Cardiomyopathy syndrome CMS:

An overview of the situation in Norway 2017

Based on data from the annual NVI report
”**Health situation in Norwegian aquaculture 2017**”,
also named ”Fish Health Report 2017” (FHR 2017)

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Cardiomyopathy syndrome (CMS)

- A serious, inflammatory heart disease in farmed Atlantic salmon

- Usually from the second year post sea transfer
  - ⇒ Possibilities for significant economic impact: ~25 mill. € in 2007 (Norway)
    - ⇒ Management costs
    - ⇒ Mortality

- Transmissable in challenge experiments by
  - i.p. injection
  - cohabitation

- Causative agent: Piscine myocarditis virus (PMCV)
  - *Totiviridae family* -like
  - Naked, ~ 50 nm
  - ds RNA-virus
  - Relative small genome

- No other known reservoar found other than the salmon itself

Clinical observations

Either

Acute outbreak:

Relatively fast occuring with high mortality, but few other observations

or

Chronic presentation:

More prolonged outbreak with moderate mortality

Photos: Per Anton Sæther, MarinHelse AS

For both clinical manifestations:

- Fish in normal to high/good condition
- «No» lethargic swimmers/moribound fish
- Still food in the gastric ventricle/GI system

Macroscopic findings

Caused by circulatory disturbances due to heart failure

Outer:

- Raised scales due to oedema
- Ventral petecchiae
- Exophtalmia

Inner:

- Ascites
- Enlarged, or ruptured atrium w. blood and bloodclots in the cardiac cavity (tamponade)
- Dark or uneven coloured liver w. fibrinous casts

Photo: Per Anton Sæther, MarinHelse AS

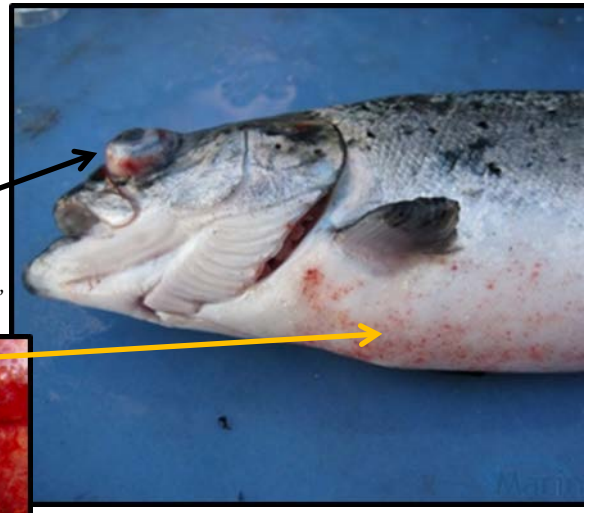
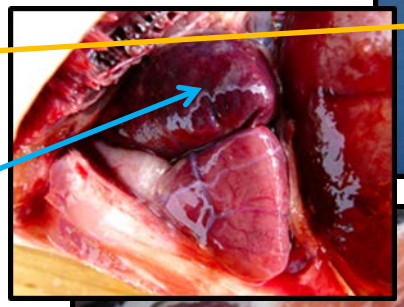


Photo: Trygve T. Poppe, Pharmaq Analytic AS



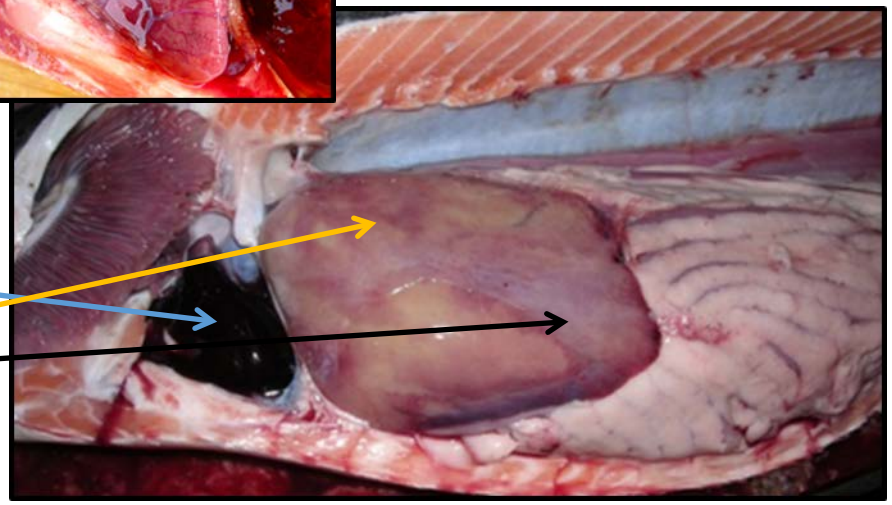


Photo: Brit Tørud, Norwegian Veterinary Institute

Microscopic findings

Normal, unaffected compact muscle layer (**C**) and severe inflammation of the spongious muscle of the cardiac ventricle (200x, HE)

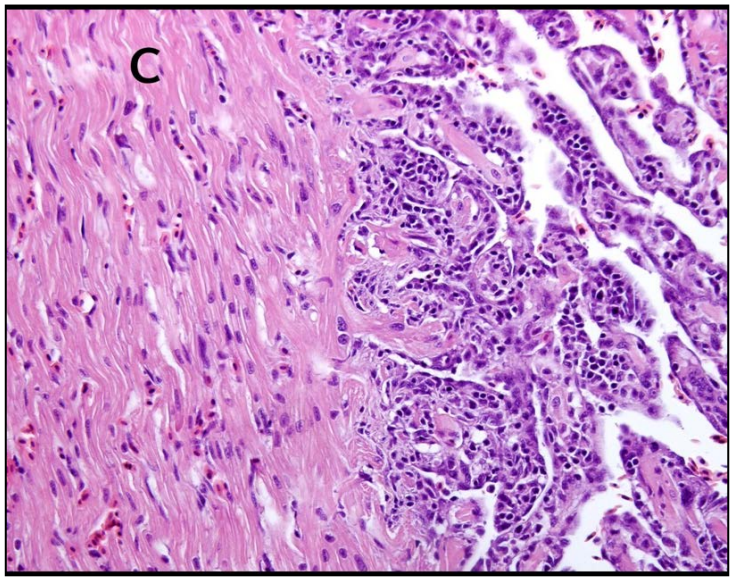


Photo: Trygve T. Poppe, Pharmaq Analytic AS

Very severe inflammation of atrial spongious cardiac tissue: Almost complete loss of muscle (**M**) replaced by inflammatory cells (↓) surrounded by hypertrophic (enlarged) endocardial cells(↗) (400x, HE)

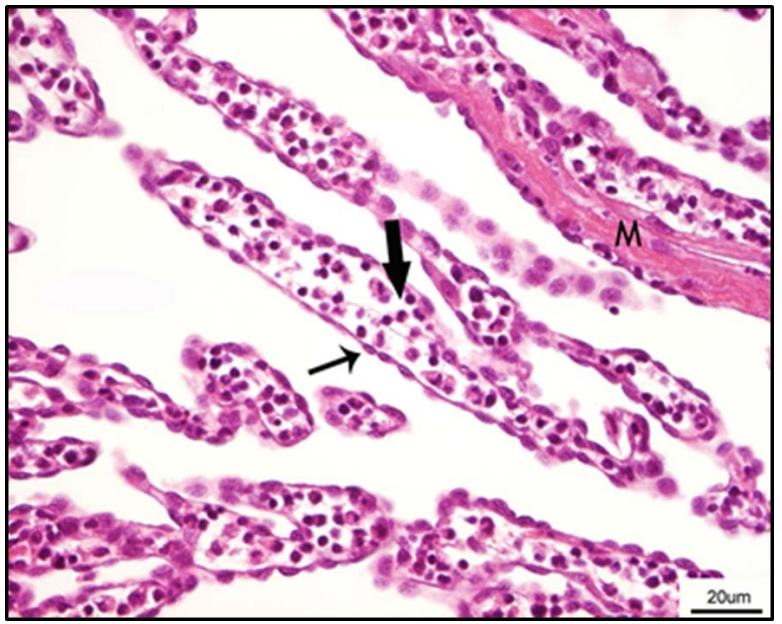


Photo: Camilla Fritsvold, Norwegian Veterinary Institute

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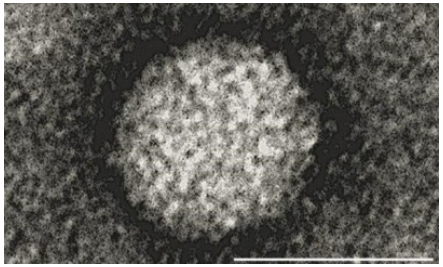
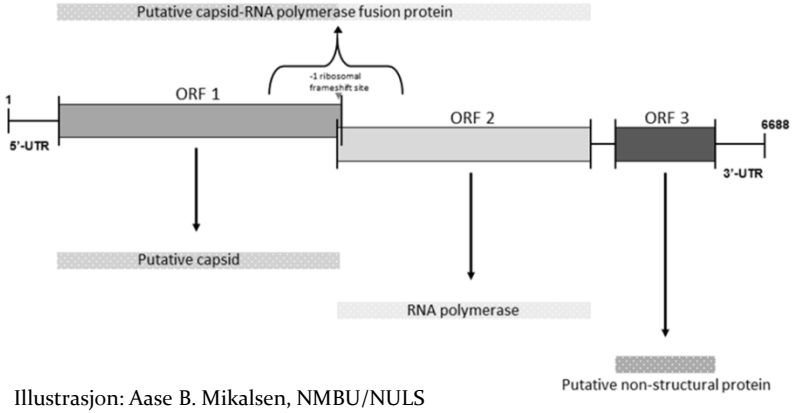
Etiologic agent: PMCV – Piscine myocarditis virus

- First description 2010
  (Haugland et al. (NMBU/NULS), Løvoll et al. (NVI))
- Unsegmented ds-RNA genome 6.688 bp
- Difficult to use genetic variation of PMCV to back trace the virus, as variation may be larger between individuals in a cage at at one farm, than between farms
- 3 open reading frames (ORFs):
  - ORF1: Putative capside
  - ORF2: RNA-polymerase
  - ORF3: Putative nonstructural protein, only seen in virus infecting vertebrate hosts. May contain virulence factors



TEM photo of PMCV particle: Trygve Eliassen, Pharmaq.



Illustrasjon: Aase B. Mikalsen, NMBU/NULS

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CMS – diagnostic methods

Diagnosis is based on a combination of

- **Clinical and autopsy findings**
- **Histopathology** (diff.diagnosis: PD & HSMI)

Inflammation of:

Betennelse i:	CMS	PD	HSMB
Atrium	+	+/-	+
Ventrikkel spongiosum	+	+	+
Ventrikkel kompaktum	-	+/-	+
Epikarditt	-	-	+
Eksokrin pankreas	-	+	-
Skjelett-muskel	-	+	+

Supplementary methods:

- **Immunohistochemistry** (method needs more validation and refinement)'
- **In situ - hybridisation**

- **PMCV-specific real-time PCR**
  - High correlation between viral amount and severity of pathological changes
  - Patented by Pharmaq Analytic AS: Free to use in research, fee for commersial use for others than Pharmaq Analytic AS.

CMS – how to prevent and control…?

- **Biosecurity:** “All in-all out” etc.
- **Management:** Reduce stress and stressfull handling/treatments, early slaughtering if diagnosed w. CMS or high viral levels detected
- **Diagnostics and screening:** Early detection of virus and disease, tool for planning of movements or treatments
- **Breeding:** High heritability of resistance to CMS mortality, QTL-roe available
- **Feed:** Functional feed available. Lower fat content and higher Ω3/Ω6-ratio shown to be beneficial in experiments
- **Vaccine:** No vaccine available, but ongoing research

Basis for FHR 2017

Numbers are based on

1. statistics from diagnostic services provided by the Norwegian Veterinary Institute (NVI) for 484 (of a total of 990) Norwegian farms with Atlantic salmon, as summarised in the '**Health situation in Norwegian aquaculture 2017**' report, also named "Fish Health Report 2017" (FHR 2017).

2. Voluntarily presented information from several **external laboratories**, particularly important as CMS is a non-notifiable disease.

3. Results from **a questionnaire** sent to

   29 fish health services/fish farming companies and
   +

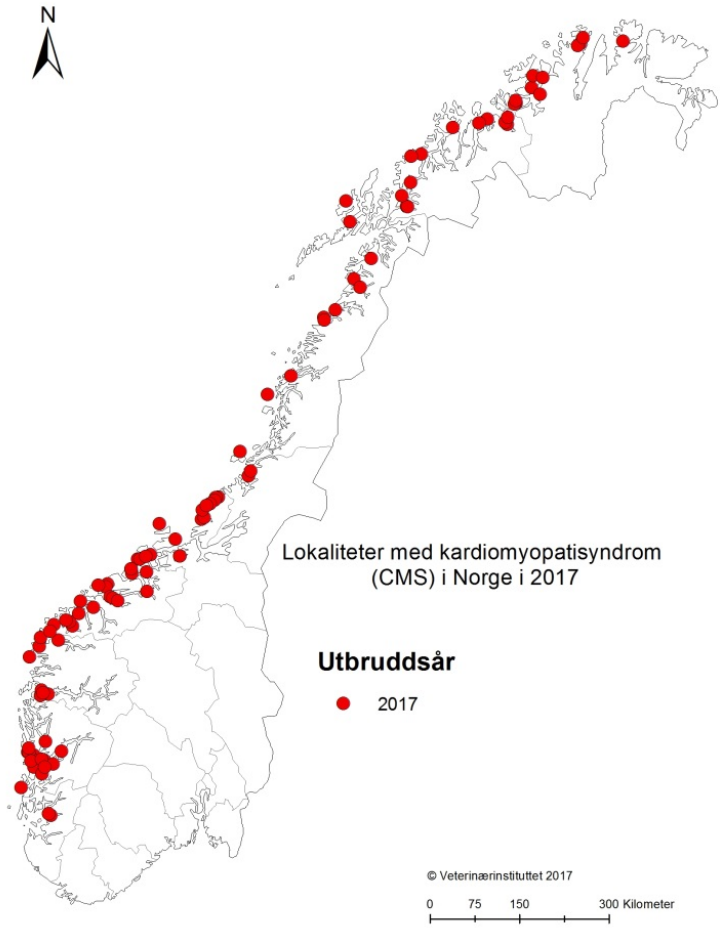
   all fish health officers of the Norwegian Food Safety Authority.

CMS in Norway 2017

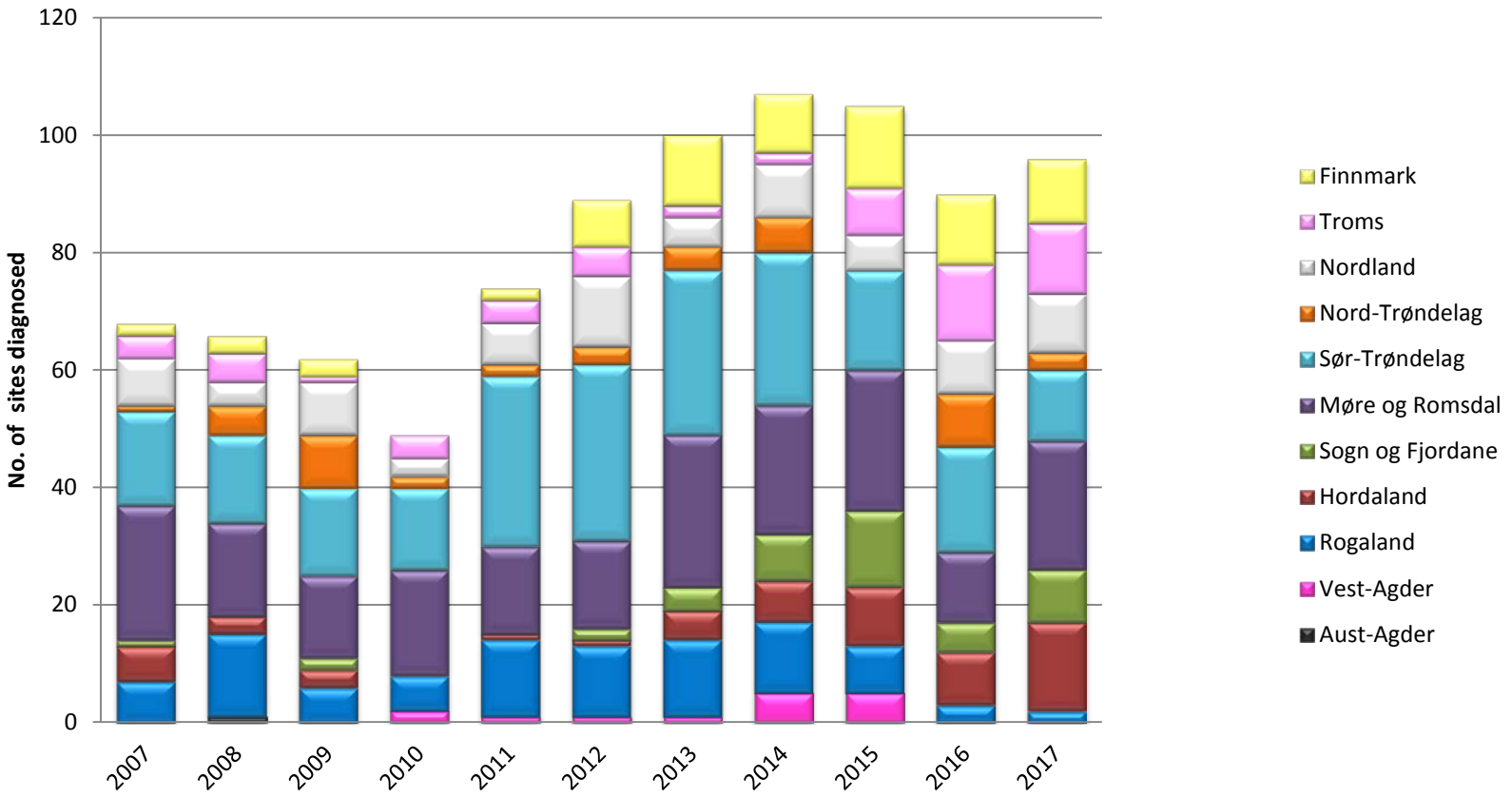
- Cardiomyopathy syndrome (CMS) was diagnosed by NVI in 96 farms in 2017.
- Probably underestimating the real situation, as the disease is non-notifiable and some of the farms may use other laboratories to diagnose their samples.
- External laboratories reported 100 farms with CMS diagnosis 2017. Possibly and probably some overlap with some of the NVI diagnoses (confidentiality agreements etc.)
- Conclusion: CMS is still a problem, and most likely an increasing one.

	No. of farms diagnosed with CMS
2017	96
2016	90
2015	105
2014	107
2013	100
2012	89
2011	74
2010	49
2009	62
2008	66

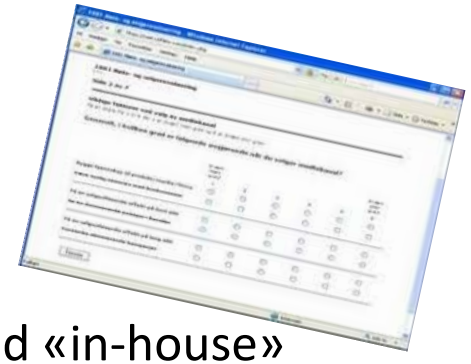
CMS - geographical distribution



CMS – diagnoses, farms by county



Questionnaire



- 45 responding fish health services (both independent and «in-house» sevices) and fish health officers in the NFSA asked to range what the most important fish health problem in their region was.

- CMS was ranged as the second most important problem, at the same level as injuries caused by mechanical delousing, and only «beaten» by the no. 1 problem: salmon lice.

- Some geographically variation, mostly in accordance with the distribution of CMS diagnoses along the coast.
  - The further north, the higher ranging of ulcers, HSMI and ISA
  - The further south, the higher ranging of gill diseases
  - In the «mid Norway»: PD is ranged high

Conclusions

- CMS is an important, probably increasing problem for Norwegian fishfarms with Atlantic salmon

- Increasing importance as the fish is subject to more sorting, handling and treatments than earlier i.e.
  - more frequent delousing
  - delousing by mechanical, very stressful methods
  - more sorting

Wishing list for the future

- Suitable cellculture
- Further refinement of excisting, and new, diagnostic methods
- More knowledge of the pathogenesis
- An effective vaccine
- More knowledge of the biophysiological properties of the virus (survival in environment, resistance to desinfectants etc.)
- More knowledge of the virus (proteinproducts, receptors etc.)
- ……

Thank you for listening!

Thanks to:

- Norwegian fish health services and commersial diagnostic laboratories contributing to the Norwegian Fish Health Report 2017

- A large number of colleagues at the NVI