Hydropower and hydromorphological impacts in freshwater pearl mussel rivers: ecological bottlenecks and potential mitigation measures

Marie-Pierre Gosselin, Jo Halleraker, Bjørn Mejdell Larsen, Knut Alfredsen

Sus-HP Conference, Trondheim, 14 June 2023.

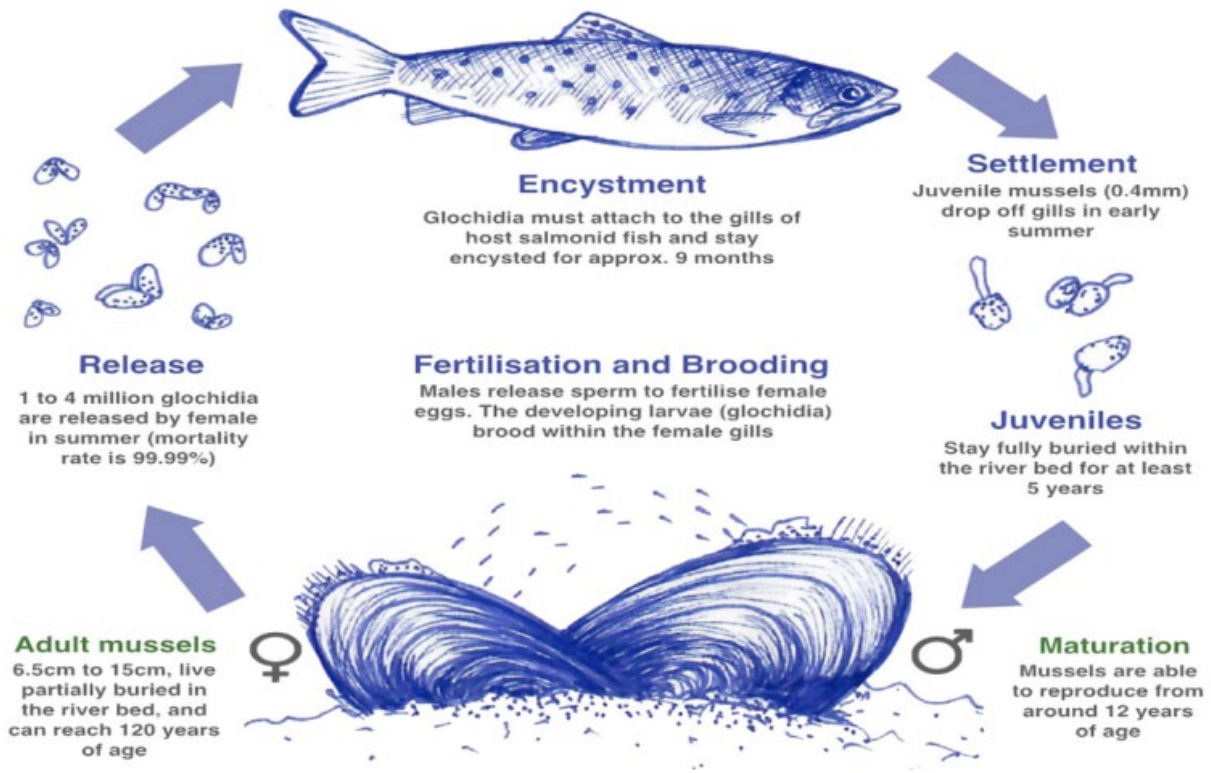
NINA
Norwegian Institute for Nature Research

Freshwater pearl mussel (*Margaritifera margaritifera)* in Norway

- Largest population in Europe
- Priority species: management plan, monitoring programme
- The main threats to FPM are linked to run off from agriculture and forestry
- Physical and hydraulic habitat requirements poorly studied
- 419 watersheds in Norway with FPM, 125 have HP…(ca. 25 %!!!)

NINA

Ecology and monitoring

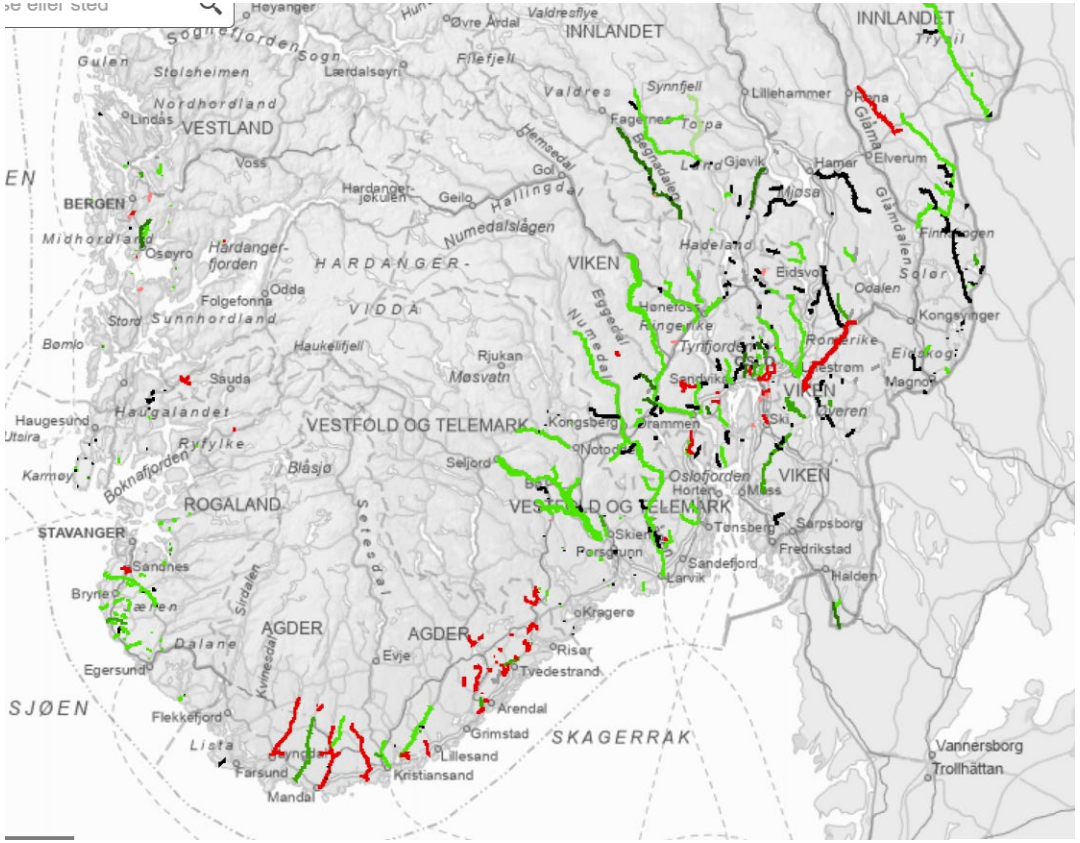


Kriterium	1 p	2 p	3 p	4 p	5 p	6 p
1 Populasjonsstørrelse (i tusen)	<5	5–10	11–50	51–100	101–200	>200
2Gjennomsnittstetthet (ind/m^2)	<2	2,1–4	4,1–6	6,1–8	8,1–10	>10
3 Utbredelse (km)	<2	2,1–4	4,1–6	6,1–8	8,1–10	>10
4 Minste musling funnet (mm)	>50	41–50	31–40	21–30	11–20	≤10
5 Andel muslinger <2 cm (%)	>0–1	>1–2	>2–3	>3–4	>4–5	>5
6 Andel muslinger <5 cm (%)	>0–5	6–10	11–15	16–20	21–25	>25

- Class I – *Little viability* (endangered; 1-7 points)
- Class II –*Likely viability*, but action required (sensitive; 8–17 points)
- Class III – *High viability* and really high conservation value (viable; 18–36 points)

NINA

Problems of cumulative impacts for mussels: WFD data in Norway



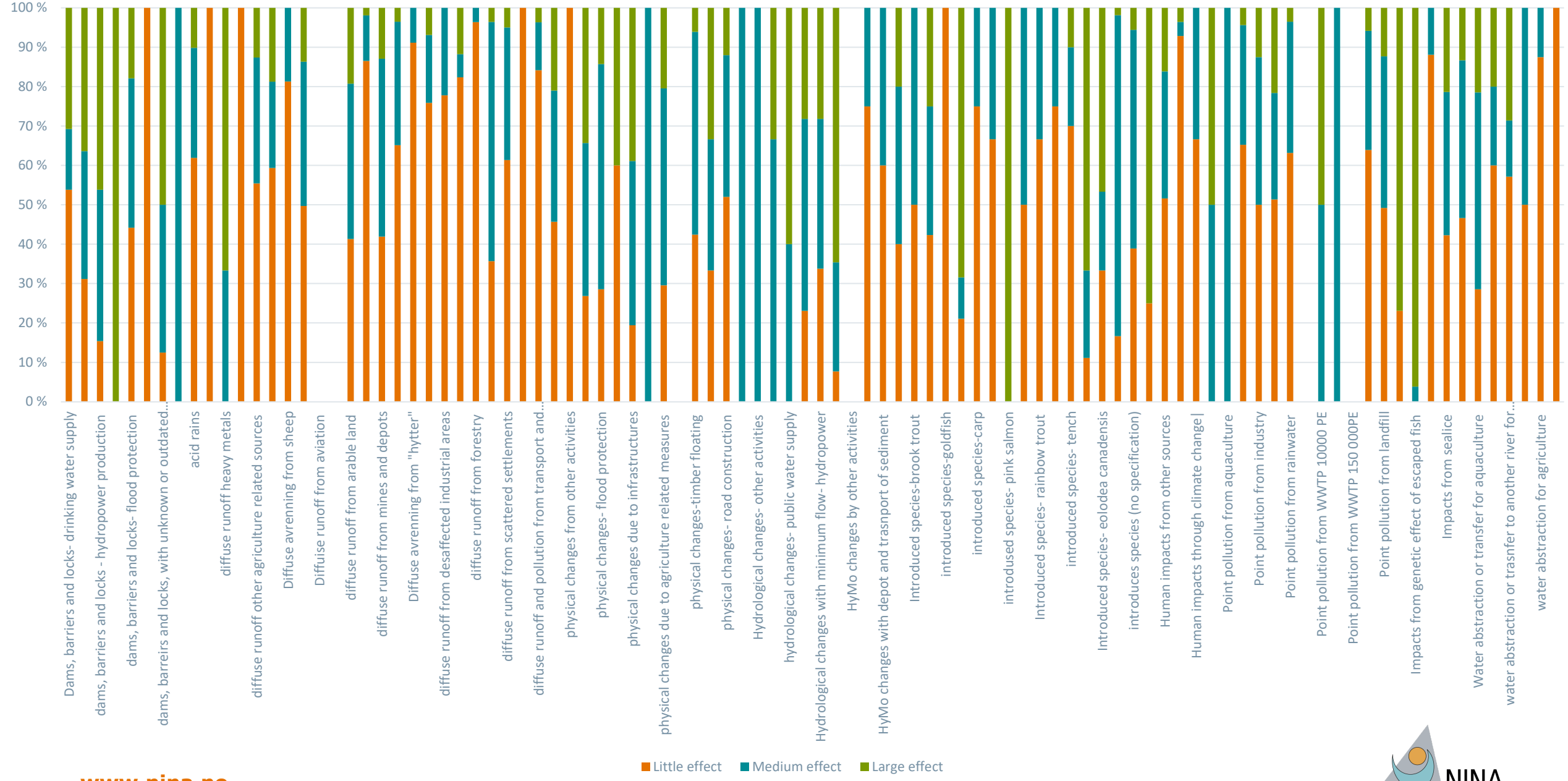
Dataset:

- National freshwater pearl mussel database
- National WFD dataset for Norway
- Data on all HP plants in watersheds with freshwater pearl mussel.

97 different pressures
16 categories of pressures
All waterbodies with HP have at least one other type of pressure.

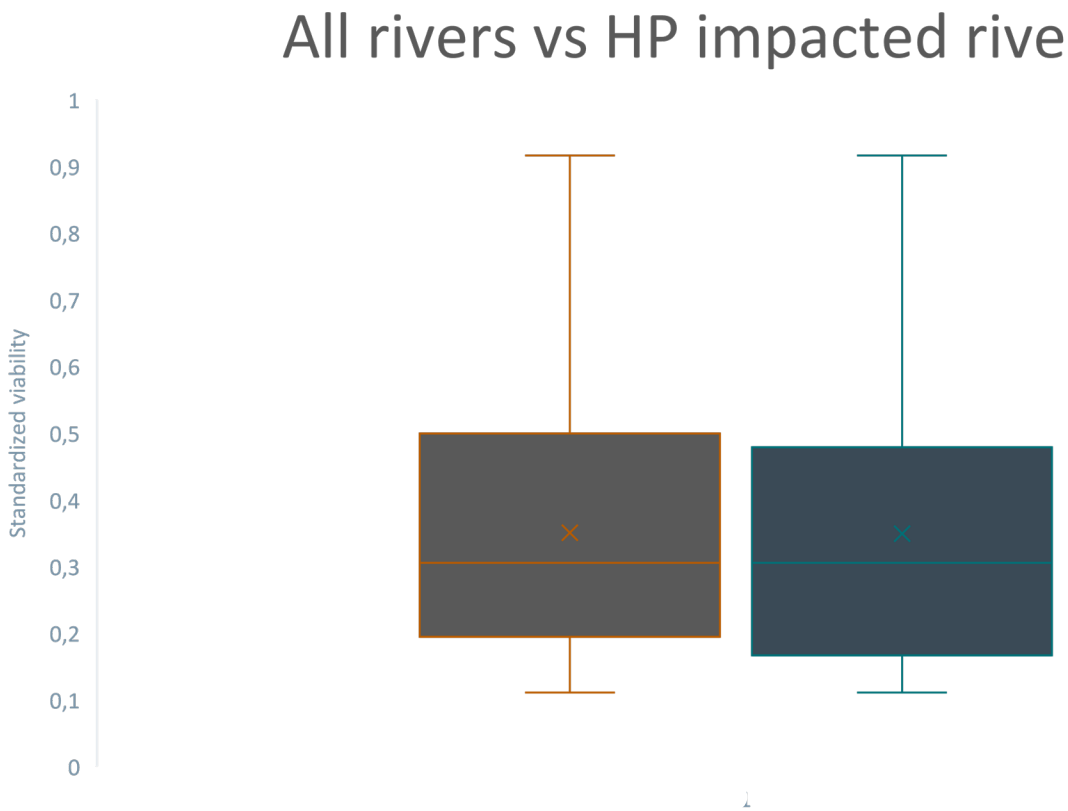
Are mussel populations responding to these?

All pressure categories and degree of impact



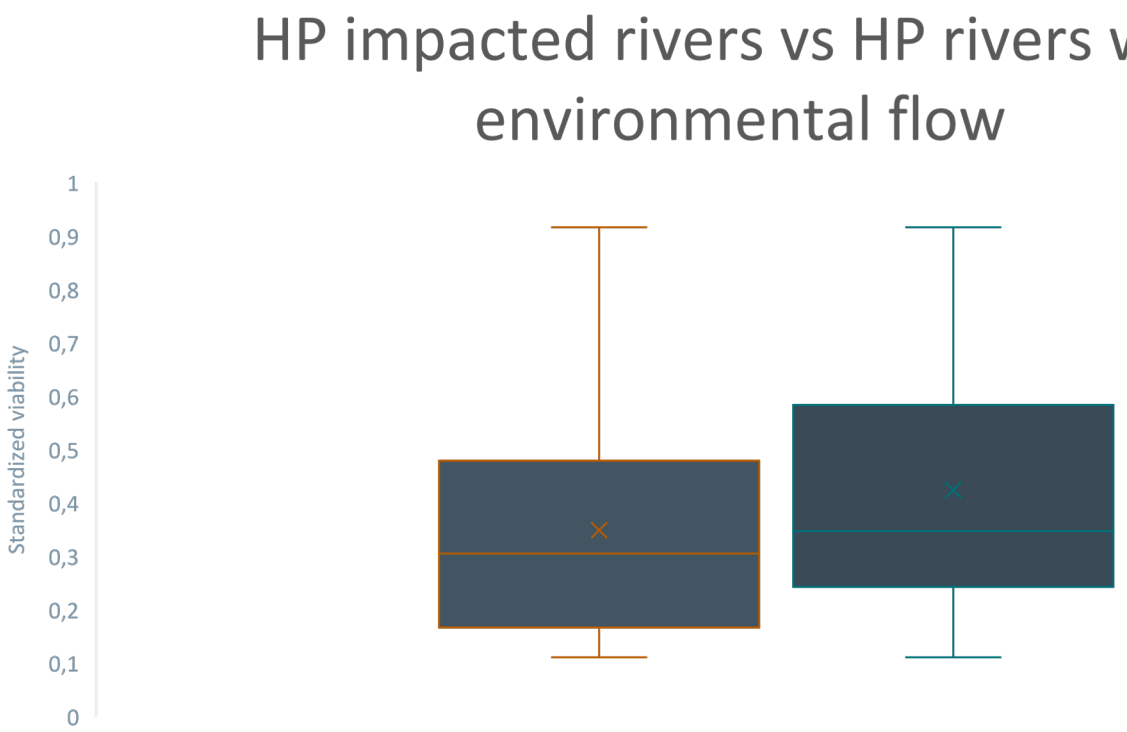
NINA

Is there a difference between the two types of water bodies?



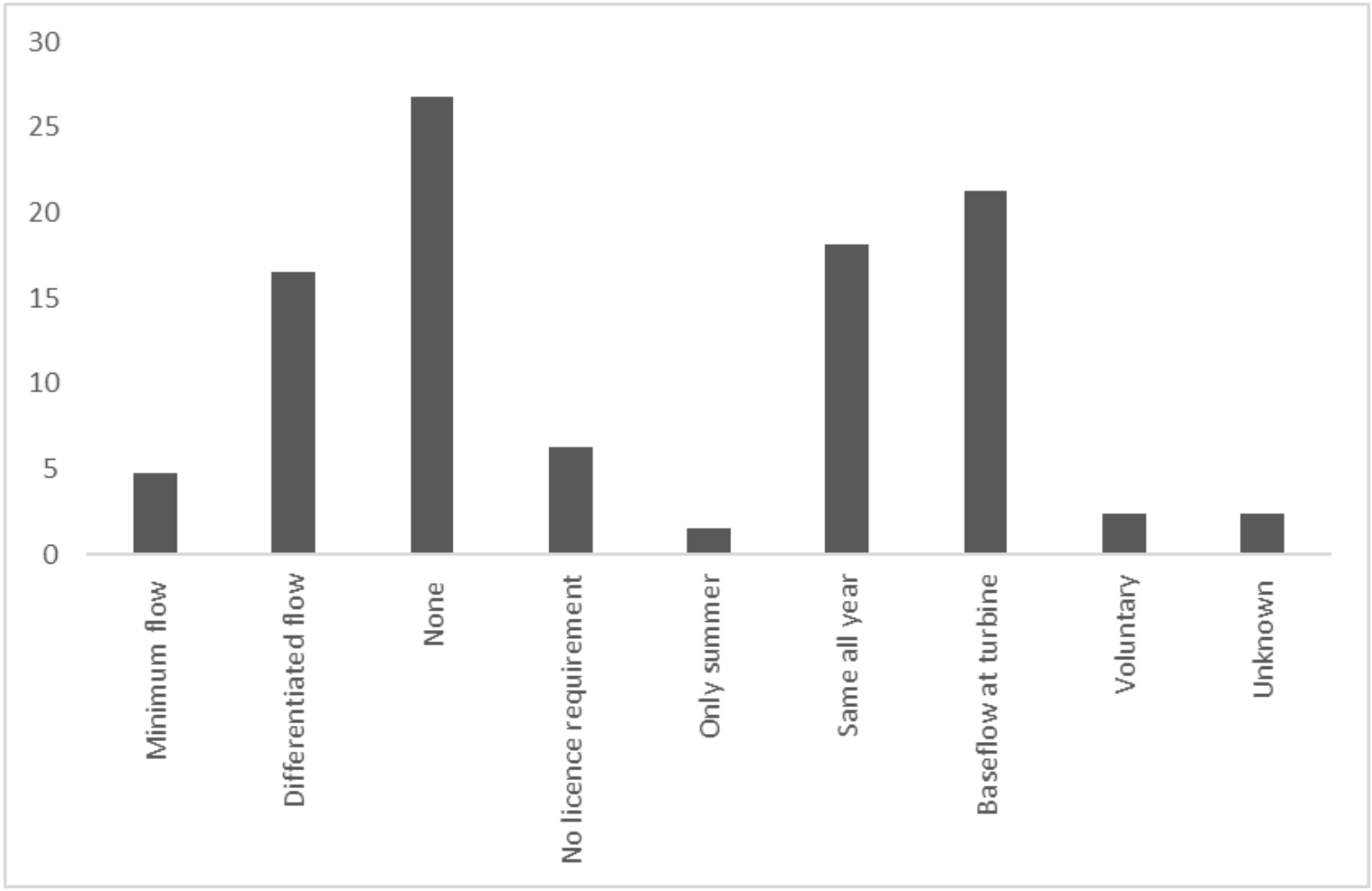
Both cases:
Mean= 0.35 – Class II
Median = 0.31 – Class II
(likely viable but sensitive)
Min= 0.11; Max= 0.92

For HP rivers: is there a difference between presence and absence of environmental flow?



	HP impacted rivers	Rivers with environmental flow
Min	0.11	0.11
Max	0.92	0.92
Average	0.35 (class II)	0.43
Median	0.31	0.35

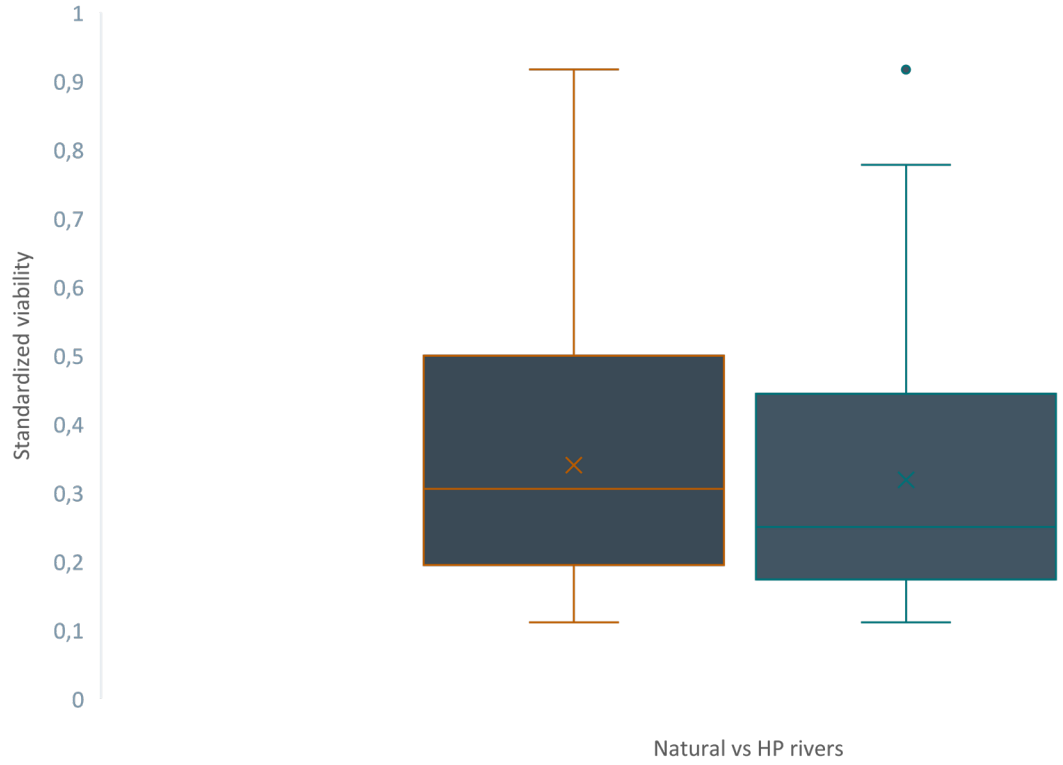
Environmental flows in freshwater pearl mussel rivers



NINA

Next steps in the analysis

- Response of mussel population to different eflow scenarios
- Response of mussel to cumulative impacts.



Example:
Viability as response to diffuse runoff from agriculture in natural vs HP impacted rivers

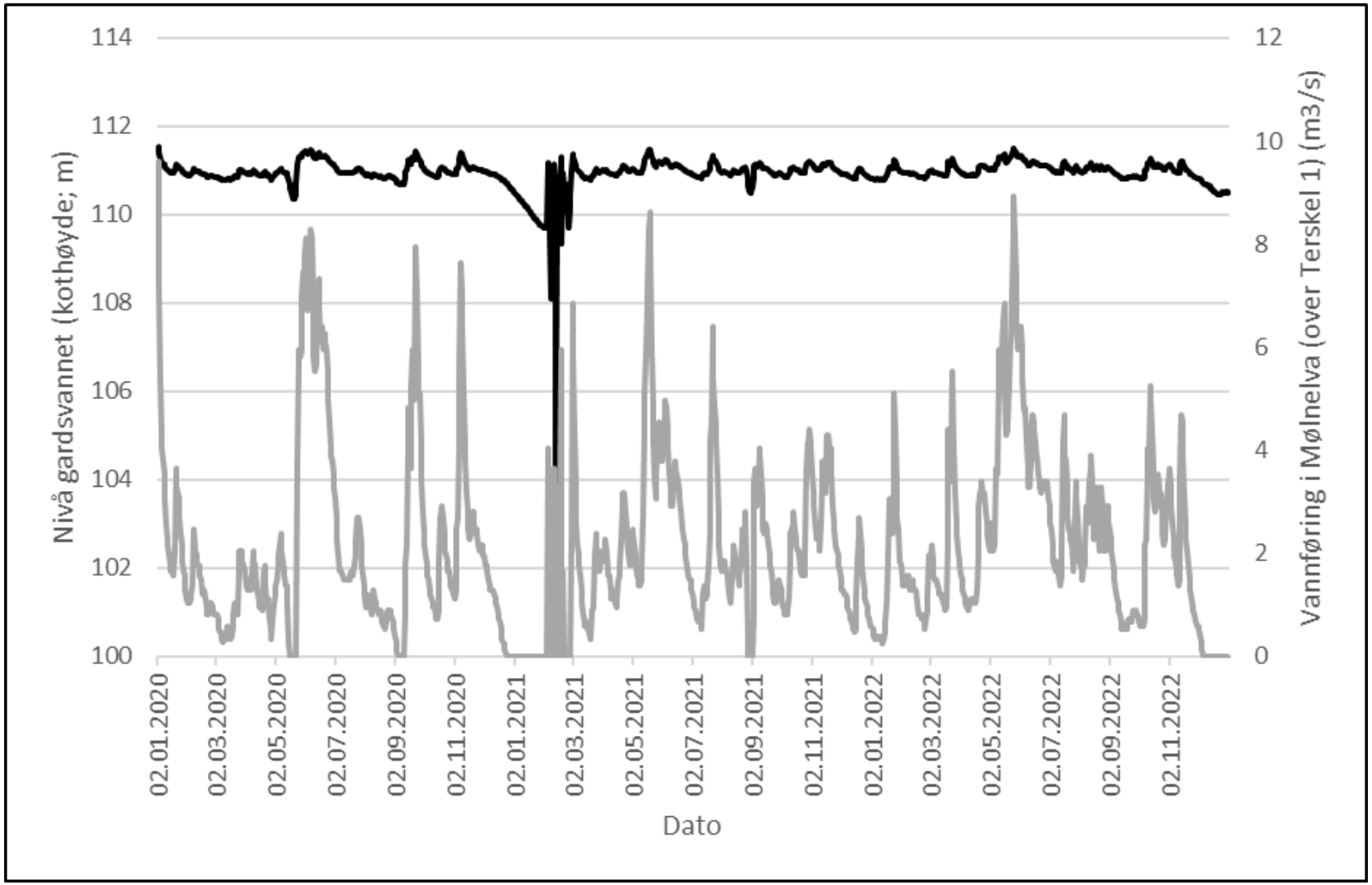
Example of the need for adapted environmental flows: Mølnelva

~ 85 000 mussels (class II)

- Hydropower
- Water abstraction for aquaculture (max 1 m^3/s)
- Minimum flow:
  - 0,260 m^3/s (summer)
  - 0,160 m^3/s (winter)
  - 0,067 m^3/s (can happen)

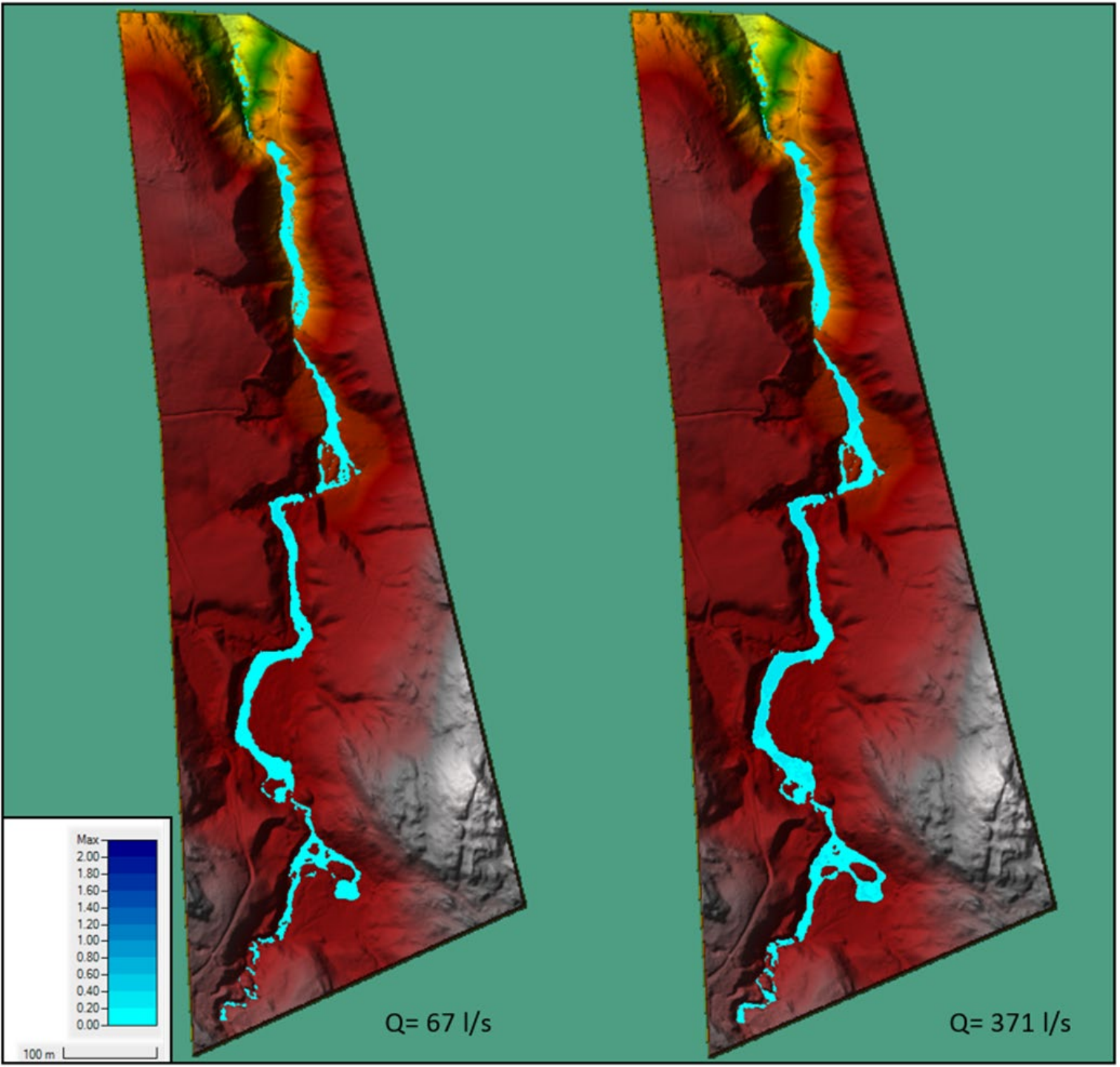
NINA

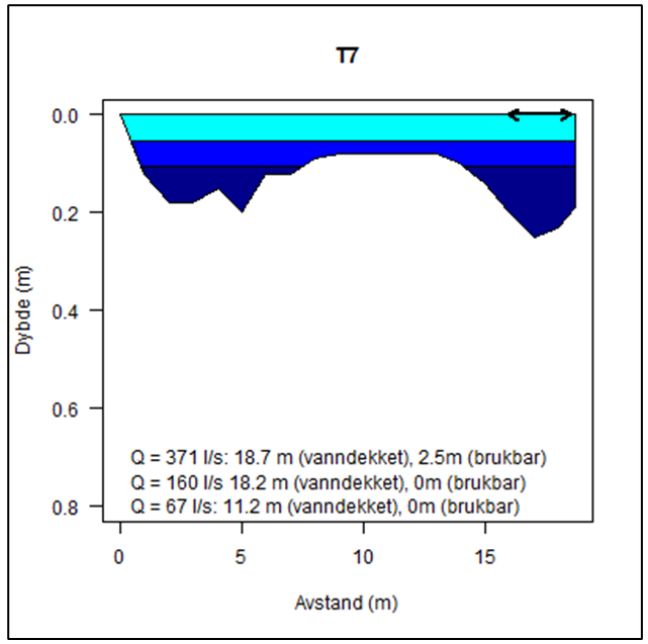
Large discharge variability

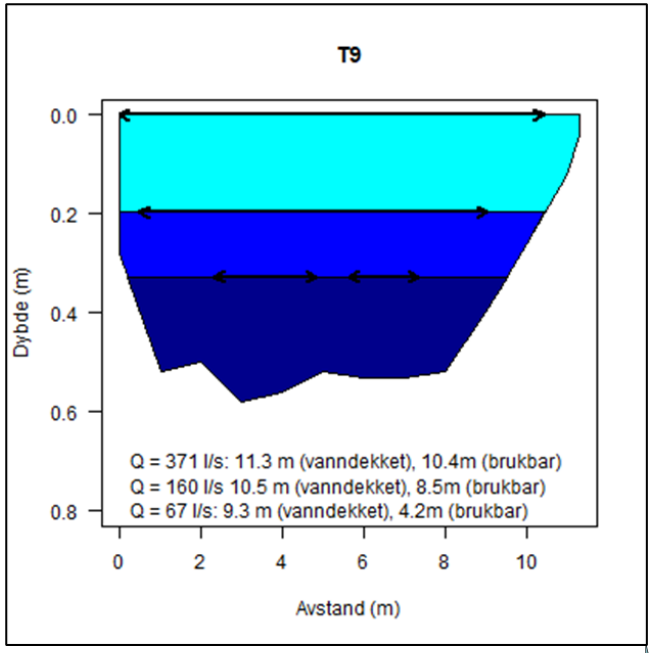



www.nina.no
NINA

Station (mussel density)	Width (m)	Min. depth (m)	Max. depth (m)	Mean depth (m)	Min. velocity (m/s)	Max. velocity (m/s)	Mean velocity (m/s)	N points
M10 (0.18)	12,0	0,14	0,69	0,48	0	0,298	0,087	12
M9 ned	23,2	0,02	0,62	0,25	0	0,328	0,05	24
M9) (5.19)	11,3	0,04	0,58	0,17	0	0,532	0,100	13
M8 (5.87)	18,2	0,02	0,34	0,25	0	0,167	0,084	19
M7 (2.51)	18,7	0,06	0,25	0,14	0	0,557	0,137	17
M6 (7.62)	14,1	0,01	0,40	0,22	0	0,222	0,149	15
M4 (0.34)	11,8	0,04	0,35	0,21	0	0,266	0,153	12
M2 (18.06)	16,0	0,02	0,38	0,24	0	0,275	0,044	17


Max
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
100 m
Q= 67 l/s
Q= 371 l/s


T7
Dybde (m)
0.0
0.2
0.4
0.6
0.8
Q = 371 l/s: 18.7 m (vanndekket), 2.5m (brukbar)
Q = 160 l/s 18.2 m (vanndekket), 0m (brukbar)
Q = 67 l/s: 11.2 m (vanndekket), 0m (brukbar)
0
5
10
15
Avstand (m)


T9
Dybde (m)
0.0
0.2
0.4
0.6
0.8
Q = 371 l/s: 11.3 m (vanndekket), 10.4m (brukbar)
Q = 160 l/s 10.5 m (vanndekket), 8.5m (brukbar)
Q = 67 l/s: 9.3 m (vanndekket), 4.2m (brukbar)
0
2
4
6
8
10
Avstand (m)

NINA

Loss of habitat with minimum flow

Station (mussel number)	% loss for Q= 0.16 m^3/s (from 0.37 m^3/s)	% loss for Q=0.067 m^3/s (from 0.16 m^3/s)	% loss from Q= 0.37 m^3/s to 0.067 m^3/s
M10 (20)	20,5	46,1	57,1
M9 (627)	38,6	48,6	68,4
M9n	18,3	50,6	59,6
M8 (349)	83,8	100	100
M7 (198)	100	-	100
M6 (648)	51.9	92,3	96,2
M4 (29)	47.6	100	100
M2 (1234)	83.8	88,9	98,2

% loss dependent upon habitat type (morphology)

Problem in summer but mostly in winter!

Based on a critical depth for mussels of 20 cm

NINA

Conclusions and thoughts….

- HP impacts freshwater pearl mussel in the same way it affects other biota (adds to cumulative impacts)..

- 'Double trouble' for mussels since they depend on a salmonid (and also migratory) fish BUT just to focus on fish does not necessarily solve the problem

- Environmental flows need to be adapted to mussels and the conditions they experience on the river bed

- Suitable mitigation for mussel means need for more knowledge to determine habitat suitability criteria

- Slow response of mussels to events makes it difficult to assess success of measures. Be patient!!!

… Continued …

- Freshwater pearl mussel =canari in the mine!
- Holistic, catchment-wide approach is key: HP +other impacts
- Hydromorphological mitigation: remember regulated rivers function differently from natural rivers
- Focus on the most sensitive taxa, not the ones that bring the most revenue or are the most «popular»


Thank you!
Marie-Pierre.Gosselin@nina.no