Novel DNA methods and instrumentation for species monitoring in fisheries

Marine fish play a vital role for global food biosecurity and economy, whose continued productivity necessitates proper fisheries management. Successful management relies on the ability to accurately determine and monitor how many fish can be sustainably caught and subsequently ensure correct reporting of catches through fisheries surveillance. However, current monitoring of marine fish is expensive and limited to annual surveys, if conducted at all. Moreover, current fisheries surveillance is reliant on visual assessment of the catch, which make advantageous onboard bulk storage and processing methods illegal. Thus, tools to improve current monitoring and fisheries surveillance will benefit both commercial fisheries, management and conservation of marine fish stocks. This present thesis examines novel genetic methods and instruments as an alternative approach or supplement to established fisheries monitoring and surveillance techniques. Utilizing advanced genetic instrumentation and methodologies, the overarching goals of this PhD were to (1) examine the current knowledge, challenges and perspectives for using modern DNA monitoring and surveillance techniques in applications relevant to fisheries, (2) test a fully automated 2. Generation Environmental Sample Processor (2G ESP) for in-situ environmental DNA (eDNA) analysis, and (3) assess the ability of DNA based methods to identify and quantify species composition in complex bulk fisheries products. The thesis opens with a general introduction briefly describing the history and present state of genetic applications of relevance to species monitoring and surveillance in fisheries management (chapter I). The introduction extends to review relevant knowledge, contemporary instrumentation and methodological issues in order to put the content of the thesis into an overarching state of the art research context. Hereafter, four manuscripts are provided in chapter II-V. In chapter II we review the wealth studies which have revealed great potential but also challenges related to the use of eDNA in marine fish monitoring. In chapter III we demonstrate that a 2G ESP has the ability to perform autonomous, remote in situ eDNA analysis for real-time monitoring of fish. Further, in chapter IV we show how DNA based methods can detect and quantify proportions of marine fish from complex tissue mixtures in bulk fisheries products, such as fish silage and frozen fish blocks. Finally, chapter V describes and discusses the potential of genetic methods in relation to the European landing obligation in order to prevent, assess and control the catch of non-targeted species. Overall, this thesis presents the immense potential of modern genetics and the rapidly developing applications in marine fisheries, but also provides critical insights to strengths and weaknesses related to various methods and applications. Further, the thesis highlights the potential of using novel methodologies and instrumentation applicable to fisheries monitoring and surveillance. Of particular note, chapter III provides the first example of a fully autonomous eDNA analysis using the 2G ESP, a finding which has broad perspectives for future monitoring in remote and inaccessible marine areas.

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