Forskningsrådet

Sluttrapport prosjekt 185262

Innholdsfortegnelse

SLUTTRAPPORT

Prosjektnummer:	185262
Prosjekttittel:	Tracing viral disease dissemination in aquaculture: an interdiciplinary approach between molecular virology and dispersal modelling
Prosjektleder:	Jansen, Peder Andreas
Aktivitet / Program:	HAVBRUKS
Prosjektansvarlig:	Veterinærinstituttet Oslo

1.	**Framdriftsrapport:** Ajourfør framdriftsrapport fram til prosjektslutt.	Utført
2.	**Sluttregnskap:** Gi et sammendrag av økonomien i prosjektet.	Utført
3.	**Resultatrapport:** Legg ved resultatrapport	Utført
4.	**Andre resultater:** Gi opplysninger om andre resultater.	Utført
5.	**Særskilt rapportering:** Dersom det foreligger krav om særskilt rapportering, skal dette utføres.	Ikke aktuelt

Sluttregnskap

Faktiske utgifter (i NOK 1000)

Konto	2008	2009	Totalsum
6050	861	911	1772
6051	407	400	807
6052			0
6053	232	145	377
Sum	1500	1456	2956

Kontobeskrivelser:
6050 = Personal- og indirekte kostnader
6051 = Innkjøp av FoU-tjenester
6052 = Utstyr
6053 = Andre driftskostnader

Faktisk kostnadssted (i NOK 1000)

Konto	2008	2009	Totalsum
6061			0
6062	1500	1456	2956
6063			0

6064			0
6065			0
Sum	1500	1456	2956

Kontobeskrivelser:
6061 = Næringsliv
6062 = Instituttsektor
6063 = UoH-sektor
6064 = Andre sektorer
6065 = Utlandet

Faktisk finansiering (i NOK 1000)

Konto	2008	2009	Totalsum
8911	0	0	0
8930			0
8913			0
8914			0
NFR	1500	1456	2956
Avvik	0	0	0
Sum	1500	1456	2956

Kontobeskrivelser:
8911 = Egne midler
8930 = Internasjonale midler
8913 = Andre offentlige midler
8914 = Andre private midler
NFR = Norges forskningsråd

Kommentar
Mangler siste innbetaling fra NFR

1. Gi et sammendrag av økonomien i prosjektet. Utført

Resultatrapport

Gi et populærvitenskapelig sammendrag av resultatene

Originalfil: Resultatrapport_Tracing_ISAV_I.pdf

Filreferanse: Resultat_rapport109216.pdf

2. Legg ved resultatrapport Utført

Andre resultater

Gi opplysninger om andre resultater (Arrangement, Medieoppslag, Foretak).

Nytt annet formidlingstiltak

Arrangement	Arrangør	Dato (ååååmmdd)
Møte næring region sør- og midt-Troms	Mattilsynet	20090115

Nytt oppslag i massemedia

Mediets navn	Type innslag	Dato (ååååmmdd)
Kyst.no	Omtale av prosjektreusltat	20090527
Kyst.no	Omtale av prosjektresultat	20090123

3. Gi opplysninger om andre resultater. Utført

Særskilt rapportering

Alternativ 1:

Alternativ 2:

Originalfil:

Filreferanse:

4. Dersom det foreligger krav om særskilt rapportering, skal dette utføres. Ikke aktuelt

SLUTTRAPPORT

Prosjektnummer:	185262
Prosjekttittel:	Tracing viral disease dissemination in aquaculture: an interdiciplinary approach between molecular virology and dispersal modelling
Prosjektleder:	Jansen, Peder Andreas
Aktivitet / Program:	HAVBRUKS
Prosjektansvarlig:	Veterinærinstituttet Oslo
Rapporteringsperiode:	20091001 - 20091231

1.	**Mål:** Er det rapporteringspliktige avvik i de avtalte mål?	Nei
2.	**Framdrift:** Er det rapporteringspliktige avvik i faglig framdrift i forhold til avtalte milepæler, prosjektbeskrivelsen eller i forhold til stipendenes tilsetting/framdrift?	Nei
3.	**Økonomi:** Er det rapporteringspliktige avvik mellom budsjett og forbruk (jfr. kostnadsplanen)	Nei
4.	**Økonomi:** Er det rapporteringspliktige avvik i finansieringsplanen?	Nei
5.	**Partnere:** Er det rapporteringspliktige endringer for samarbeidspartnere?	Nei
6.	**Andre avvik:** Er det andre vesentlige avvik i forhold til det som er avtalt i kontrakten (særlig art. 8)?	Nei
7.	**Stipend:** Opplysninger om alle stipend må være fullstendige og korrekte. Har du oppdatert månedsverk og andre opplysninger for hver stipendiat?	Nei
8.	**Resultat - Sammendrag:** Det skal gis et populærvitenskapelig sammendrag av resultater som er framkommet i prosjektet i rapporteringsperioden. Er dette gjort?	Ja
9.	**Resultatindikatorer:** Alle resultatdata som er framkommet i prosjektet skal rapporteres. Er rapportering foretatt?	Ja
10.	**Publiseringsinformasjon:** Er opplysninger om publisering gitt?	Ja
11.	**Internasjonalt:** Omfanget av internasjonalt samarbeid skal angis. Har det vært slikt samarbeid i rapporteringsperioden?	Ja
12.	**Særskilt rapportering:** Dersom det foreligger krav om særskilt rapportering i egen melding skal dette utføres. Er særskilt rapportering utført?	Nei

Mål

Prosjektets hovedmål og delmål

The principal objective is to disentangle major transmission pathways for ISAV in salmon farming, and ultimately develop more precise models for viral disease dispersal in salmon farming. Sub-goals are to: 1.Progress the studies on phylogeny and virulence of different strains of ISAV. 2.Initiate studies on the prevalence of non-virulent ISAV isolates circulating within farmed salmon populations, and the possible role of these in disease dissemination. 3.Utilise the phylogenetic relationships between virus isolates to assess model predictions regarding transmission pathways for ISAV. 4.Initiate the incorporation of molecular characteristics of virus isolates, eg. phylogeny, into disease dispersal models to ultimately increase model precision.

1.	Er det rapporteringspliktige avvik i de avtalte mål?	Nei

Kommentar

Framdrift

Prosjektperiode

Fra dato (ååååmmdd): 20080101 **Til dato (ååååmmdd):** 20091231

Hovedaktiviteter og milepæler i prosjektperioden (år og kvartal)

	Fra		Til	
Stochastic dispersal modelling	2008	1	2009	4
Prevalence, phylogeny and HPR-type studies	2008	1	2009	4
Screening salmon populations for ISAV	2008	1	2009	4
Statistics relating phylogeny to dispersal	2008	1	2009	4
Dissemination of results, meetings etc.	2009	1	2009	4

2. Er det rapporteringspliktige avvik i faglig framdrift i forhold til avtalte milepæler, prosjektbeskrivelsen eller i forhold til stipendenes tilsetting/framdrift? Nei

Kommentar

Økonomi

Kostnadsplan (i 1000 kr)

Konto	2008	2009	2010	2011	2012	2013	2014	2015	Totalsum
6050	850	850							1700
6051	400	400							800
6052									0
6053	250	250							500
Sum	1500	1500	0	0	0	0	0	0	3000

Faktisk kostnadssted (i 1000 kr)

Konto	2008	2009	2010	2011	2012	2013	2014	2015	Totalsum
6061									0
6062	1500	1500							3000
6063									0
6064									0
6065									0
Sum	1500	1500	0	0	0	0	0	0	3000

Finansieringsplan (i 1000 kr)

Konto	2008	2009	2010	2011	2012	2013	2014	2015	Totalsum
8911									0

8930									0
8913									0
8914									0
NFR	1500	1500							3000
Sum	1500	1500	0	0	0	0	0	0	3000

Kontobeskrivelser:

6050 = Personal- og indirekte kostnader
6051 = Innkjøp av FoU-tjenester
6052 = Utstyr
6053 = Andre driftskostnader
8911 = Egne midler
8930 = Internasjonale midler
8913 = Andre offentlige midler
8914 = Andre private midler
NFR = Norges forskningsråd

3. Er det rapporteringspliktige avvik mellom budsjett og forbruk (jfr. kostnadsplanen) Nei
4. Er det rapporteringspliktige avvik i finansieringsplanen? Nei

Kommentar

Partnere

Samarbeidspartnere som skal delta i prosjektet med faglige og/eller økonomiske ressurser

5. Er det rapporteringspliktige endringer for samarbeidspartnere? Nei

Kommentar

Andre avvik

6. Er det andre vesentlige avvik i forhold til det som er avtalt i kontrakten (særlig art. 8)? Nei

Kommentar

Stipend

Stipender finansiert av prosjektet

7. Opplysninger om alle stipend må være fullstendige og korrekte. Har du oppdatert månedsverk og andre opplysninger for hver stipendiat? Nei

Resultat - sammendrag

8. Det skal gis et populærvitenskapelig sammendrag av resultater som er framkommet i prosjektet i rapporteringsperioden. Er dette gjort? Ja

Populærvitenskapelig framstilling

The present project aimed to disentangle major transmission pathways of infectious salmon anaemia virus (ISAV) and characterise molecular virus traits that may affect the probability of disease outbreaks. The project has employed an interdisciplinary approach of molecular virology and stochastic disease modelling. During 2007 ? Desember 2009 there has been a total of 33 verified outbreaks of ISA in salmon farms in Norway. 17 of these outbreaks form a cluster in a local area in Troms County. The main activity in the project has been sampling fish from these

outbreaks and sampling fish from farm locations that were considered to be at risk of ISAV infection due to potential contact with farms with ISA. At-risk-farms were not under suspicion of ISA and were selected due to proximate location to farms with ISA, due to shared ownership with ISA farms or due to sharing smolt suppliers. Furthermore, juvenile fish from smolt producers that delivered fish to farms with ISA outbreaks have been sampled. The most important achievements in the project have been the gathering of convincing evidence for local horizontal transmission of ISAV giving rise to local ISA epidemics. Furthermore, a substantial number of HPR0-subtype ISAV?s have been isolated, and low virulence of this subtype has been substantiated. Finally, a stochastic model framework for ISAV transmission between fish farms, accounting for the genetics of the virus, has been developed. The results from this show a clear effect of genetic distance. The effect of seaway distance on infection intensity, which is a central part in both the previous and the new version of the model, has been estimated with improved precision.

Resultatindikatorer

Resultater	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Akkumulert hittil
Vitenskapelige/faglige publikasjoner											
Publiserte artikler i andre vitenskapelige og faglige tidsskrifter		1									1
Publiserte foredrag fra internasjonale møter/konferanser		8									8
Øvrige rapporter, foredrag og presentasjoner fra faglige møter		2									2
Resultatformidling											
Formidlingstiltak rettet mot relevante målgrupper	1										1
Allmennrettede formidlingstiltak (populærvitenskapelige artikler, høringer,utstillinger etc.)	0	1									1
Oppslag i massemedia	2										2
FoU-resultater											
Kommersielle resultater med bidrag fra prosjektet											
Ny virksomhet											
Innføring av teknologi											
Doktorgrader											

9. Alle resultatdata som er framkommet i prosjektet skal rapporteres. Er rapportering foretatt? Ja

Publiseringsinformasjon

Gi opplysninger om vitenskapelige utgivelser, annen publisering og foredrag enten ved å velge "Type" eller ved å laste opp en liste under "Liste over publiseringsinformasjon".

Liste over publiseringsinformasjon

Originalfil: Publiseringsaktivitet_ILA_I.pdf

Filreferanse: PUBLISERINGER_Framdriftsrapport109216.pdf

12. Er opplysninger om publisering gitt? Ja

Internasjonalt samarbeid

Internasjonalt samarbeid finansiert av prosjektet (i NOK 1000)

Beløp i NOK 1000

Land	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Danmark	10									
Færøyene	15									

10. Omfanget av internasjonalt samarbeid skal angis. Har det vært slikt samarbeid i rapporteringsperioden? Ja

Særskilt rapportering

Alternativ 1:

Alternativ 2:

Originalfil:

Filreferanse:

11. Dersom det foreligger krav om særskilt rapportering i egen melding skal dette utføres. Er særskilt rapportering utført? Ikke aktuelt

Resultatrapport: 185262 - **Tracing viral disease dissemination in aquaculture: an interdisciplinary approach between molecular virology and dispersal modelling**

Viral diseases are a large problem in Norwegian salmon farming imposing economic as well as welfare-related challenges to the industry. In order to control the spread of viral diseases, knowledge on the transmission pathways of the disease agents and key factors affecting the interaction between the disease agent and the host, is vital. Molecular virological methods have proven useful for sensitive detection as well as genomic characterisation in studies on molecular epidemiology of important viral diseases, making use of phylogenitic analyses and identification of mutations important for virulence. Concomitantly, stochastic modelling of infectious diseases, and the spread of disease in aquaculture systems, is a developing field. The contribution from such models is that they may predict the space-time dynamics of disease dispersal. When disease dispersal is reasonably predicted, models can also be valuable as tools to simulate scenarios of importance to disease control or disease surveillance. However, model precision is critically dependent on knowledge of the biological and environmental factors that govern the development of host-pathogen interactions, and thus disease development. The present project aimed to disentangle major transmission pathways of infectious salmon anaemia virus (ISAV) and characterise molecular virus traits that may affect the probability of disease outbreaks. The project has employed an interdisciplinary approach of molecular virology and stochastic disease modelling.

The principal objective of the project was to disentangle major transmission pathways for ISAV in salmon farming, and ultimately develop more precise models for viral disease dispersal in salmon farming.

Sub-goals were to:

1. Progress the studies on phylogeny and virulence of different strains of ISAV.
2. Initiate studies on the prevalence of non-virulent ISAV isolates circulating within farmed salmon populations, and the possible role of these in disease dissemination.
3. Utilise the phylogenetic relationships between virus isolates to assess model predictions regarding transmission pathways for ISAV.

4. Initiate the incorporation of molecular characteristics of virus isolates, eg. phylogeny, into disease dispersal models to ultimately increase model precision.

During 2007 – Desember 2009 there has been a total of 33 verified outbreaks of ISA in salmon farms in Norway. 17 of these outbreaks form a cluster in a local area in Troms County. The main activity in the project has been sampling fish from these outbreaks and sampling fish from farm locations that were considered to be at risk of ISAV infection due to potential contact with farms with ISA. At-risk-farms were not under suspicion of ISA and were selected due to proximate location to farms with ISA, due to shared ownership with ISA farms or due to sharing smolt suppliers. Furthermore, juvenile fish from smolt producers that delivered fish to farms with ISA outbreaks have been sampled. 30 fish from each At-risk-farm have been sampled and analysed for ISAV with real-time PCR in kidney, gills and heart tissue. A total of 23 marine At-risk-farms and 6 smolt-producers have been sampled.

For all positive findings of ISAV, segments 5 (the F-gene) and 6 (the HE-gene) have been sequenced. Furthermore, a database has been compiled from all sampled farms containing information that may potentially connect farms with regard to ISAV transmission.

The most important findings and accomplishments in the project have been:

- ISAV isolates from the 17 outbreaks that form a cluster in Troms County have been sequenced. These isolates form a narrow genetic cluster both in the F-gene and the HE-gene, and they share a common and rare deletion pattern in the HPR-region of the HE-gene. Hence we conclude that these isolates have a common origin. Since there is a variety of ownerships for these ISA farms, and there is no common source of smolts or broodfish, this local small scale ISA epidemic is evidently due to local horizontal transmission of the virus.
- A novel method to analyse transmission pathways for ISAV by the use of genetic similarity matrixes was adapted from Legendre (2000). The idea is to test what transmission pathways that best explain genetic similarity between pairs of virus isolates. Due to the dependency that was introduced to the data in the pair wise comparisons of virus isolates, permutation techniques were employed to evaluate the significance of results. These analyses show that the best predictor of genetic similarity between ISAV isolates from different sites is proximate location. Sequences from the HPR part of the He-gene were featured in these analyses. Hence it has been

shown for the first time that the information contained in the He-HPR region of ISAV is informative with regard to assessments of transmission pathways.

- Six of the outbreaks in the Troms cluster were verified in 2009 and in stocks that were put to sea cages in 2008. These were all sampled first as At-risk-farms due to being located close to ISA farms, with no positive findings of ISAV. This indicates that these fishes were infected with ISAV in the marine environment.
- Positive ISAV samples were found in 43% (10 out of 23) of marine At-risk-farms and in 2 out of 6 freshwater smolt farms. Of these findings, 8 ISAV isolates were of the presumably low virulent HPR0 subtype. Both isolates from smolts were of the HPR0 subtype. Considering that only a few HPR0 isolates have previously been described from Norway, the abundance of HPR0 isolates found in this project is remarkable.
- Seven of the HPR0 isolates were found in association with the Troms cluster of outbreaks, but never in fish with clinical ISA. The genetic variation between the HPR0 isolates significantly exceeded the variation between the isolates from the outbreaks in the area. There have also been findings of HPR0 isolated from At-risk-farms that later went on to develop ISA, and where ISAV isolates from diseased fish were genetically relatively different from the prior HPR0 isolate. Evidently, ISAV HPR0 and ISAV HPR subtypes represent independent infections in these instances. These findings indicate that the HPR0 subtype of ISAV is more abundant than previously assumed.
- Prevalence of PCR-positive fish was generally much higher in samples where HPR subtypes ISAV were isolated, compared to HPR0 subtypes. The lowest Ct-values attained from HPR0 subtypes were markedly higher than for HPR subtypes. These observations support that HPR0 subtypes are of low virulence.
- The stochastic model framework presented by Scheel et al. (2007) and Aldrin et al. (2010) has now been adapted to account for genetic distance between ISAV isolates from infectious farms at time t and farms that become infected at time t. The model has been applied to data from 2003 until late summer 2009. The results show a clear effect of genetic distance. The effect of sea distance on infection intensity, which is a central part in both the previous and the new version of the model, has been estimated with improved precision. A scientific paper presenting these results is under preparation.

In conclusion, the project will contribute significantly to both the principal objective in the project and all four sub-goals. The most important contribution so far is convincing evidence for local horizontal spread of ISAV resulting in local small scale epidemics of ISA. Due to the importance of these findings for the Norwegian fish farming industry, we have disseminated project findings in meetings with affected fish farmers, in fish farming popular press and in scientific meetings. The first scientific paper from the project is now ready for submission. A second scientific paper presenting the stochastic model for ISAV transmission, incorporating virus genetics, is in preparation.

References

Aldrin M., Storvik B., Frigessi A., Viljugrein H., Jansen P.A. (2010). A stochastic model for a comparative study of transmission pathways for three infectious diseases in fish farming. *Prev Vet Med* 93: 51-61.

Legendre P. (2000). Comparison of permutation methods for the partial correlation and partial Mantel tests. *J Statist Compute Simul* 67: 37-73.

Scheel, I., Aldrin, M., Frigessi, A., Jansen, P.A. (2007). A stochastic model for infectious salmon anemia (ISA) in Atlantic salmon farming. *J Royal Soc Interface* 4: 699-706.

Internasjonale foredrag

September 2008. Brun E, Jansen PA. Current sanitary status and epidemiological surveillance in Norwegian salmon aquacultures, prevention of potential emergent diseases to the salmon industry. Infectious salmon anemia (ISA) and other potential emergent diseases for the Chilean salmon farms: relevant aspects for an effective control. International seminar, Puerto Varas, Chile, 4-5th September 2008.

September 2008. Jansen PA. Epidemiology and control of ISA in Norway. Infectious salmon anemia (ISA) and other potential emergent diseases for the Chilean salmon farms: relevant aspects for an effective control. International seminar, Puerto Varas, Chile, 4-5th September 2008.

May 26-28 2009. Lyngstad TM, Hjortaas MJ, Jansen PA, Kristoffersen AB, Karlsen E, Johansen EJ and Jonassen CM. Tracing infectious salmon anaemia virus (ISAV) in salmon farms in Norway. 13th Annual Meeting of the National Reference Laboratories for Fish Diseases. Copenhagen, Denmark

August 2009. Lyngstad TM, Jonassen CM, Hjortaas MJ, Kristoffersen AB, Karlsen E, Johansen EJ, Jansen, P.A. Tracing infectious salmon anaemia virus in salmon farms in Norway. *Proceedings of the 12th Symposium of the International Society for Veterinary Epidemiology and Economics, Durban, South Africa: ISVEE* 12, 129, 2009

August 2009. Karlsen E, Johansen EJ, Lyngstad TM, Jansen, P.A. Infectious salmon anaemia in Norwegian salmon farming, a chronicle of events relating to a small scale epidemic. *Proceedings of the 12th Symposium of the International Society for Veterinary Epidemiology and Economics, Durban, South Africa: ISVEE* 12, 128, 2009

August 2009. Jonassen CM. Comparative aspects of influenza A virus in birds/ mammals and infectious salmon anaemia virus: implications for our understanding of transmission routes and ecology of ISAV. *Proceedings of the 12th Symposium of the International Society for Veterinary Epidemiology and Economics, Durban, South Africa: ISVEE* 12, 127, 2009

September 2009. Hjortaas MJ, Lyngstad TM, Jansen, P.A., Kristoffersen AB, Karlsen E, Johansen EJ, Jonassen CM. Tracing the spread of infectious salmon anaemia virus (ISAV) in salmon farms in Norway. Proceedings of the 14th EAFP International Conference, Prague.

September 2009. Karlsen E, Johansen EJ, Lyngstad TM, Jansen, P.A. Infectious salmon anaemia in Norwegian salmon farming, a chronicle of events relating to a small scale epidemic. Proceedings of the 14th EAFP International Conference, Prague.

Nasjonale foredrag

Januar 2009. TM Lyngstad, CM Jonassen, MJ Hjortaas, AB Kristoffersen, E Karlsen, EJ Johansen and PA Jansen. Infeksiøs lakseanemi (ILA) i Sør- og Midt Troms – Smittesporing. Oral presentasjon på Frisk fisk 2009, Bergen

Januar 2009. E Karlsen, EJ Johansen, TM Lyngstad og PA Jansen. Kronologisk beskrivelse av oppdrettsbestander av laks og forekomst av infeksiøs lakseanemi (ILA) i Sør- og Midt Troms i 2007 – 2008. Oral presentasjon på Frisk fisk 2009, Bergen

Populærvitenskapelige artikler

August 2009. Jansen, P.A., Lyngstad, T.M., Hjortaas, M., Kristoffersen, A.B., Karlsen, E., Johansen, E.J. 2009. Bruk av slektskapsanalyser til sporing av spredningsveier for infeksiøs lakseanemi (ILA) virus. Norsk fiskeoppdrett nr. 8. august 2009, s. 70-73

Vitenskapelige artikler under utarbeidelse

T.M. Lyngstad, M.J. Hjortaas, A.B. Kristoffersen, E.T. Karlsen, C.M. Jonassen, P.A. Jansen (2010). Using genetic information to trace transmission pathways for Infectious salmon anaemia virus (ISAV) in Norway. Ready for submission to: *Epidemics*

Aldrin et al. (2010). A stochastic model for the assessment of the transmission pathways of infectious salmon anaemia: incorporation of virus genetics improves model precision. (Tentative title; manuscript in preparation).