sex dependent thresholds in adult survival. *Proceedings of the Royal Society London Series B* 280: 20131483.

5. Herzke, D. 2013. Perfluorinated alkylated substances, brominated flame retardants and chlorinated paraffins in the Norwegian Environment -Screening 2013. NILU rapport, Miljødirektoratet rapport M40

6. Leat, E.H.K., Bourgeon, S., Eze, J., Muir, D., Bustnes, J.O., Furness, R.W. & Borgå, K. 2013a. Perfluoroalkyl substances in eggs and plasma of an avian top predator, great skua *Stercorarius skua*, in the North Atlantic. *Environmental Toxicology and Chemistry* 32: 569-576.

7. Leat, E.H.K, Bourgeon, S., Magnusdottir, E., Gabrielsen, G.W., Grecian, J., Hanssen, S.A., Olafsdottir, K., Petersen, A., Phillips, R.A., Strøm, H., Ellis, S., Fisk, A.T., Bustnes, J.O., Furness, R.W. & Borgå, K. 2013b. Influence of wintering area on persistent organic pollutants in a breeding migratory seabird. *Marine Ecology Progress Series* 491: 277-293.

8. Sonne, S., S. A.B. Mæhre , K. Sagerup , M. Harju , E. S. Heimstad , P. S. Leifsson , R. Dietz & G. W. Gabrielsen. 2013. A screening of liver, kidney, and thyroid gland morphology in organochlorine-contaminated glaucous gulls (Larus hyperboreus) from Svalbard, Toxicological & Environmental Chemistry, 95:1, 172-186

9. Sonne, C., Rigét, F.F., Leat, E.H.K., Bourgeon, S., Borgå, K., Strøm, H., Hanssen, S.A., Gabrielsen, G.W., Petersen, A., Olafsdottir, K., Magnusdottir, E., Bustnes, J.O., Furness, R.W. & Kjelgaard-Hansen, M. Organohalogen contaminants and blood plasma clinical-chemical parameters in three colonies of North Atlantic Great skua (*Stercorarius skua*). *Ecotoxicology and Environmental Safety* 92: 245-251.

10. Tartu, S., Goutte, A., Angelier, F., Moe, B., Clément-chastel, C., Bech, C., Gabrielsen, G.W., Bustnes, J.O., Bustanmante, P. & Chastel, O. To breed or not to breed: endocrine response to mercury contamination by an arctic seabird. *Biology Letters* 9: 20130317.

11. Verreault, J., L B. Helgason, G. W. Gabrielsen, M. Dam, B. M. Braune. 2013. Contrasting retinoid and thyroid hormone status in differentially-contaminated northern fulmar colonies from the Canadian Arctic, Svalbard and the Faroe Islands. *Environment International* 52: 29–40.

Submitted

12. Fenstad, A.A., Jenssen, B.M., Moe, B., Hanssen, S.A., Bingham, C., Herzke, D., Bustnes, J.O. & Krøkje, Å. Persistent organic pollutants and DNA double-strand breaks in a fasting seabird.

13. Tartu, S., Angelier, F., Herzke, D., Moe, B., Bech, C., Gabrielsen, G.W., Bustnes, J.O. & Chastel, O. The stress of being contaminated? Fitness and adrenocortical responses to persistent organic pollutants exposure in pre-breeding Svalbard black legged kittiwakes.

14. Bourgeon, S., Leat, E.H.K., Magnusdottir, E., Furness, R.W., Strøm, H., Petersen, Æ., Gabrielsen, G.W., Hanssen, S.A., & Bustnes, J.O. Feather corticosterone levels on wintering grounds have no carry-over effects on breeding among three populations of great skuas (*Stercorarius skua*).

Manuscripts to be submitted

15. Bustnes, J.O, Bourgeon, S., Leat, E.H.K, Hanssen, S.A., Petersen, Æ., Strøm, H., Fisk, A.T., Borgå, K., & Furness, R.W. a. Multiple stressors in in a top predator seabird: ecological consequences of environmental contaminants, breeding conditions and population health.

In preparation

16. Bustnes, J. O., Bårdsen B.J., Moe, B., Nordstad, T., Gabrielsen, G.W., Bech, C., Chastel,O., Tartu, S. & Herzke, D. b. Environmental and biological impacts on concentrations of persistent organic pollutants in a high arctic pelagic seabird.

Communicated Results

NFR, Havkyst program Faktaark: Hva styrer forekomsten og effekter av ulike miljøgifter i Nordøst Atlanteren; illustrert ved hjelp av en sjøfugl

Invited talks:

37'th Waterbird conference in Wilhelmshaven September 2013: Jan Ove Bustnes

Top predator seabirds as potential bio-indicators for persistent pollutants in marine ecosystems

Ecological impacts of environmental contaminants and feeding conditions in a top predator seabird: observational and experimental evidence

Interdisciplinary Cooperation

Ecology, physiology, chemistry

Budget in accordance to results

- **In which way has the funding from the Fram Centre helped the project?**
- Did the Fram Centre funding act as a sufficient boost for completing the project through other sources of funding?
- It has been essential for continuing the research on seabirds in at Svalbard and northern Norway, which is especially important for the continuity of the multi-stress perspective.
- Yes

Could results from the project be subject for any commercial utilization

No

Conclusions

a) Indicate future research and/or perspectives which the project results have led to

b) List and describe new methods or techniques that have been developed during the project or that the project has revealed a need for

1. Understanding variation and impacts of POPs in the vulnerable ecosystems of the north is a long-term endeavor. In this respect this project is important because it allows us to have a long horizon on our research. The project is now starting to generate new results, both with regard to trends and effects of POPs that is novel to ecotoxicology.
2. No new methods have been developed