ANNUAL REPORT ON HEALTH MONITORING OF WILD ANADROMOUS SALMONIDS IN NORWAY 2019

Screening of Atlantic salmon (Salmo salar) smolts for viral infections

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Summary (English):

Svært få funn av virus i utvandrende smolt og postsmolt

Havforskningsinstituttet har undersøkt forekomsten av flere virus som er prevalent i oppdrett i utvandrende smolt fra Hardangerfjorden (N=81) og Boknafjorden (N=80) og postsmolt (N=150) fra Norskehavet. Forekomsten av SAV-, PRV1-, ILAV-, IPNV og PMCV-infeksjoner ble testet ved å bruke sanntids RT-PCR. Infeksjoner med disse virusene er vanlig i opprett i Norge. Disse virusene kan forårsake sykdommene pankreassyke (PD), hjerte- og skjelettmuskelbetennelse (HSMB), infeksiøs lakseanemi (ILA), infeksiøs pankreas nekrose (IPN) og kardiomyopatisyndrom (CMS, hjertesprekk) hos oppdrettslaks. SAV, ISAV og PMCV ble ikke påvist i fisken. Derimot ble PRV1-, og IPNV-infeksjoner påvist i hhv. 1 og 3 individer. Disse resultatene viser svært lav forekomst av disse virusene i vill utvandrende smolt og post-smolt.

Summary (Norwegian):

Very few virus infections found in migrating smolts and postsmolts

The Institute of Marine Research has investigated the prevalence of several viruses that are prevalent in salmon farming in migrating smolt from the Hardanger fjord (N = 81) and Bokna fjord (N = 80) and postsmolt (N = 150) from the Norwegian sea. The prevalence of SAV, PRV1, ILAV, IPNV and PMCV infections was tested using real-time RT-PCR. Infections with these viruses are common in the salmon farming in Norway. These viruses may cause pancreatic disease (PD) and heart and skeletal muscle inflammation (HSMB), infectious salmon anaemia (ILA), infectious pancreatic necrosis (IPN) and cardiomyopathy syndrome (CMS) in farmed salmon. SAV, ISAV and PMCV were not detected in any of the fish. However, PRV1 and IPNV infections were detected in 1 and 3 individuals, respectively. These results indicate a very low prevalence of these viruses in wild migrating smolts and postsmolts.

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1 - Introduction

Viral infections are one of the major challenges facing Atlantic salmon farming in Norway, often leading to disease outbreaks (Table 1) and to substantial economic losses. The most common viral diseases in salmon farming the last five years are; pancreas disease (PD), caused by salmonid alphavirus (SAV), heart and skeletal muscle inflammation (HSMI), caused by a piscine orthoreovirus 1 (PRV1), cardiomyopathy syndrome (CMS) caused by piscine myocarditis virus (PMCV), infectious salmon anaemia (ISA) caused by ISA virus (ISAV) and infectious pancreatic necrosis (IPN) caused by IPN virus (IPNV).

Table 1: The number of registered viral disease outbreaks in fish farming in the last 5 years [1]

	2015	2016	2017	2018	2019
PD	137	138	176	163	152
HSMB	135*	101*	93*	104*	79*
CMS	105*	90*	100*	101*	82*
ISA	15	12	14	13	10
IPN	30	27	23	19	23

* Under reported

It is believed that pathogen exchange between farmed and wild salmon occurs and that disease outbreaks in salmon farms may lead to increased infection pressure on wild fish populations. There is an increasing public concern of this negatively impacting wild salmonids in Norway. However, there are limited data on the prevalence of pathogens in wild salmonid populations [2]. It is difficult to quantify disease incidence and its impact in wild fish since sick individuals may be less catchable or may disappear unnoticed (e.g. due to predation). Therefore, it is challenging to evaluate the impact of pathogens on individuals as well as stocks in nature, since we normally are only able to collect infected but non-diseased fish such as individuals that has recently acquired or has survived an infection (carriers).

The effect of fish farming on the infection status of wild salmon stocks may be evaluated by comparing pathogen prevalence in wild fish populations originating from areas having different fish farming intensities and disease outbreak profiles.

Wild salmon may be infected by viruses prevalent in salmon farming; in rivers as fry or parr by virus-infected farmed escapees and spawning wild salmon, or from salmon farms in the fjord when migrating as smolts or returning as adults. Therefore, infection status in migrating smolts may represent a direct indicator of infection pressure from salmon farming during their migration routes. On the other hand, there is limited knowledge about the prevalence of viral infections in postsmolt at the oceanic feeding areas. Studying viral infection during all life stages of salmon life cycle is necessary to assess the impact of diseases in fish farming on the salmon wild stocks.

Since 2012, the Institute of Marine Research (IMR) has been commissioned by the Norwegian Food Safety Authority (NFSA) to carry out an annual health monitoring of wild anadromous salmonids in Norway. The current monitoring activities are financed by both NFSA and the Norwegian Ministry of Trade, Industry and Fisheries (NFD). These activities lie under a program that is part of prioritized research area at IMR which addresses the environmental impact of disease transmission from Norwegian fish farming to wild fish. The program aims to evaluate the virus transmission from farmed fish to wild salmonids by monitoring and identifying changes in the prevalence of selected viruses in wild

salmonids as a result of fish farming activities. In addition, the program will help to increase the knowledge base on pathogens in wild salmonids in general, as well as establish a biobank that can be used when new disease challenges arise.

Part of the research activities in the program aim to generate data about:

- Virus prevalence in fry, parr, postsmolt and returning adult salmon,
- Prevalence of viruses in sea trout
- Prevalence of infectious escaped salmonids
- Genotyping of detected pathogens

The virus screening is based on selected materials obtained through monitoring of virus infections in wild salmonids project and other associated projects at IMR, such as:

- Salmon lice monitoring program (NALO)
- Escaped salmon monitoring program
- Etne research station (fish trap)
- Dale research project
- Atlantic salmon at sea (Seasalar) project

The program aims to investigate the occurrence of pathogen infections in wild salmonids captured from different Norwegian coastal areas with different farming intensities and disease outbreak frequencies. Each year selected sets of fish are analysed in order to complement or complete our data and time series. Part of the results from pathogen screening are used in an annual health monitoring of wild anadromous salmonids in Norway commissioned by NFSA. The generated knowledge from the program contributes to the institute's main goal/strategy in providing advice and further development of sustainable management of aquaculture and is utilized in the IMR's annual risk assessment of Norwegian fish farming.

2 - Aim

The aim of the current study was to investigate the occurrence of SAV, PRV1, PMCV, ISAV and IPNV infections in migrating wild Atlantic salmon and postsmolts captured in the Norwegian sea.

3 - Materials and methods

To continue the assimilation of data on prevalence of different viruses in different life stages and different geographical regions, we selected two sets of fish from our available material for analysis in 2019. These materials were: a) migrating smolts (N=161) captured in the outer parts of the Bokna and Hardanger fjords by trawling in May-June 2017, as part of the national salmon lice monitoring program [3], and b) oceanic postsmolts (N=150) originated from trawl bycatch during the annual International Ecosystem Summer Survey in the Nordic Seas (2017-19) conducted by IMR. All oceanic postsmolt were sampled in the Norwegian Sea in July and early August. Weight and length of all fish were recorded and the smolts were then frozen (-20 oC) as soon as possible. At autopsy, tissues from the gills, head kidney and heart were taken from the fish while still frozen and preserved at -80 oC. Samples for analysis were sent on dry ice to an accredited commercial laboratory for RNA extraction and virus testing (Pharmaq Analytic AS). All fish were tested for the five most prevalent viruses in salmon farming in Norway (SAV, PRV1, PMCV, ISAV and IPNV; Table 1) by real-time RT-PCR assays (for detection viral RNA). A total of 1555 analyses were performed on samples from 311 fish and were used in the current report.

4 - Results

SAV, PMCV and ISAV were not detected in any of the tissues from any of the tested smolt (Table 2). PRV1 was detected in one single smolt (Ct-value 32) from the Bokna fjord and IPNV was detected in 3 of the smolts (Ct-value 28-34) from the Hardanger fjord. None of the postsmolts from the Norwegian sea were infected with the tested viruses.

Table 2: The numbers and the collection sites of tested fish and the numbers of virus-positive smolt.

Collection Site	Year	N	SAV	PRV1	PMCV	ISAV	IPNV
Bokna fjord	2017	81	-	1	-	-	-
Hardanger fjord	2017	80	-	-	-	-	3
Norwegian sea	2017	32	-	-	-	-	-
	2018	71	-	-	-	-	-
	2019	47	-	-	-	-	-
Total/positive		311	311/0	311/1	311/0	311/0	311/3

- : not detected

5 - Discussion and Conclusion

Except one PRV1- and three IPNV-positive fish, none of the migrating smolts were infected with the tested viruses. SAV3 and PRV1 is endemic in western Norway where fish in many of the salmon farms become infected during production cycle [1, 4, 5]. PMCV (CMS-virus) infections has been a growing problem in Norwegian fish farming in the recent years [6]. On the other hand, ISAV (virulent ISAV-D) and IPNV infections are less prevalent in salmon farms. It is likely that migrating smolt were exposed to virus released from the fish farms before (subclinical infections) and during disease outbreaks. The absence of SAV, PMVC and ISAV the low prevalence of PRV1 and IPNV infections in the tested migrating smolt is consistent with previous findings in wild salmonids [7-14]. Our previous report showed that migrating smolts from Trondheim fjord which has no fish farming activities also had very low occurrence of virus infections [13]. Our previous and current findings showed no apparent relationship to the fish farming intensity or the frequency of disease outbreaks. These observations may indicate that wild salmon are exposed to a low infection pressure from fish farming. However, the possibility that infection may lead to rapid disappearance, altered behaviour or biased sampling of the infected fish and therefore may affect the results, cannot be ruled out. Other explanation for the low prevalence of viruses (especially PRV1 and PMCV) is the time needed after virus exposure (incubation time) before the virus can be detected in tissues of fish.

Data about virus prevalence in wild salmon during the oceanic life stage is scarce. In the current study, none of the tested postsmolts from Norwegian sea were positive for the tested viruses. These are interesting results, and in accordance with our previous findings, suggesting that infections with most of these virus are uncommon in all life stages of salmon in Norway [15].

The results in the current report showed very low prevalence of viral infections in both migrating smolts in fjords and oceanic postsmolts for the major viruses prevalent in Norwegian aquaculture. The findings of 2019 complement and corroborate our previously reported data and may suggest that wild salmon are exposed to a low infection pressure from fish farming. Time series of samples of all life stages of wild salmonids from areas with different salmon farming intensities are needed to better evaluate the effect of infection pressure from aquaculture on the virus prevalence in wild salmon populations. Such series will also enable us to assess changes in the prevalence due to increased fish farming activities and the emergence of new diseases.

6 - References

1. Sommerset, I., et al., Fish health report 2019 (in Norwegian). 2020, Norwegian Veterinary Institute: Norwegian Veterinary Institute. p. 156.
2. Taranger, G.L., et al., Risk assessment of the environmental impact of Norwegian Atlantic salmon farming. ICES Journal of Marine Science, 2015. 72(3): p. 997-1021.
3. Nilsen, R., et al., Lakselusinfestasjon på vill laksefisk langs norskekysten i 2016; med vekt på modellbasert varsling og tilstandsbekreftelse. 2017, Havforskningsinstituttet: Havforskningsinstituttet.
4. Løvoll, M., et al., Quantification of piscine reovirus (PRV) at different stages of Atlantic salmon Salmo salar production. Diseases of Aquatic Organisms, 2012. 99(1): p. 7-U5.
5. Jansen, M.D., et al., Salmonid alphavirus (SAV) and pancreas disease (PD) in Atlantic salmon, Salmo salar L., in freshwater and seawater sites in Norway from 2006 to 2008. Journal of Fish Diseases, 2010. 33(5): p. 391-402.
6. Garseth, A.H., et al., Cardiomyopathy syndrome in Atlantic salmon Salmo salar L.: A review of the current state of knowledge. Journal of Fish Diseases, 2018. 41(1): p. 11-26.
7. Madhun, A.S., et al., Annual report on health monitoring of wild anadromous salmonids in Norway 2013, in Rapport fra Havforskningen. 2014, Institute of Marine Research: Bergen. p. 15.
8. Garseth, Å.H., et al., Annual report on health monitoring of wild anadromous salmonids in Norway 2014, in Rapport fra Havforskningen. 2015, Institute of Marine Research: Institute of Marine Research. p. 14.
9. Madhun, A.S., et al., Annual report on health monitoring of wild anadromous salmonids in Norway 2015, in Rapport fra Havforskningen. 2016, Institute of Marine Research: Bergen.
10. Garseth, Å.H., et al., Annual report on health monitoring of wild anadromous salmonids in Norway 2016, in Rapport fra Havforskningen. 2017, Institute of Marine Research: Institute of Marine Research. p. 15.
11. Madhun, A.S., et al., Prevalence of piscine orthoreovirus and salmonid alphavirus in sea-caught returning adult Atlantic salmon (Salmo salar L.) in northern Norway. J Fish Dis, 2018. 41(5): p. 797-803.
12. Madhun, A.S., et al., Annual report on health monitoring of wild anadromous salmonids in Norway 2017; Health monitoring of returning adult salmon from river Etne, western Norway in Rapport fra Havforskningen. 2018, Institute of Marine Research: Bergen. p. 13.
13. Madhun, A.S., et al., Annual report on health monitoring of wild anadromous salmonids in Norway 2018; Screening of migrating Atlantic salmon (Salmo salar) postsmolts from the Trondheim fjord for viral infections, in Rapport fra Havforskningen. 2019, Institute of Marine Research: Bergen. p. 9.
14. Madhun, A.S., et al., Prevalence and genotypes of infectious salmon anaemia virus (ISAV) in returning wild Atlantic salmon (Salmo salar L.) in northern Norway. Journal of Fish Diseases, 2019.
15. Grefsrud, E.S., et al., Risk assessment of Norwegian fish farming (in Norwegian). 2018, Institute of Marine Research: Institute of Marine Research. p. 181.

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