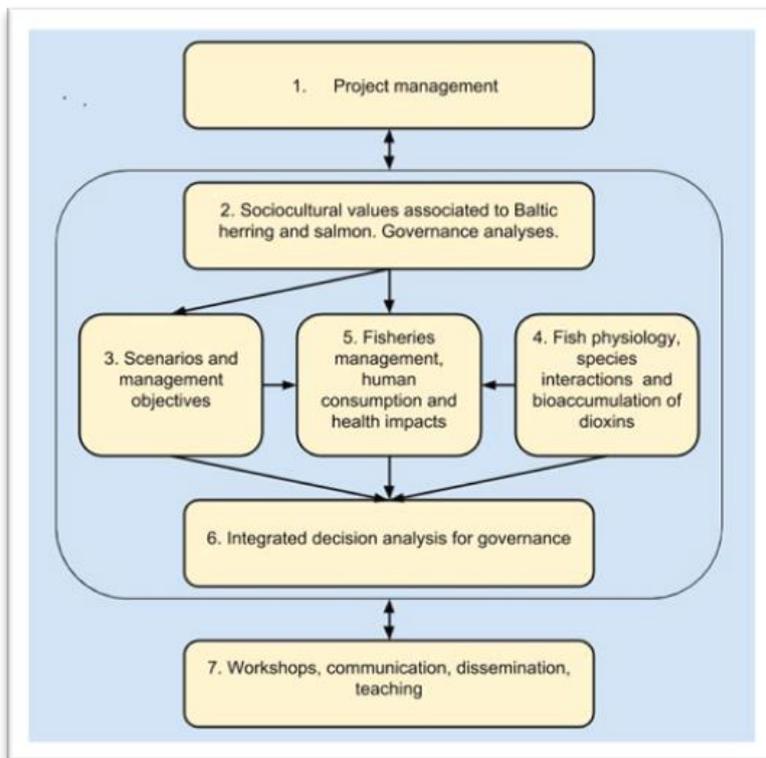


**BONUS GOHERR PROJECT (April 1, 2015 - June 30, 2018)**  
**The final publishable summary report**  
**December 20, 2018**

**1 Project outline of goals and results envisaged at the beginning of the project cycle**

Baltic salmon and herring fisheries share a dioxin problem. High dioxin concentration in fish causes a risk for human health and has socio-economic and cultural consequences due to the selling restrictions that aim to protect consumers from the adverse effects of the toxic chemicals. BONUS GOHERR used natural and social scientific methodologies and data, and interdisciplinary modelling to analyse the dioxin problem of the two fisheries in the framework of ecosystem-based fisheries management (EBFM). EBFM entails viewing fisheries as holistic social-ecological systems and involves a requirement to understand the interactions between species, fisheries, and sectors. The overarching aim was to identify holistic management and governance approaches for Baltic herring and salmon fisheries and the dioxin problem, to widen the scope of management beyond food safety to also involve other objectives, such as fostering livelihoods, traditions, and the viability of coastal communities. To this end, the project:



*Figure 1 BONUS GOHERR work packages and the flow of information between them*

- Analysed socio-cultural values associated with Baltic herring and salmon (WP2)
- Analysed the governance requirements of the dioxin problem (WP2)
- Defined policy objectives for the use and management of salmon and herring fisheries, and ways to reach the objectives in different societal scenarios (WP3)
- Explored the transfer of dioxins from lower trophic levels to herring and further through the predator-prey relationship to salmon, and possibilities to control the problem by integrated management of the fisheries (WP4)
- Updated the benefit-risk assessment of Baltic salmon and herring intake (WP5)
- Examined the formation of dioxin risk in different Baltic Sea basins (WP6)
- Evaluated alternative inter-sectoral strategies to manage the dioxin problem (WP6)

## 2 Work carried out in the project

WP2 aimed to understand why and how Baltic herring and salmon are important for stakeholders in the Baltic Sea area, how the socio-cultural values associated with these fishes are represented in governance and management, and how values, overall, could be taken into account explicitly in governance. For this, an empirical study including 58 interviews in Finland, Estonia, Denmark and Sweden was conducted. In addition, WP2 combined theoretical considerations and empirical material collected throughout the project to analyse governance requirements and possibilities for managing the dioxin problem of Baltic herring and salmon fisheries in a way that enables addressing the wide-scale societal effects of the problem. An international expert workshop was arranged in November 2017 to evaluate the potential and challenges of integrated multispecies and inter-sectoral governance to manage the dioxin problem in a holistic way.

In WP3 a backcasting exercise was conducted in another international expert workshop, in February 2016, to develop pathways on how to increase the currently low human consumption of Baltic herring and thus the contribution of Baltic herring to the food security objective of the Common Fisheries Policy (CFP). The results of the study were combined with exploratory scenarios for Baltic fisheries governance, to theorise how the identified pathways (normative recommendations) could work under four plausible futures. WP3 applied also Bayesian belief networks to explore the implications of changing societal conditions to the governance of Baltic fisheries and to assess the future sustainability of the fisheries.

WP4 built a biological model to analyse how the predator-prey interaction between salmon and herring affects the transfer of dioxins from herring to salmon. The model was used to study possibilities to control the bioaccumulation of dioxins through fisheries management. The results were compared to reduced dioxin concentration in the aquatic environment.

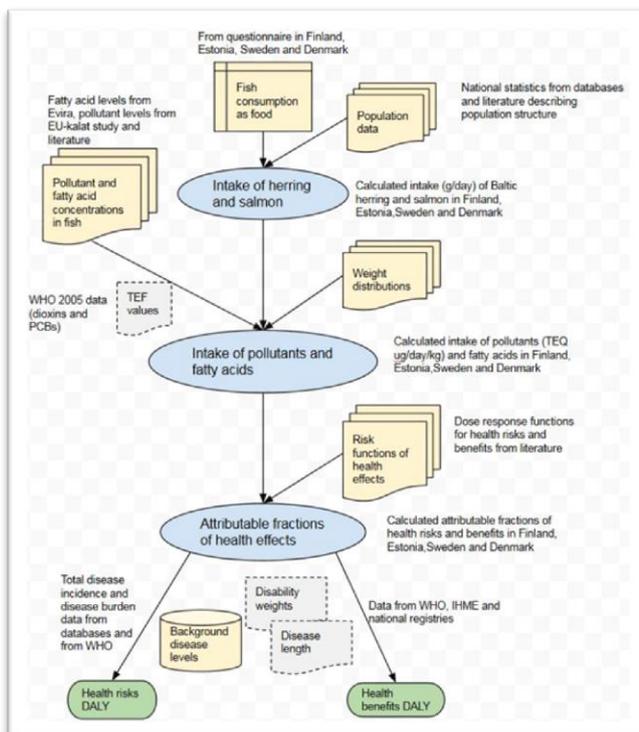


Figure 2. Schematic picture of the health-benefit risk assessment model for Baltic herring and salmon intake (WP5).

The main task of WP5 was to update an existing health-benefit risk assessment of Baltic herring and salmon intake (Figure 2). For this, a fish consumption survey was undertaken in Finland, Sweden, Estonia and Denmark.

WP6 integrated the results of the biological modelling (WP4) and the health-benefit risk assessment (WP5) in a Bayesian policy analysis model, to evaluate alternative sectoral and inter-sectoral strategies (information sharing, dietary guidance, fisheries management measures) and scenarios (nutrient loading, dioxin emissions) to manage the dioxin problem, and to achieve social, economic, and environmental objectives, as identified in WP3 (Figure 3). To support the model that focused on the Bothnian Sea, a social-ecological systems analysis was conducted to understand and

compare the formation of the dioxin risk of Baltic herring and salmon to humans in different Baltic Sea areas.

WP7 included activities to involve stakeholders in the project and to communicate the research to the general public. Two international expert workshops with participants representing different stakeholder groups were arranged, stakeholder interviews conducted, an ethnographic short film titled [Heeringas](#) on the socio-cultural importance of Baltic herring produced, numerous conference and seminar presentations given, and both scientific and popular articles published. In addition, BONUS GOHERR themes were utilized in university teaching.

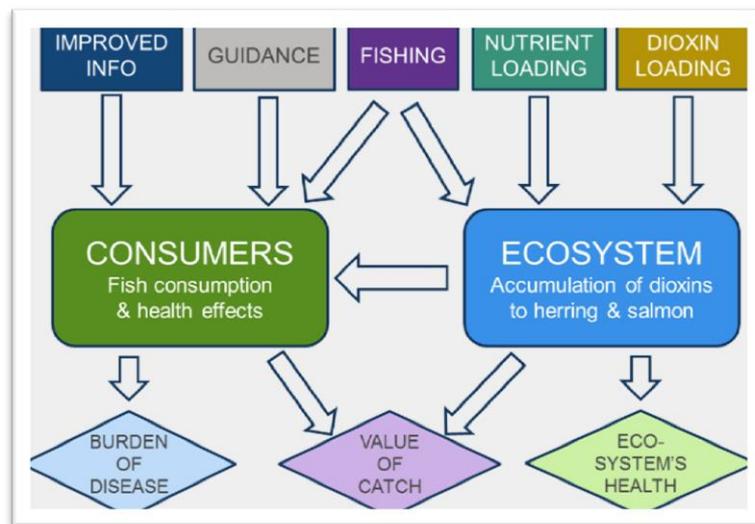
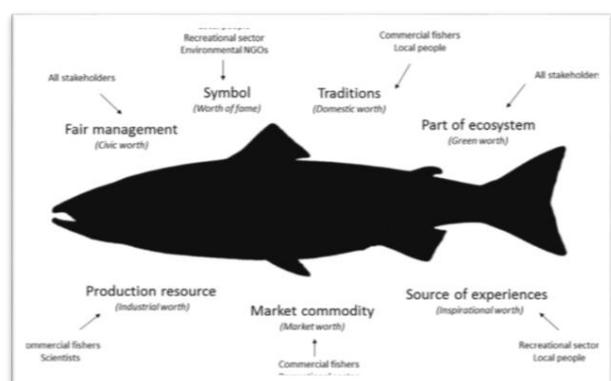


Figure 3. Key elements of the policy analysis model for governing the dioxin problem of Baltic herring and salmon fisheries (WP6). The impacts of different sectoral and inter-sectoral management strategies (improved information provided to consumers on the health effects of Baltic salmon and herring consumption; dietary guidance on fish consumption; fisheries management measures) and alternative scenarios (nutrient and dioxin loading), on the accumulation of dioxins in the ecosystem and on the human consumption of these fishes and the consequent health effects were analyzed, given different management objectives (human health/burden of disease; value of catch; ecosystem's health).

### 3. Main results achieved during the project

Figure 4. The socio-cultural values of Baltic salmon. Source: Ignatius and Haapasaari 2018. *Marine Policy* 88: 167-173.

- The analysis of socio-cultural values (WP2) revealed that stakeholders attach a wide variety of values to Baltic salmon and herring but that only some of them are actively discussed and promoted in fisheries governance (Ignatius and Haapasaari 2016; Ignatius and Haapasaari 2018; Ignatius et al. forthcoming). Thus, some issues such as the dioxin problem, or the use of catches, have marginal presence in the EU level fisheries governance, while their inclusion in national level governance varies. The results call for analysing the diversity of values that stakeholders associate with fish and fisheries, and incorporating the values in governance in a structured way, to ensure that management is in balance with these values and to enhance the legitimacy of decisions.
- The governance analysis (WP2) suggests framing the dioxin problem of Baltic fisheries not only as a natural scientific problem involving health and environmental aspects, but also as a social, cultural



and economic problem. This would imply 1) enhanced governance interaction between the environmental, public health, and fisheries sectors, 2) stakeholder involvement in governance, 3) adopting environmental, economic and social sustainability and food security as principles for governing the dioxin problem, in addition to food safety and ecosystem health, 4) putting more emphasis on governance at regional level. Broadening the scope of governance would enhance the capacity of society to deal with the dioxin problem, and result in a wider variety of instruments or actions to manage the problem. The results of the expert workshop propose that non-binding “soft” governance involving both the public sector and civil society e.g. in terms of regional stakeholder organisations, could be a feasible way to implement integrated multispecies or inter-sectoral governance.

- The backcasting study (WP3) found that there is a shared interest among stakeholders to use Baltic herring primarily as food and only secondarily for industrial purposes, and identified several ways to increase the use of Baltic herring as safe-to-eat food, thus increasing its contribution to CFP food security objective (Pihlajamäki et al. 2016; Pihlajamäki et al. 2018). The study concludes that implementation of the different identified strategies would entail a paradigm shift in fisheries governance involving 1) inclusion of well-defined objectives for catch use in CFP and the related regional multiannual plans, 2) broadening the scope of the maximum sustainable yield (MSY)-driven governance and management to one that addresses catch use, and 3) proactive catch use governance.



Figure 5. Traditional herring market in Helsinki, 2016

- WP3 also explored how the identified pathways to increase the contribution of Baltic herring to food security could work under four exploratory scenarios for Baltic fisheries governance. As a result, six generalised dynamics answering the question on how normative recommendations function across exploratory scenarios were identified and discussed (Sarkki and Pihlajamäki 2018). The results stress the need to analyse simultaneously multiple drivers, stakeholders, exploratory scenarios, normative recommendations, and synergies and frictions between recommendations.
- The Bayesian analysis of the future of Baltic salmon and herring fisheries in a wider societal context, involving the different dimensions of sustainability and the related management objectives, suggests that Baltic herring fishery is more resilient towards changes in societal driving forces than Baltic salmon fishery mainly due to the better ecological state of the stocks, larger landing volumes, and contribution potential to food security (WP3). Salmon, on the contrary, is more vulnerable to environmental changes. The results highlight the dependence of both fisheries on the surrounding societal and environmental conditions, which can undermine the expected benefits related to the best management decisions.
- The biological herring-salmon model (WP4) suggests that fishing intensity and size-selectivity influence herring growth and dioxin concentration at length and age of herring and that the size-structure of the herring population has a significant impact on dioxin bioaccumulation in salmon. Consequently, herring fisheries can have a strong effect on dioxin concentration also in salmon, depending on salmon body size. The results also highlight that measures reducing dioxin concentration-at-length in herring may at the same time increase dioxins in salmon. Thus, it would be challenging to invent herring fisheries measures decreasing dioxin levels in herring and salmon alike. The analyses also showed that a general reduction in the dioxin concentration of the invertebrate

prey of herring resulted in a much greater reduction in dioxin in both herring and salmon than any of the fishing scenarios tested. Thus, reductions in dioxin concentrations in the environment (e.g. by reducing emissions) is more likely to result in reduced dioxin concentrations in both herring and salmon than management measures altering the intensity or size-selectivity of herring fisheries.

- The fish consumption survey (WP5) indicated that the use of Baltic herring as food is limited by 1) the dioxin problem, 2) poor availability of the fish on the food market, and 3) perceptions on the state of the stocks. This suggests that in the short-term the use of herring as food could be increased by ensuring sufficient availability of eco-labelled and safe-to-eat Baltic herring on the fish food market.
- According to the benefit-risk modelling (WP5) the health benefits of Baltic herring and salmon outweigh dioxin risks in age groups over 45 years and in young males. For this reason, consumption of small herring (< 17 cm) and young salmon (40-80 cm) should not be restricted in these groups. In women at fertile age the critical issue is the potential negative impacts of dioxins on the tooth development and sperm concentration of their children, not on the women themselves.
- The policy optimization modelling (WP6) revealed that the order in which decisions in the environmental, fisheries, and public health sectors are taken affects their usefulness and mutual ranking in controlling the dioxin problem. Also the sectoral assessment criteria (state of the ecosystem vs. market value of catch vs. human health) affects the optimal management strategy. The model suggests collaboration between the public health, environmental and fisheries sectors: managing only one species or policy domain may not be effective, and can have unanticipated systemic effects. The most recommendable single actions over the sectors and assessment targets are: 1) reducing dioxin emissions; 2) developing information sharing (consumer group-specific information) and 3) developing products and markets to promote the use of small fish (herring < 17 cm, salmon 40-80 cm). The spatial analysis (WP6) demonstrates how the formation of the dioxin risk in different areas of the Baltic Sea is the sum of several ecological and social factors. The study highlights the importance of holistic regional-level analyses of the dioxin problem when designing management strategies.

#### 4. Conclusion

- The importance of sustainability and food security is growing in the face of climate change, which implies a need for developing sustainable climate-smart food systems. Small pelagic fish, such as Baltic herring, can become an important part of climate-efficient food. However, increasing the contribution of Baltic herring to food security requires a concerted effort from different actors and sectors to manage the dioxin problem. As for salmon, a broader scope of ways to manage the dioxin problem could facilitate developing economically and socially sustainable salmon markets that could contribute to stronger coastal livelihoods and at the same time support ecologically sustainable fishing of the vulnerable stocks. The results of BONUS GOHERR have demonstrated the potential of inter-sectoral governance in solving the dioxin problem of Baltic salmon and herring fisheries.

#### 5. The continuity plan of the project

- ❖ The project will produce approximately 20 articles in peer-reviewed journals.
- ❖ Personal twitter accounts and websites will be utilised to communicate new publications to the scientific community, decision makers, and stakeholders. The results will be presented and the publications promoted in seminars and conferences. BONUS GOHERR webpage will be kept up-to-date.

- ❖ The research methodologies and approaches developed and results achieved in GOHERR will be utilised in forthcoming projects. For example, the lessons learned concerning knowledge co-production, scenario building and integrated modelling is currently utilized in The Academy of Finland Strategic Research Council project *Creative adaptation to wicked socio-environmental disruptions* (WISE).
- ❖ BONUS GOHERR successfully utilized structured discussions and insight networks to organize and understand differing views and argumentation about the health benefit-risk dilemma of Baltic salmon and herring. These novel methods will be promoted in future policy support.
- ❖ The study on socio-cultural values related to fisheries continues by focusing on one of the key value-bases in fisheries governance, that is, social justice. Stakeholder interviews conducted in the project will be utilised to analyse how stakeholders define social justice in the context of fisheries governance and how this affects the governability of the fisheries.

### 6. Peer-reviewed publications (by December 2018)

- ❖ Ignatius, S. and Haapasaari, P. 2016. Addressing socio-cultural values in the use and management of Baltic herring. In Anna S. Olsson, Sofia M. Araujo, and M. Fatima Vieira (eds.): Food futures: ethics, science and culture. Conference proceedings of EurSafe 2016, pages 233-238 (refereed). Wageningen Academic Publishers. [https://doi.org/10.3920/978-90-8686-834-6\\_35](https://doi.org/10.3920/978-90-8686-834-6_35)
- ❖ Pihlajamäki, M., Sarkki, S. and Karjalainen, T.P. 2016. Food or feed? The contribution of Baltic herring fisheries to food security and safety. In Anna S. Olsson, Sofia M. Araujo, and M. Fatima Vieira (eds.): Food futures: ethics, science and culture. Conference proceedings of EurSafe 2016, pages 239-243 (refereed). Wageningen Academic Publishers. <https://doi.org/10.3920/978-90-8686-834-6>
- ❖ Ignatius, S. and Haapasaari, P. 2018. Justification theory for the analysis of the socio-cultural value of fish and fisheries: The case of Baltic salmon. *Marine Policy* 88: 167-173. <https://doi.org/10.1016/j.marpol.2017.11.007>
- ❖ Jacobson, P., Gårdmark, A., Östergren, J., Casini, M. and Huss, M. 2018. Size-dependent prey availability affects diet and performance of predatory fish at sea: a case study of Atlantic salmon. *Ecosphere*. Volume 9(1), e02081. doi: 10.1002/ecs2.2081
- ❖ Pihlajamäki, M., Sarkki, S., and Haapasaari, P. 2018. Food security and safety in fisheries governance. A case study on Baltic herring. *Marine Policy* 97:211-219. <https://doi.org/10.1016/j.marpol.2018.06.003>
- ❖ Sarkki, S. and Pihlajamäki, M., (2018). Baltic herring for food: Shades of grey in how backcasting recommendations work across exploratory scenarios. *Technological Forecasting and Social Change* (in press) <https://doi.org/10.1016/j.techfore.2018.11.001>
- ❖ Ignatius, S., Delaney, A., and Haapasaari, P. Socio-cultural values as a dimension of fisheries governance: the cases of Baltic salmon and herring. *Environmental Science and Policy* (accepted, in production).

