

Project information

Keywords

Bjørnøya, POPs, cocktail effect, Arctic char

Project title

Is the cocktail effect of environmental contaminants a threat for Arctic fish populations?

Year

2015

Project leader

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Flagship

Hazardous Substances

Funding Source

Norwegian Research Council and Fram Centre

Summary of Results

This is a project that has lasted for 4 years. It started with a pilot project in 2012. The pilot study was funded by the flagship. In 2013 the project received funding from the Research Council of Norway (RCN). Some highlights from 2013 – 2015 are given below.

2013

- Concentrations of all organohalogen- (OHC) groups, Σ HCHs, HCB, Σ CHLs, mirex, Σ DDTs, and Σ PCBs (all in ww), were significantly higher in both muscle and gonads of char from Ellasjøen than Laksvatn, except from Σ HCHs in muscle that did not differ between the lakes.
- Contaminant profiles: Muscle and gonad samples from Lake Ellasjøen had a higher proportion of Σ PCBs compared to those from Laksvatn, while the proportion of Σ HCHs, HCB, Σ CHLs, and mirex were higher in muscle and gonad samples from Lake Laksvatn compared to those from Ellasjøen. The proportion of Σ DDTs in muscle and gonads did not differ between the lakes.

- The lipid-normalized levels of HCB, Σ CHLs, mirex, Σ DDTs and Σ PCBs in gonads were approximately 0.4 to 1.1 times the levels in muscle tissue. No significant between-lake differences in the Gonad/Muscle-ratios for any of the compound groups was found (lw).
- EROD-activity was low in all fish. This was probably due to the fact that the cytochrome P450 enzyme system is depressed during maturation.
- Estradiol-17 β (E2), testosterone (T), 17 α , 20 β -P-dihydroxy-4-pregnen-3-one (17 α 20 β -P) were measured in female char (Laksvatn: n =10, Ellasjøen: n =11), and 11-ketotestosterone (11-KT) was measured in male char (Laksvatn: n=10, Ellasjøen: n =11). The results showed that there were some differences in steroid profiles between fish from the two lakes. This might indicate that they were in different stages of the reproduction cycle at the time of sampling. This is important information for the planning of the large-scale field experiment that will be performed in 2014.

2014:

- An extensive fieldwork was carried out at Bjørnøya in September 2014.
- Samples collected in 2012 were analyzed for hitherto unknown contaminants (target and non-target screening). The results showed that PCBs are the dominating compounds in the samples from Bjørnøya, but several other compounds were detected. These include e.g. organophosphorous flame retardants, brominated flame retardants ("old and new"), MeS-PCBs, MeSo-PBDEs, and mirex. In the non-target screening a few unknown compounds were detected, but the levels seemed to be low compared to e.g. PCB.

2015:

- Contaminant extracts have been prepared from muscle and gonad-tissues. The extracts (containing the natural contaminant cocktail) has been used in in vitro experiments on rainbow hepatocytes. Preliminary results show that the contaminant mixture from Ellasjøen is more potent than the mixture from Laksvatn. The Ellasjøen extract had a more potent estrogenic effect (i.e. induction of vitellogenin) as well as a stronger influence on components involved in the detoxification systems (i.e. induces CYP1A and EROD).
- After these initial tests optimization of isolation, culturing and exposure of Arctic char hepatocytes were performed to establish an in vitro assay for studying toxic effects and biomarker responses in arctic organisms. This assay is now being used for further tests.
- A stress response test has been performed, and gene expression and hormone levels in the hypothalamus-pituitary-interrenal (HPI) axis were measured before and after the stress challenge. The results show that gene expression in the HPI axis of fish from Ellasjøen is affected, but that there are no between-lake differences in their functional response (plasma cortisol levels). Further analyses, involving e.g. metabolomics analyses on the fish used in the stress experiments, are in progress.

For the Management

In order to regulate the use of chemicals it is important to acquire more knowledge about how the environmental suite of chemicals that Arctic animals are exposed to work together. Today regulatory actions are generally based on effects of one chemical alone, and very little is known about the effects of contaminant cocktails. New knowledge about cocktail effects will be useful to the management in the work with international conventions that aim at phasing out chemicals with harmful effects (alone or in synergy with other compounds). In this project we have studied effects of contaminants on different levels of organization, from molecular responses to the functional responses (stress and reproduction), and the results are therefore directly relevant for assessments of population effects. The results indicate that the

contaminant cocktail is exerting an effect on the fish, but it seems likely that compensatory mechanisms are preventing effects on a population level.

Published Results/Planned Publications

Bytingsvik, J., Frantzen, M., Götsch, A., Heimstad, E.S., Christensen, G., Evenset, A. 2015. Organohalogenated compounds (OHCs) in mature Arctic char (*Salvelinus alpinus*) from Bjørnøya, Svalbard (Norway). *Sci. Tot. Environ.* 521-522: 421-430.

Publications in prep:

Bytingsvik, J.; Frantzen, M.; Götsch, A.; Heimstad, E.S.; Christensen, G., Johnsen, H.K., Tassara, L, Hestdahl, H.I., Evenset, A. Reproductive effects of organohalogenated compounds (OHCs) in Arctic char (*Salvelinus alpinus*) from Bjørnøya, Svalbard (Norway).

Jørgensen, E.H., Maule, A., Evenset, A., Christensen, G., Frantzen, M., Bytingsvik, J., Vijayan, M. Physiological response to capture stress in char from Lake Ellasjøen (high OC levels) and Lake Laksvatn (low OC levels).

Petersen, K., Evenset, A., Tollefsen, K.E. Arctic char (*Salvelinus alpinus*) primary hepatocytes as an in vitro screening method for acute and sub-lethal toxicity assessment.

Communicated Results

In 2015:

Bytingsvik, Frantzen, Götsch, Heimstad, Christensen, Evenset 2015. Is the cocktail effect of environmental contaminants a threat to the Arctic char population in Lake Ellasjøen, Bjørnøya(Svalbard, Norway)? Primo, Trondheim 2015.

Petersen, Evenset, Tollefsen 2015. Arctic char (*Salvelinus alpinus*) primary hepatocytes as an in vitro screening method for acute and sub-lethal toxicity assessment. Primo, Trondheim 2015.

Bytingsvik, Frantzen, Götsch, Heimstad, Christensen, Evenset 2015. Current status, between-year comparisons and maternal transfer of organohalogenated compounds (OHCs) in Arctic char (*Salvelinus alpinus*) from Bjørnøya, Svalbard (Norway). Setac, Barcelona 2015.

Bytingsvik, Frantzen, Götsch, Heimstad, Christensen, Johnsen, Tassara, Hestdahl, Evenset 2015. Levels of organohalogenated contaminants (OHCs) and potential reproductive effects on the Arctic char population in Lake Ellasjøen, Bjørnøya. 8th International char symposium, Tromsø 2015.

Jørgensen, Maule, Evenset, Christensen, Frantzen, Bytingsvik, Vijayan 2015. The strongly polluted Arctic char in Lake Ellasjøen, Bjørnøya; shaken but not beaten? 8th International char symposium, Tromsø 2015.

Interdisciplinary Cooperation

The project involves ecologists, chemists and ecotoxicologists. By combining knowledge from these three research disciplines we believe that we will be able to get a good overview of both chemical and biological processes that may cause negative effects in fish.

Budget in accordance to results

The funding from the Fram Centre was essential to perform a pilot project which led to the financing of the main project from the Norwegian Research Council. As the budget allocated from the NRC was lower than applied for, the Fram Centre funding in 2014 and 2015 allowed us to carry out project activities in accordance with the original plan. In addition, the funding made it possible to expand the fieldwork (increase the number of samples) and to include some extra biomarker analyses that will strengthen the total outcome of the project. The funding was also used to perform a better screening for unknown substances than would have been possible without extra funding.

Could results from the project be subject for any commercial utilization

No

If Yes

No commercial products

Conclusions

- a. The results from this project has shown that there are some interesting aspects related to responses on different levels of organization, i.e. that responses on molecular levels not necessarily means that the functional endpoint is affected, i.e. compensatory mechanisms are mitigating effects. This is a research theme that needs to be explored in future studies.
- b. A new assay for in vitro studies on Arctic char has been developed. This will be useful for future studies of effects of contaminants on Arctic fish species.