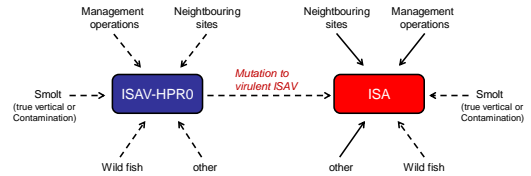


## Tracking ISAV-HPRO transmission pathways in Faroese Atlantic salmon aquaculture

Debes H. Christiansen  
Senior Researcher and head of  
Faroese National Reference Laboratory for Fish Diseases

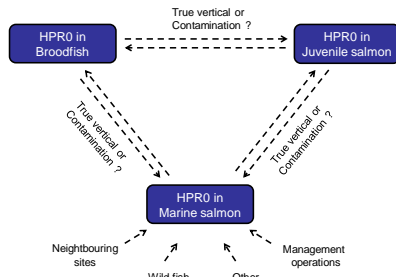
19<sup>th</sup> NRL meeting,  
Copenhagen, Denmark, May 27-28<sup>th</sup>, 2015

## Possible transmission pathways to ISA



Modified from Trude Lyngstad, PhD Thesis 2012

Very little is known about ISAV-HPRO transmission pathways between the three compartments of Atlantic salmon production

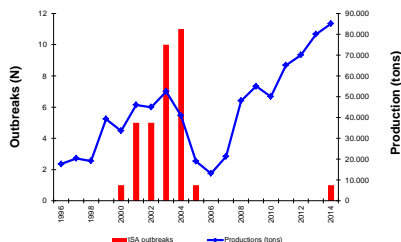


## Faroese Atlantic salmon Aquaculture



- One landbased broodstock company
- Eight fresh water (Fw) farms with juveniles
- 26 marine (Sw) production sites with Atlantic salmon

## Re-establishment of the Atlantic salmon farming industry



## Re-establishment of the Atlantic salmon farming industry

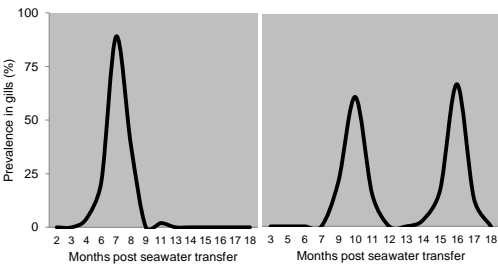
- New legislation on biosecurity
- Vaccination against ISAV
- Screening for ISAV of all three compartments to study the risk of re-emergence of ISA

# High prevalence of ISAV-HPR0 in sea water farmed Atlantic salmon

Year	Kidneys			Gills		
	Total	HPR0 +ve		Total	HPR0 +ve	
	n	n	%	n	n	%
2005	2998	0	0	-	-	-
2006	7157	10	0.1	-	-	-
2007	6505	142	2.2	5387	811	15.1
2008	-	-	-	9066	1100	12.1
2009	-	-	-	8847	852	9.6
Total	16660	152	0.9	23300	2763	11.9

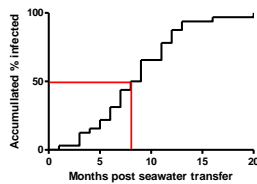
Christiansen et al. J Gen Virol. (2011), 92, 909-918

# ISAV-HPR0 causes a transient infections



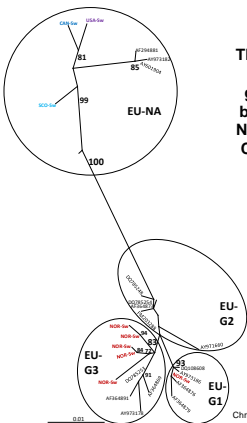
Christiansen et al. J Gen Virol. (2011), 92, 909-918

# Marine production sites were infected with ISAV-HPR0 on average 8 months post sea water transfer



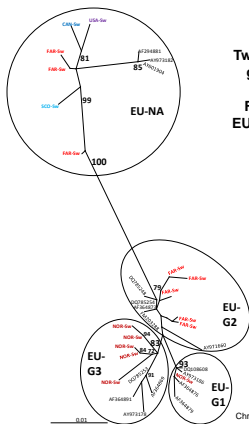
potential marine reservoir

Christiansen et al. J Gen Virol. (2011), 92, 909-918



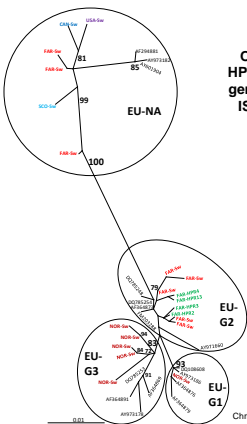
Three different EU ISAV-HPR0 genotypes have been identified in Norway, Scotland, Canada and USA

Christiansen et al. J Gen Virol. (2011), 92, 909-918



Two major ISAV-HPR0 genotypes are co-circulating in the Faroe Islands; one EU-NA and one EU-G2

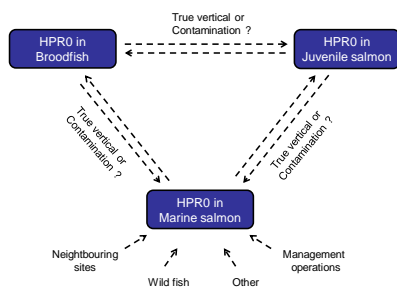
Christiansen et al. J Gen Virol. (2011), 92, 909-918



One of the Faroese ISAV-HPR0 genotype shows close genetic relationship with the ISAV isolates responsible for the Faroese ISA epidemic

Christiansen et al. J Gen Virol. (2011), 92, 909-918

## HPR0 in fresh water juvenile salmon and Broodfish



## Prevalence of ISAV-HPR0 in fresh water juvenile salmon

	Total N	HPR0 N	HPR0 %
2007	639		
2008	732		
2009	1917		
2010	1792		
2011	2150		
2012	406		
2013	285		
total	7921		

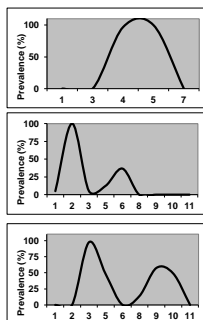
## Prevalence of ISAV-HPR0 in fresh water juvenile salmon

	Total N	HPR0 N	HPR0 %
2007	639	0	0
2008	732	39	5.3
2009	1917	85	4.4
2010	1792	288	16.1
2011	2150	131	6.1
2012	406	71	17.5
2013	285	16	5.6
total	7921	630	8.0

## Production cycles of juvenile salmon tested HPR0 +ve

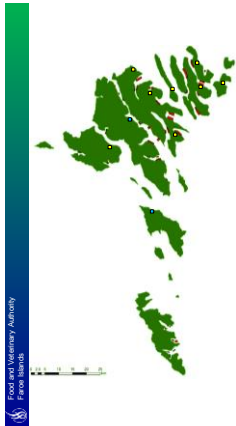
Year	Freshwater pre-smolt fish groups					
	N	H	F	L	G	V
2008	0	0	0	0	1	0
2009	1	0	0	0	0	2
2010	1	2	0	0	2	2
2011	0	0	0	0	1	1
2012	0	2	0	0	2	2
2013	0	1	0	0	1	1
Total	2	5	0	0	7	8

## ISAV-HPR0 infection in juvenile salmon is transient



## Prevalence of HPR0 in broodfish at stripping

Year	Total N	HPR0 N	HPR0 %
2007	256		
2008	474		
2009	50		
2010	427		
2011	210		
2012	263		
2013	65		
Total	1745		



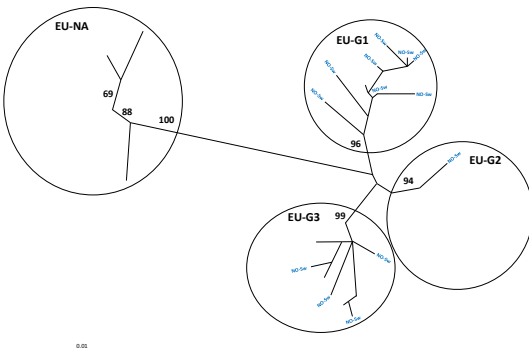
Prevalence of HPR0 in broodfish at stripping

Year	Total N	HPR0 N	HPR0 %
2007	256	9	5
2008	474	210	40
2009	50	0	0
2010	427	395	93
2011	210	73	35
2012	263	1	0.3
2013	65	0	0
Total	1745	688	39

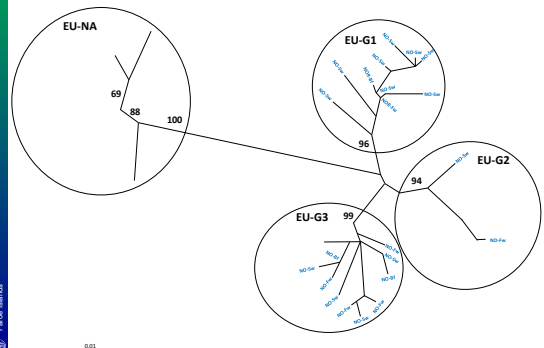
## Phylogenetics analysis of ISAV-HPR0 in the three compartments

- The phylogenetic analysis is based on 1051 bp of the *HE* gene including the HPR.
- Phylogenetic relationship between
  - HPR0 in Broodfish
  - HPR0 in juvenile Atlantic salmon
  - HPR0 in marine Atlantic salmon
  - All published HPR0

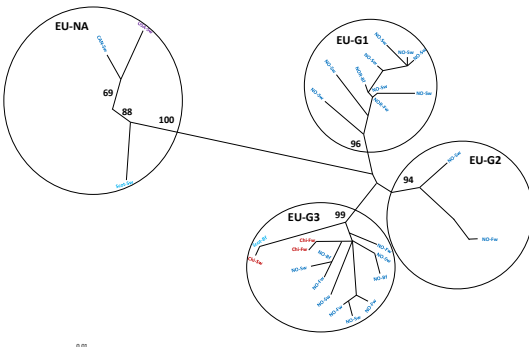
Phylogenetic tree showing the relationship between ISAV-HPR0 isolated at sea water sites in Norway



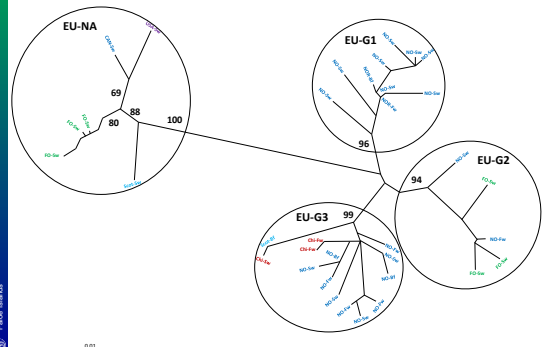
Phylogenetic tree showing the relationship between the ISAV-HPR0 isolated in all three compartments in Norway

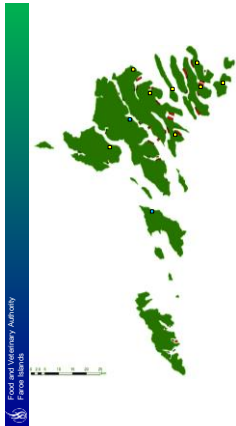


Phylogenetic tree showing the relationship between all ISAV-HPR0 isolated in the three compartments in NO, SCO, USA, CAN and CHI



Phylogenetic tree showing the relationship between representative ISAV-HPR0 isolates of the four major EU subgroups

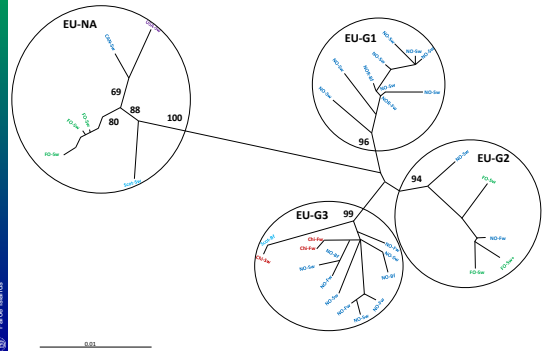




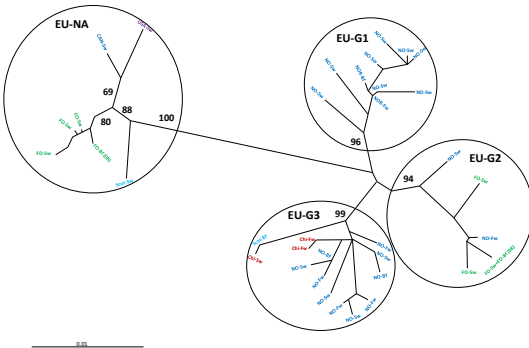
Prevalence of HPR0 in broodfish at stripping in 2008

Year	Total N	HPRO N	HPRO %
2007	256	9	5
2008	474	210	40
2009	50	0	0
2010	427	395	93
2011	210	73	35
2012	263	1	0.3
2013	65	0	0

Phylogenetic tree showing the clustering of FO Broodfish (2008)



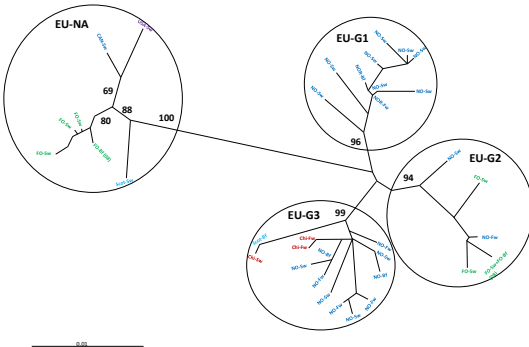
Phylogenetic tree showing the clustering of FO Broodfish (2008) in the EU-G2 and EU-NA



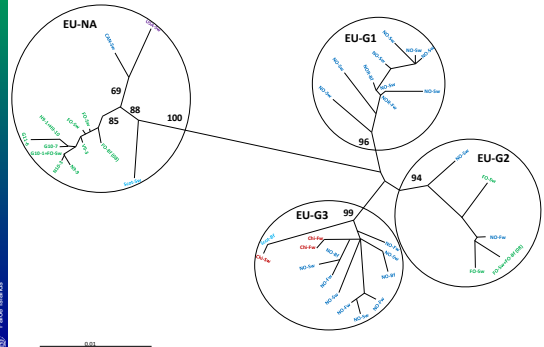
Fresh water smolt farms receiving eggs from HPR0 +ve Broodfish (late 2008 / early 2009)

Stripping No	Stripping (month)	HPRO BF (%)	Eggs (10E6)	Fw-smolt farms	2009 HPRO (%)	2010 HPRO (%)
1	Sept.	2	1.3	G	0	30
2+3	Oct.	15	0.9	N+H	3	28
4	Oct.	36	0.8	V	17	11
7+8	Oct.	68	1.4	F	0	0

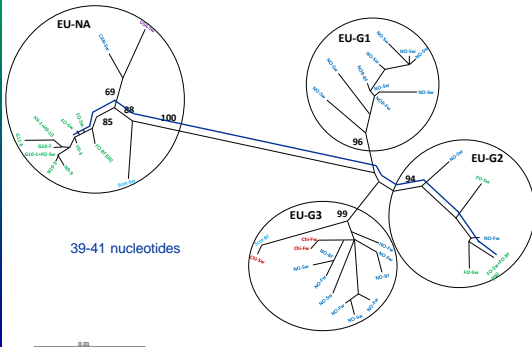
Phylogenetic tree showing clustering of FW juvenile salmon (2009-10)



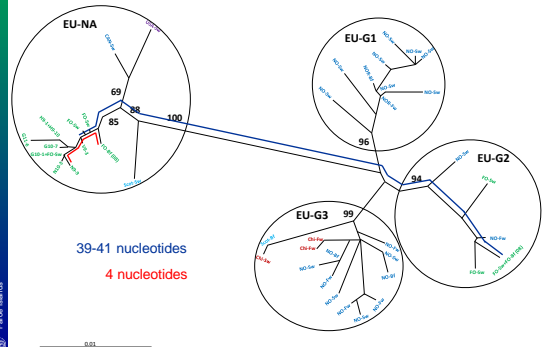
Phylogenetic tree showing clustering of FW juvenile salmon (2009-10) in the EU-NA subgroup



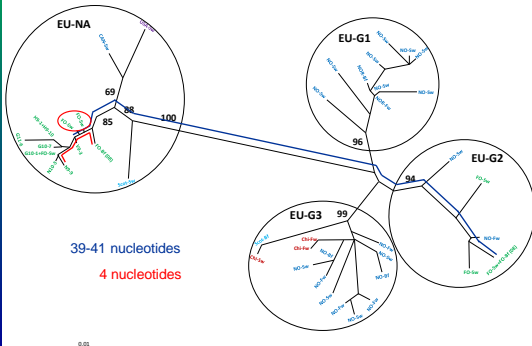
Genetic distance between Broodfish (2008) and Fw juvenile salmon (2009/10)



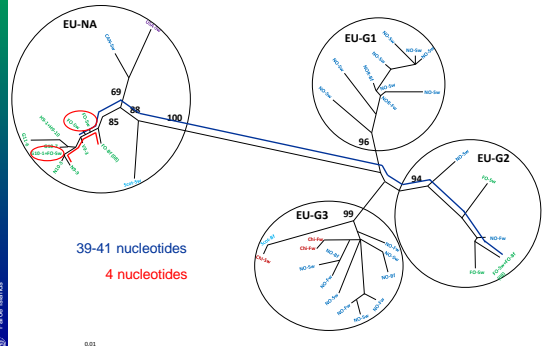
Genetic distance between Broodfish (2008) and Fw juvenile salmon (2009/10)



Genetic distance between Broodfish (2008) and Fw juvenile salmon (2009/10)



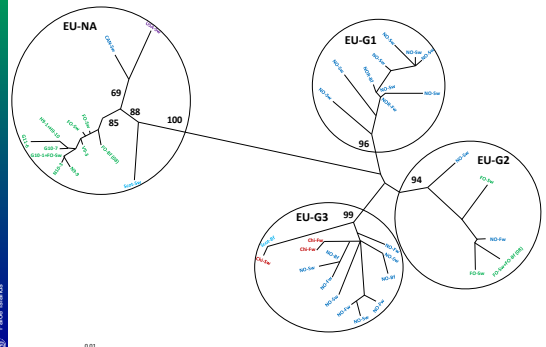
Little genetic evidence that HPR0 was transmitted vertically from Broodfish via eggs to juveniles



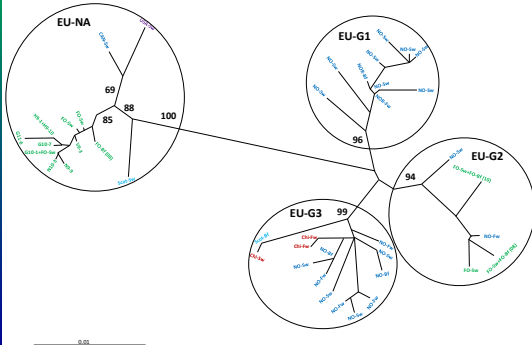
Prevalence of HPR0 in brood fish at stripping in 2010

Year	Total N	HPR0 N	HPR0 %
2007	256	9	5
2008	474	210	40
2009	50	0	0
2010	427	395	93
2011	210	73	35
2012	263	1	0.3
2013	65	0	0

Phylogenetic three showing clustering of FO-Broodfish (2010)



Phylogenetic three showing clustering of FO-Broodfish (2010) in the EU-G2 subgroup

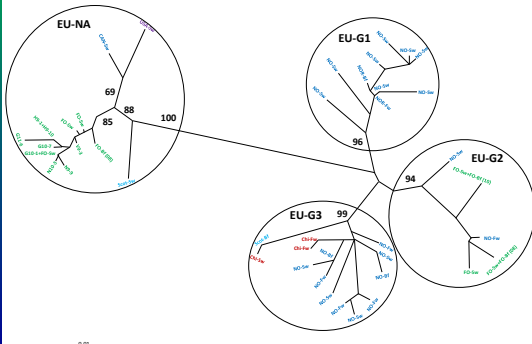


Fresh water smoltfarms reseiving eggs from HPR0 +ve Broodfish (2010/11)

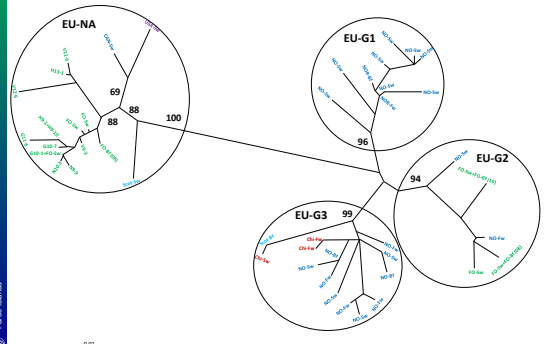
Stripping No	Stripping (month)	HPR0 (%)	Eggs (10E6)	Fw Smolt farms	2011 HPR0 (%)	2012 HPR0 (%)	2013 HPR0 (%)
1-3	Sept.	91	0.6	N+H	0	38	6
8+9	Oct.	98	0.4				
19	Nov.	80	2.1	G	19	4	18
4+5	Oct.	80	1.2				
6+7	Oct.	80-100*	0.7	V	15	48	8
11	Oct.	100					
12	Nov.	100	0.3				
14	Nov.	100*	0.6	F	0	0	0

\*Not tested for HPR0

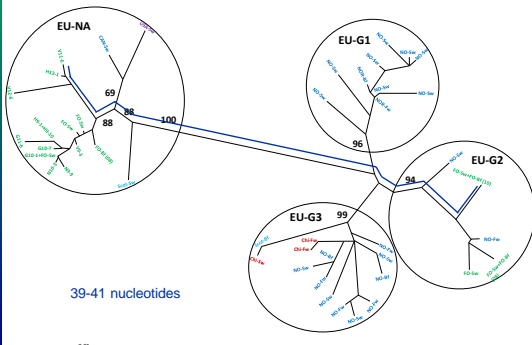
Phylogenetic three showing clustering of Fw-smolt (2011-2013)



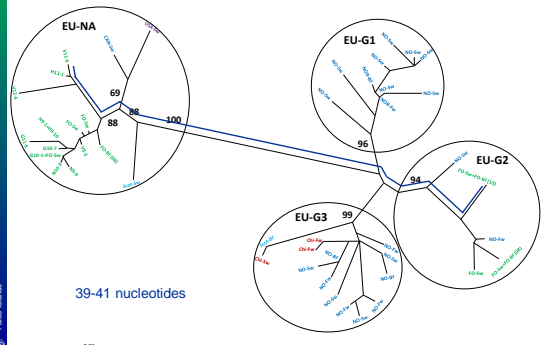
Phylogenetic three showing clustering of Fw juvenile salmon (2011-2013) in EU-NA subgroup



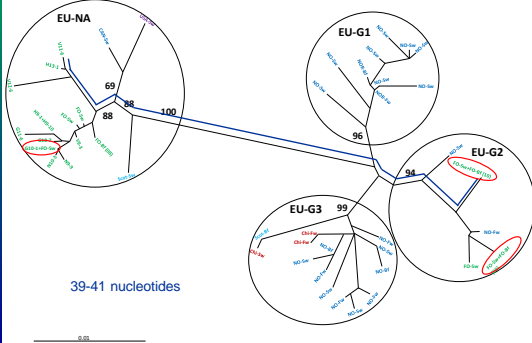
Genetic distance between Broodfish (2010) and Fw juvenile salmon (2011-13)



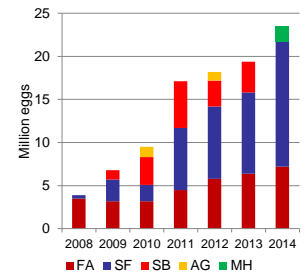
No genetic evidence that HPR0 was transmitted vertically from Broodfish via eggs to juveniles



### Close genetic link between HPR0 in marine salmon and in Broodfish and in juveniles



### All fresh water smolt farms have received eggs from Norway, Faroes Island and Iceland



### Stofnfiskur



### HPR0 in Icelandic Broodfish

Year	Samples N	HPR0 +ve N	HPR0 +ve %
2009	2374		
2010	4502		
2011	6120		
2012	2320		
2013	2425		
2014	1272		
Total	19013		

### HPR0 in Icelandic Broodfish

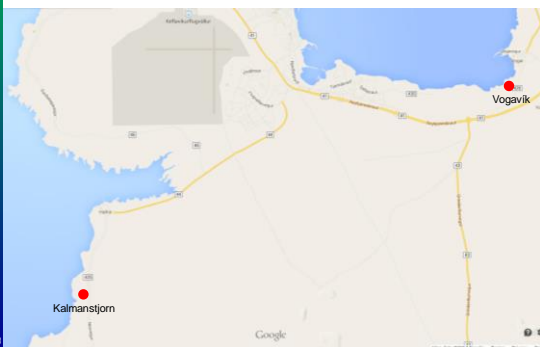
Year	Samples N	HPR0 +ve N	HPR0 +ve %
2009	2374	455	19
2010	4502	183	4
2011	6120	110	2
2012	2320	6	0,3
2013	2425	117	5
2014	1272	3	0,2
Total	19013	874	5

### Icelandic HPR0 cluster in two distinct subgroups

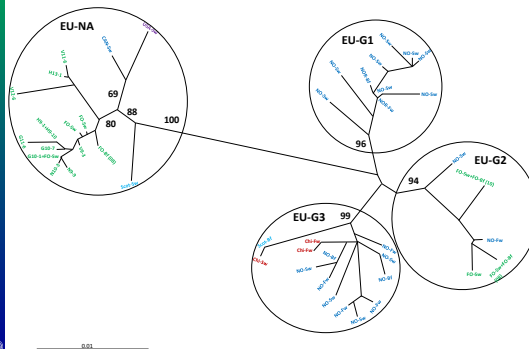




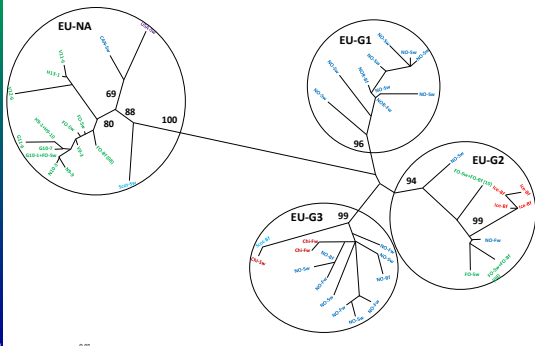
The Icelandic HPR0 are geographically structured



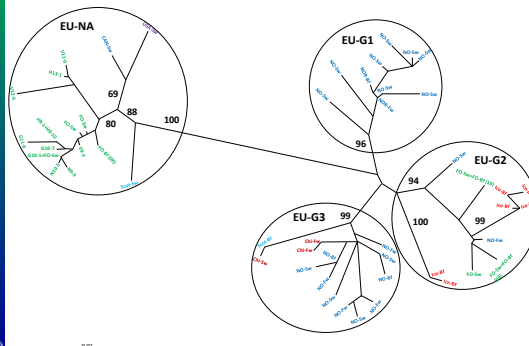
Phylogenetic three showing clustering of the Icelandic HPR0 isolates



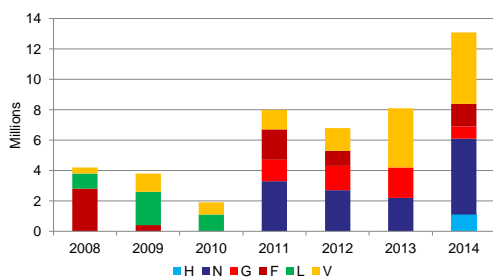
Phylogenetic three showing clustering of ISAV-HPR0 at Kalmanstjorn in EU-G2



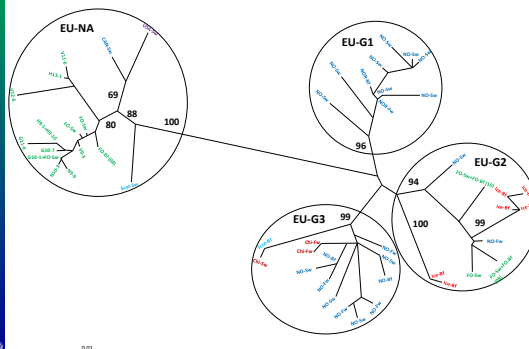
Phylogenetic three showing clustering of ISAV-HPR0 at Vogavik in EU-G2



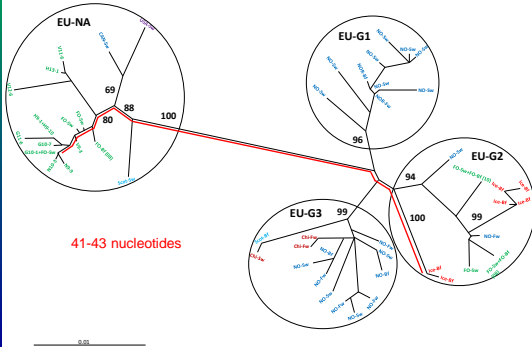
All six smolt farms have received eggs from SF



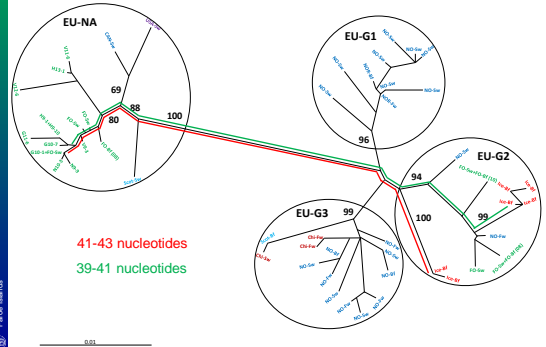
Genetic distance between Ice-Bf and FO-Fw-smolt



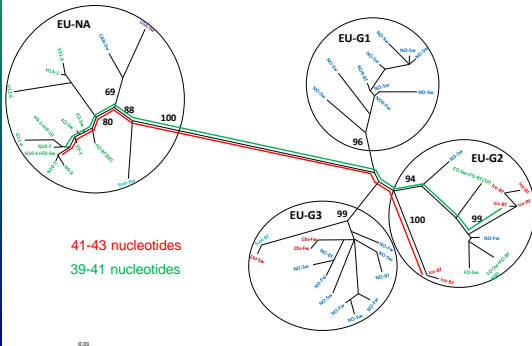
Genetic distance between Ice-Bf and FO-Fw-smolt



Genetic distance between Ice-Bf and FO-Fw-smolt



No genetic evidence that HPR0 is transmitted vertically from Icelandic Broodfish via eggs to Faroese juvenile salmon



## Conclusions

- HPR0 is prevalent in all three compartments of Atlantic salmon production in the Faroe Islands
- HPR0 infection is highly contagious and transient in all three compartments suggesting salmon is infection and not carriers

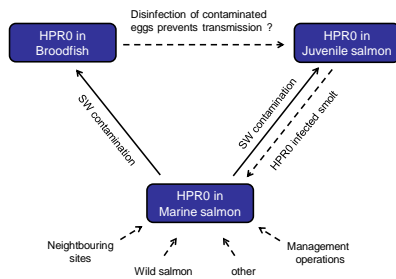
## Conclusions

- No or little genetic link between
  - HPR0 in FO Broodfish and FO juvenile salmon
  - HPR0 in Ice Broodfish and FO juvenile salmon
  - HPR0 in NO Broodfish and FO juvenile salmon

## Conclusions

- Close genetic link between
  - HPR0 in marine salmon and juvenile salmon
  - HPR0 in marine salmon and Broodfish
  - FO-HPR0 and FO-HPRdel in EU-G2

HPRO is transmitted horizontally from marine salmon to broodfish and juvenile salmon



#### Acknowledgements:

- Knut Falk
- Maria Kampfer
- Alexander Nordmann
- Anne Marie Jensen
- Peter S. Østergaard
- Ann-Brit Borg Hansen
- Ragnfríð Björnsdóttir
- Marita Høns
- Janus I. Dali
- Ólafur Hansen
- Anja K. Olsen
- Ingibjörg Egholm
- Marnar Djurhuus
- The Faroese Atlantic salmon farmers