Veterinærinstituttet
Norwegian Veterinary Institute

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An overview of current knowledge of, and the potential for the transfer of infections and parasites.

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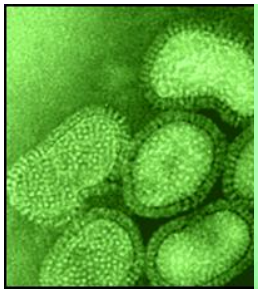
Themebased Special Session (TBSS) of the Council of NASCO
Wednesday 5 June 2024, Westport, Ireland

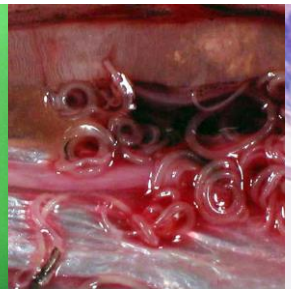
Pathogens and Diseases

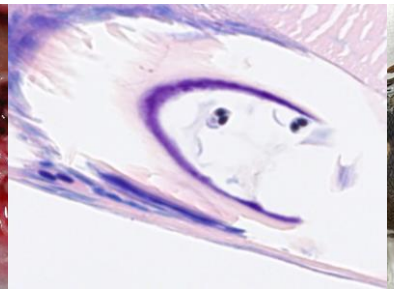
Virus



Bacteria

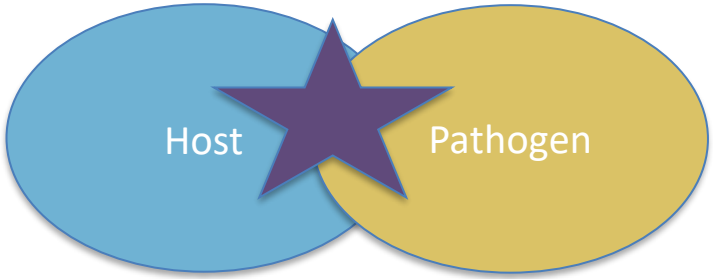
Paracites



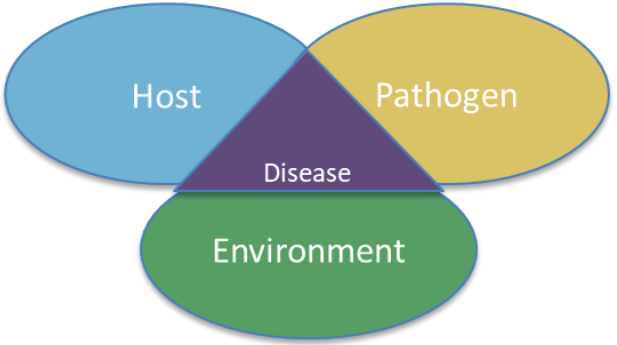


Fungi & Oomycetes

Primary vs. opportunistic pathogens
Obligate vs. facultative pathogens



- Cause disease regardless of the host's health status (Virulence factors)
- Outcome: host condition vs. virulence
- Ex. *Renibacterium salmoninarum* (BKD)



- Utilise other niches than animal hosts
- Host weakened by internal or external factors
  - Age/stage (spawning), other diseases, stress
  - Water quality, host density, handling,
- Ex. *Aeromonas hydrophila*

Are pink salmon susceptible? – WOAH listed diseases

Disease and Pathogen	WOAH	Literature
INFECTIOUS HEMATOPOIETIC NECROSIS (IHN-virus)	Not listed as susceptible	*Follett et al., 1997, Dixon et al. 2016*
VIRAL HAEMORRHAGIC SEPTICAEMIA (VHS-virus)	Not listed as susceptible	Follett *et al.,* 1997.
INFECTIOUS SALMON ANAEMIA (ISA-virus)	Not listed as susceptible	
PANCREAS DISEASE (Salmonid alphavirus-SAV)	Not listed as susceptible	
GYRODACTYLUS SALARIS	Not listed as susceptible	

Susceptibility - pink salmon

Disease and Pathogen	Susceptible?	Literature
INFECTIOUS PANCREATIC NECROSIS IPN-virus	?	Hindar et al., 2020 (expert opinion: Probably susceptible)
HSMI-LIKE DISEASE OF RAINBOW TROUT PRV-3 (Piscine orthoreovirus-3)	?	
YERSINIOSIS/ENTERIC REDMOUTH DISEASE *Yersinia ruckeri* ¥	?	
CARDIOMYOPATHY SYNDROME Piscine myocarditis virus	?	
SALMON GILL POX SGP-virus	?	

¥ Clonal complex 1 (CC1) in Atlantic salmon in Norway, CC2 serious disease in rainbow trout worldwide

Disease and Pathogen	Susceptible?	Literature
BACTERIAL KIDNEY DISEASE * *Renibacterium salmoninarum*	Yes	Bell 1961, Meyers *et al.,* 1993, Delghandi *et al.,* 2020.
FURUNCULOSIS *Aeromonas salmonicida* ssp. *salmonicida**	Yes	Subspecies is often not specified
FURUNCULOSIS *Aeromonas salmonicida sp.*	Yes	Nomura, T., & Kimura, T. (1981). Beacham & Evelyn (1992)
VIBRIOSIS *Vibrio anguillarum, V. ordalii*	Yes	Beacham & Evelyn (1992)
SALMONID RICKETTSIAL SEPTICEMIA *Piscirickettsia salmonis*	Yes	Kent 1992, Brocklebank *et al.,* 1993
HEART AND SKELETAL MUSCLE INFLAMMATION (HSMI) Piscine orthoreovirus-1	Yes	Garseth et al., 2020

*Notifiable in Norway

What does monitoring show?

- Targeted approach
  - Random sampling of “healthy” pink salmon
  - Aimed at detecting predefined pathogens (specific PCR assays)
  - Parasite fauna (several studies), salmon lice surveillance
  - Cultivation for bacteria and virus, histopathology
- Risk based approach
  - Examination of pink salmon with signs of illness

PCR based screening

Disease/Pathogen	Approx. number of pink salmon tested (Northern Europe)	Detected?	
Infectious hematopoietic necrosis (IHNV)	~600	No	
Viral haemorrhagic septicaemia (VHSV)	~500	No	
Infectious salmon anaemia (ISAV)	~600	No	
Bacterial kidney disease *Renibacterium salmoninarum*	~600	No	
Heart and skeletal muscle inflammation (PRV-1)	~500	Yes	Garseth et al. 2020, Rullestad 2021, Sommerset et al., 2022

Pink salmon are susceptible to PRV-1

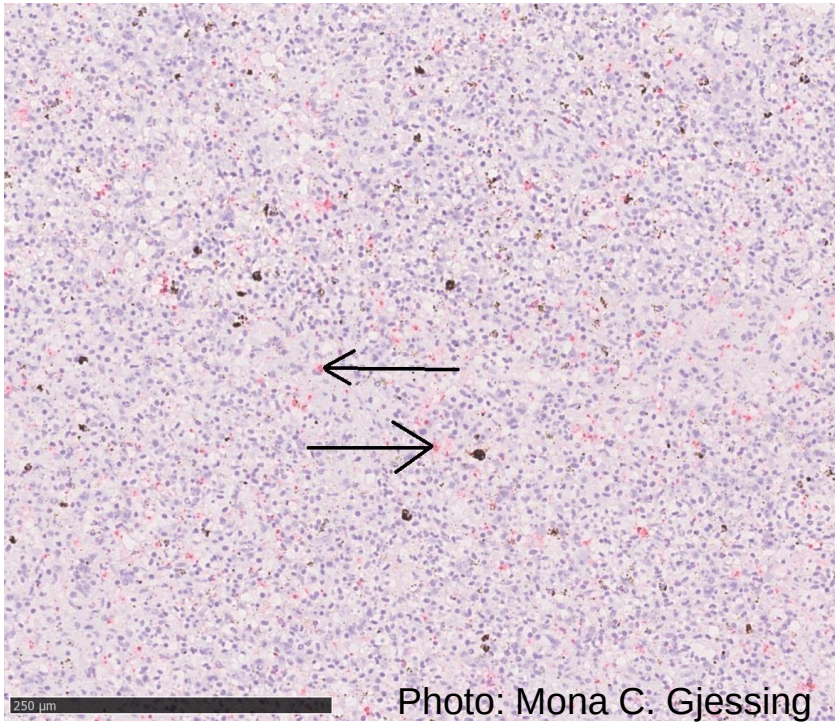


Photo: Mona C. Gjessing

- Detection by qPCR
- In this case:
  - Moderate to high viral load - Cq 13
  - In Situ hybridization places virus in several organs
  - Sequencing: PRV-1b that cause HSMI in Atlantic salmon in Chile and Norway

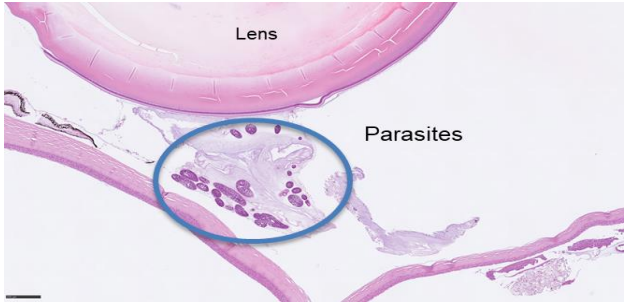
Cultivation of bacteria (from NVI)

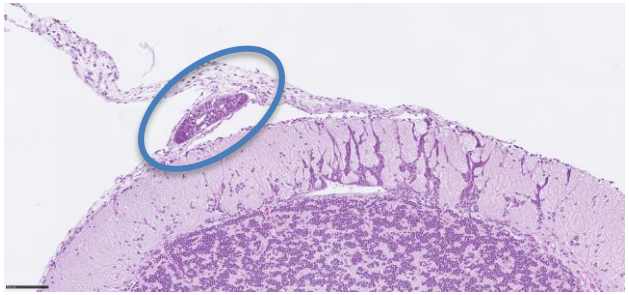
- Bacteria present in water and fish
- Some are opportunistic pathogens

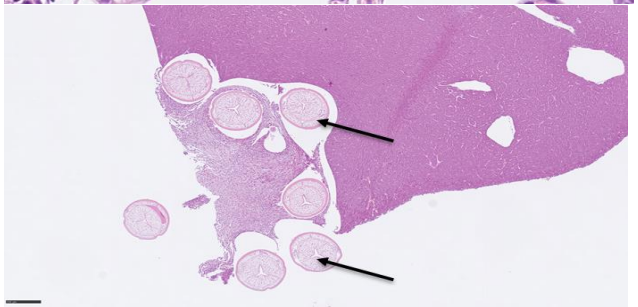
- Motile Aeromonas
  - *Aeromonas hydrophila*
- *Pseudomonas sp.*
  - *Pseudomonas fluorescence*
- *Carnobacterium maltaromaticum*

- *Serratia sp., Acinetobacter sp., Leclercia sp., Photobacterium sp.*

Histopathology







Photos: Lisa Furnesvik, NVI

Parasite fauna

- Marine parasites, generalists (wide host range)
- North Atlantic pink salmon occupy same ecological niche as in Pacific Ocean
- Salmon lice surveillance programme (IMR):
  - 74% *Caligus elongatus*, 20 % Adult *Lepeophtheirus salmonis*, 6% Young attached *L. salmonis*

Risk based monitoring

Cases reported to Norwegian Veterinary Institute

Wild fish health reporting system
(Syk villfisk portalen)
www.vetinst.no/syk-villfisk

Aeromonas hydrophila septicemia

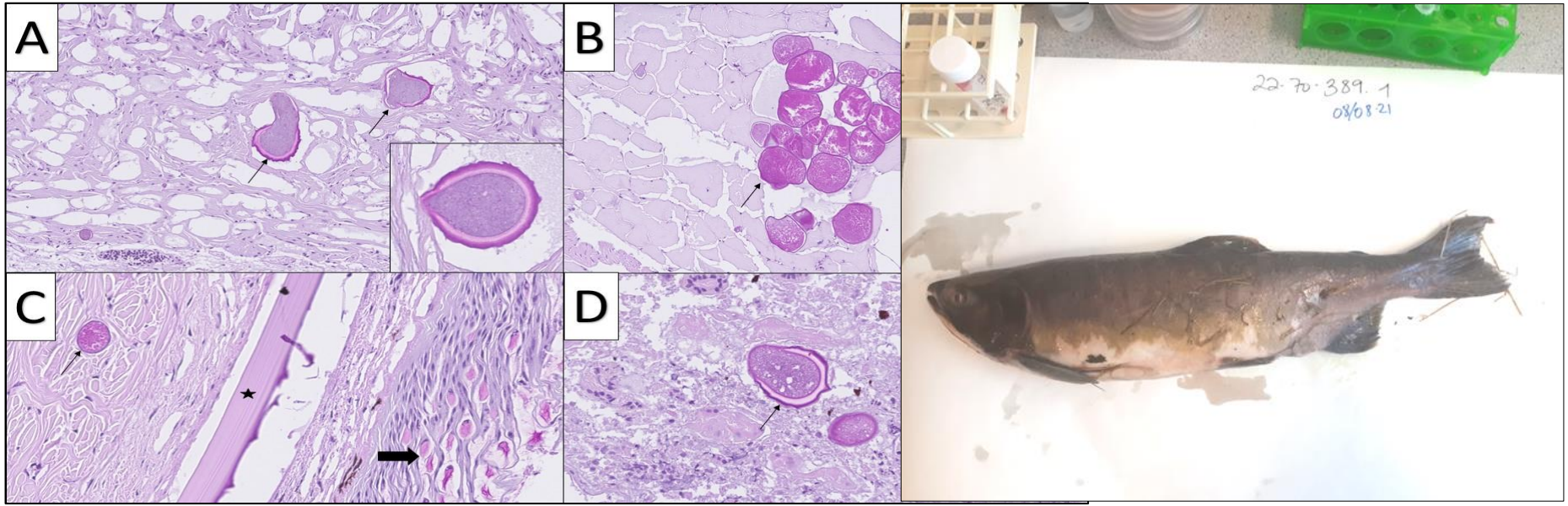
- River Gjersjøelva, near Oslo
- Resembling furunculosis
- Opportunistic pathogen


Photo: Duncan Colquhoun


Photo: Sander Engeland

Ichthyophonus sp

- *Ichthyophonus sp*



Photos: Toni Erkinharju, NVI

Deformities can be a symptom of infection (*Flavobacterium* sp., *Myxobolus cerebralis*)

Photos: Roar Sandodden

Decaying pink salmon in rivers

Photo: Rune Muladal

Photo: Skule S. Isaksen

In summary

- Surveillance: No of few alarming findings
  - Mismatch: target in surveillance vs. susceptibility
  - Narrow scope (qPCR)
- «Healthy appearance» until spawning
  - Young (2 year), less exposure and accumulation of pathogens
  - Enemy release hypothesis
- Pacific: pink salmon less studied than Chinook, Coho, Rainbow tr.
-  ?

Risk for Atlantic salmon


Photo: Ketil Skår

- Introduction of new pathogens
  - Imports to Russia is not an active threat (1999 last import)
  - Climate change: circumpolar distribution, invasion other sources

- Long distance & local translocation of pathogens
  - Mind your country's specific diseases challenges/goals
  - Norway:
    - Bacterial kidney disease, furunculosis, pancreas disease
    - *Tetracapsuloides bryosalmonae* (PKD), *Myxobolus cerebralis ??*

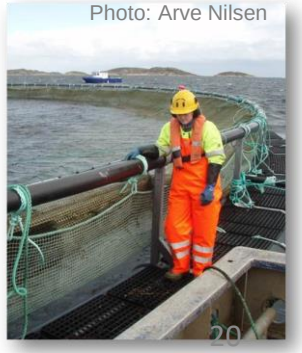


Photo: Arve Nilsen

Risk for Atlantic salmon

- Increased host number and density
  - Impact on local infection dynamics
  - Transmission and establishment of endemic infections
- High number of immunosuppressed, moribund/dead
  - Local impact on infection dynamics
  - Boost load of microorganisms, opportunistic pathogens
- Black swans

  climatic changes, emerging diseases, covert carriers

Research- pathogens and diseases

- Salmonid aquaculture - reservoir of many primary pathogens
  - Pink salmon behaviour near aquaculture sites
  - Pink salmon susceptibility (SAV, ISAV, PMCV…transmission trials)
- Moribund, dead and decaying in high numbers
  - Impact of microbial community and load on salmonids at different stages
- Continue to investigate pink salmon health
  - Broaden scope, use cultivation methods, risk based monitoring
  - Immune diversity (MHC), immunological state

Faglig ambisiøs, fremtidsrettet og samspillende - for Én helse!

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