Early warning through video monitoring

Dissolved hydrogen sulphide (H_2S) affects Atlantic salmon swimming behavior in recirculating aquaculture systems

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Recirculating Aquaculture Systems (RAS)

https://commons.wikimedia.org/wiki/File:Switch_from_a_Regular_fish_farm_to_RAS.jpg
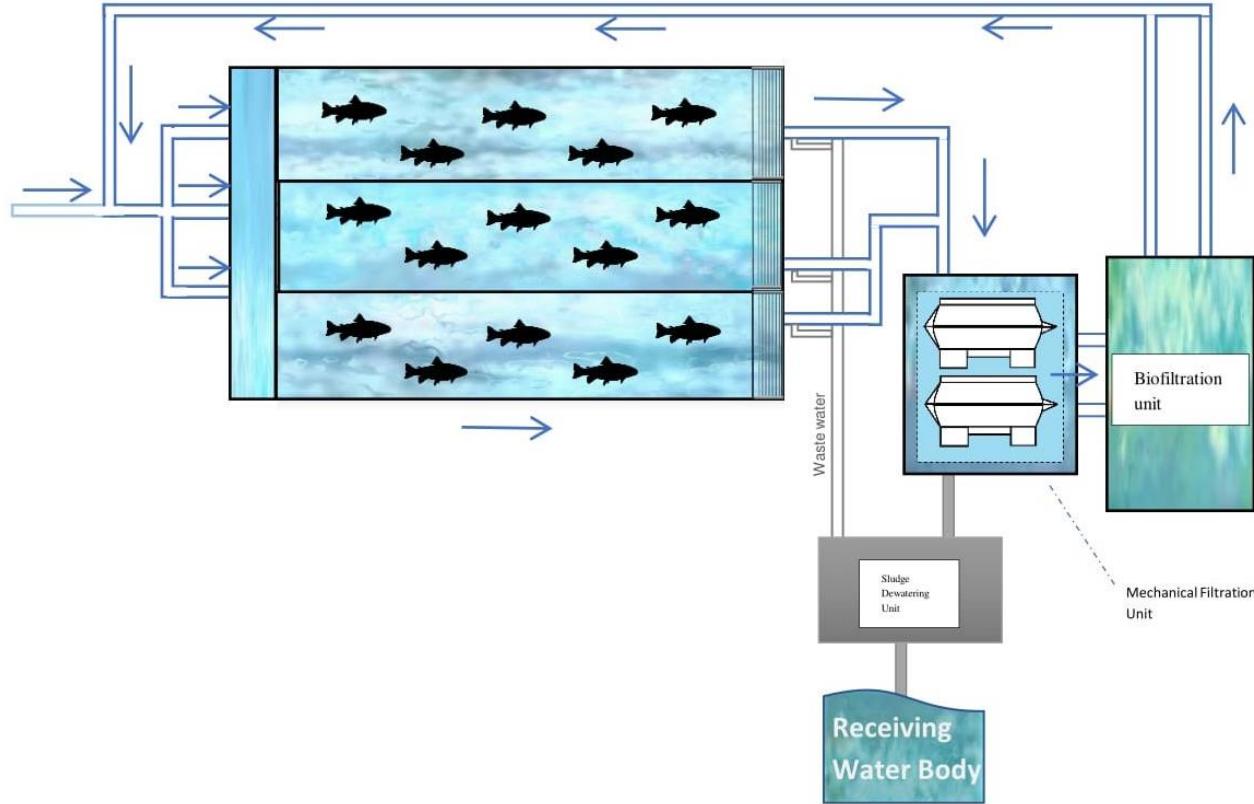
- **Suboptimal filtration** might lead to proliferation of **sulfate-reducing** bacteria

- **Hydrogen sulfide** (H_2S) causes acute **mass mortalities**

- There is a **need** for **early warning** tools

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- Does **swimming behaviour** changes in response to H_2S?

- Can we **quantify** it?

- Can **video monitoring** be a reliable **early warning** tool?

Experimental design

Control

Treatment

Biofilter

Water reservoir

Biofilter

CTR

70 fish
10 Kg/m^3

H$_2$S

TR-1

70 fish
10 Kg/m^3

TR-2

200 fish
30 Kg/m^3
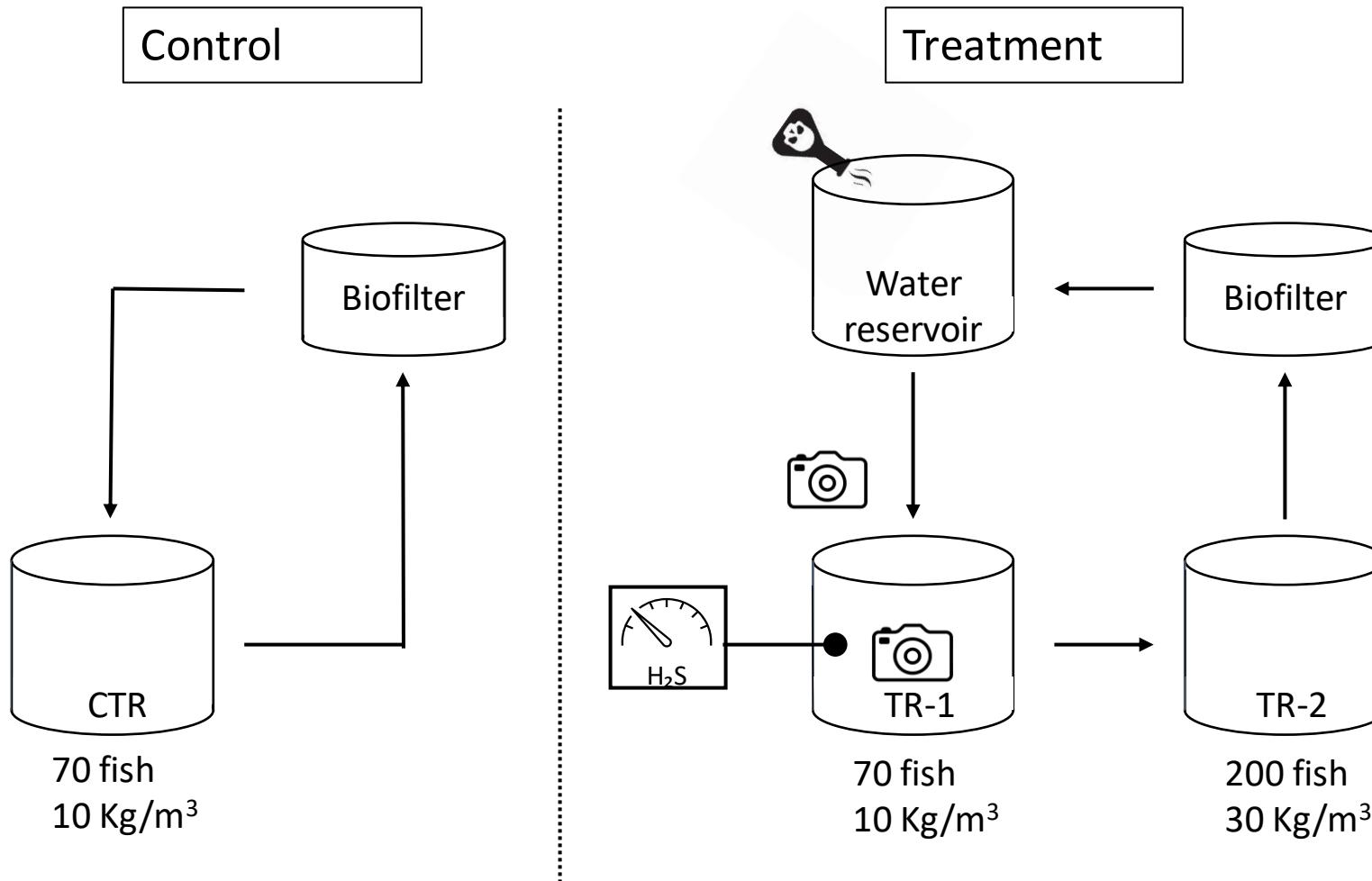
Treatment:
H$_2$S exposure

- Daily exposures
- Increasing concentrations
  (0-70 µg/L)
- Duration 10-180 min

# Video recording system

1 overhead camera (2D)   2 submerged cameras (stereo, 3D)
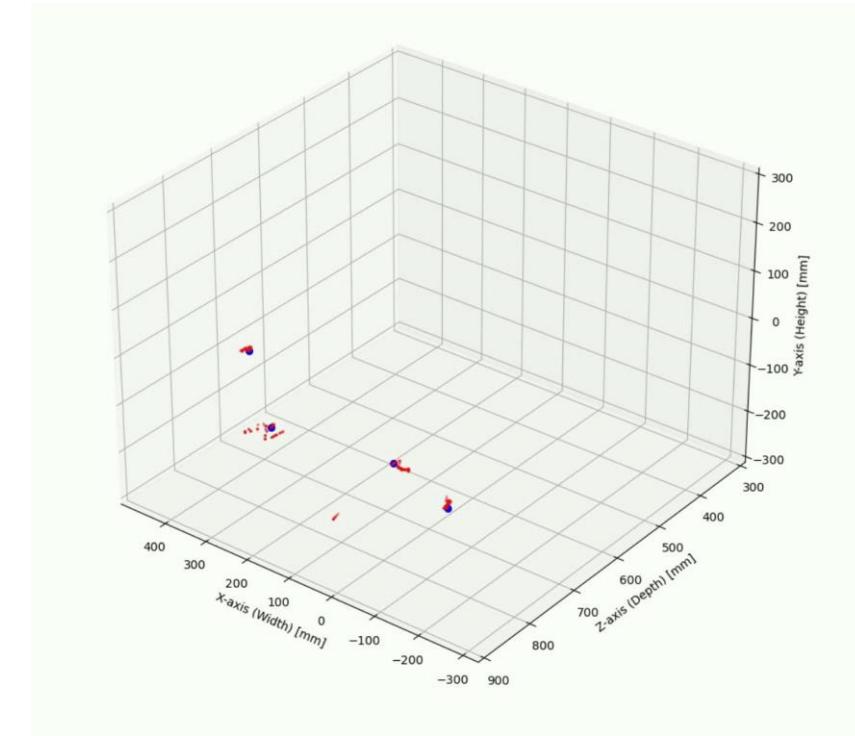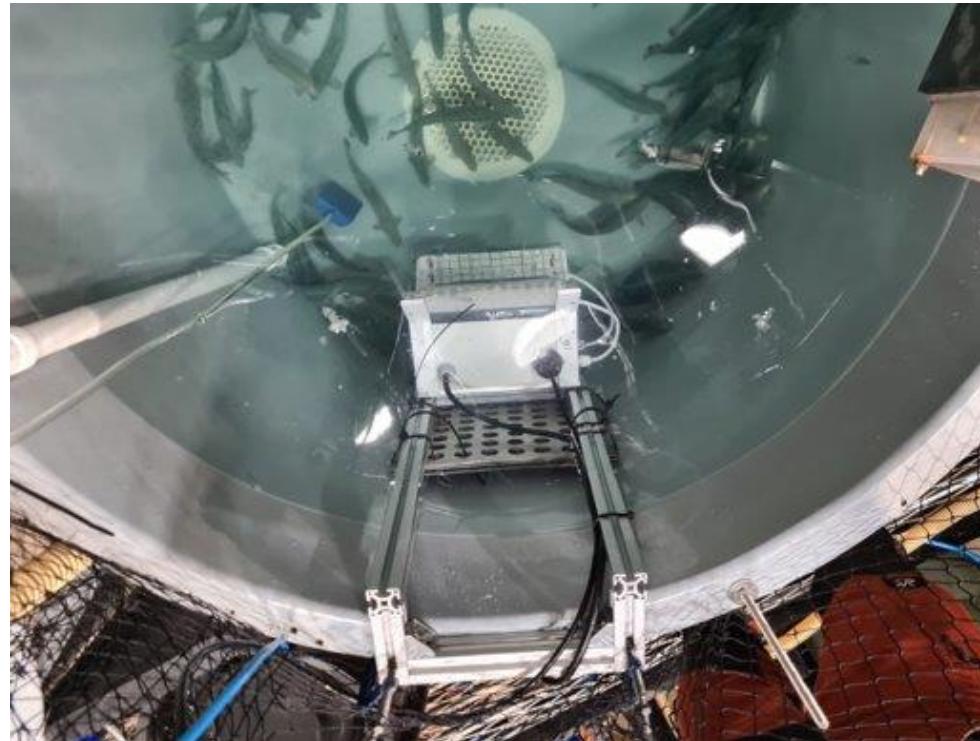
Speed   Pattern   Dispersion
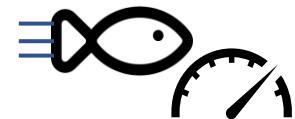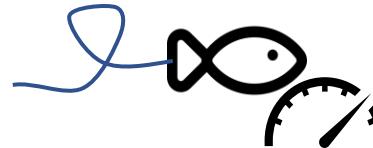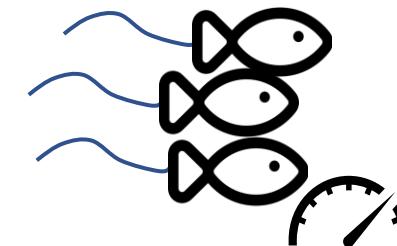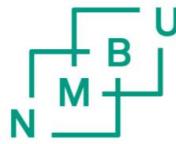
Normal behavior
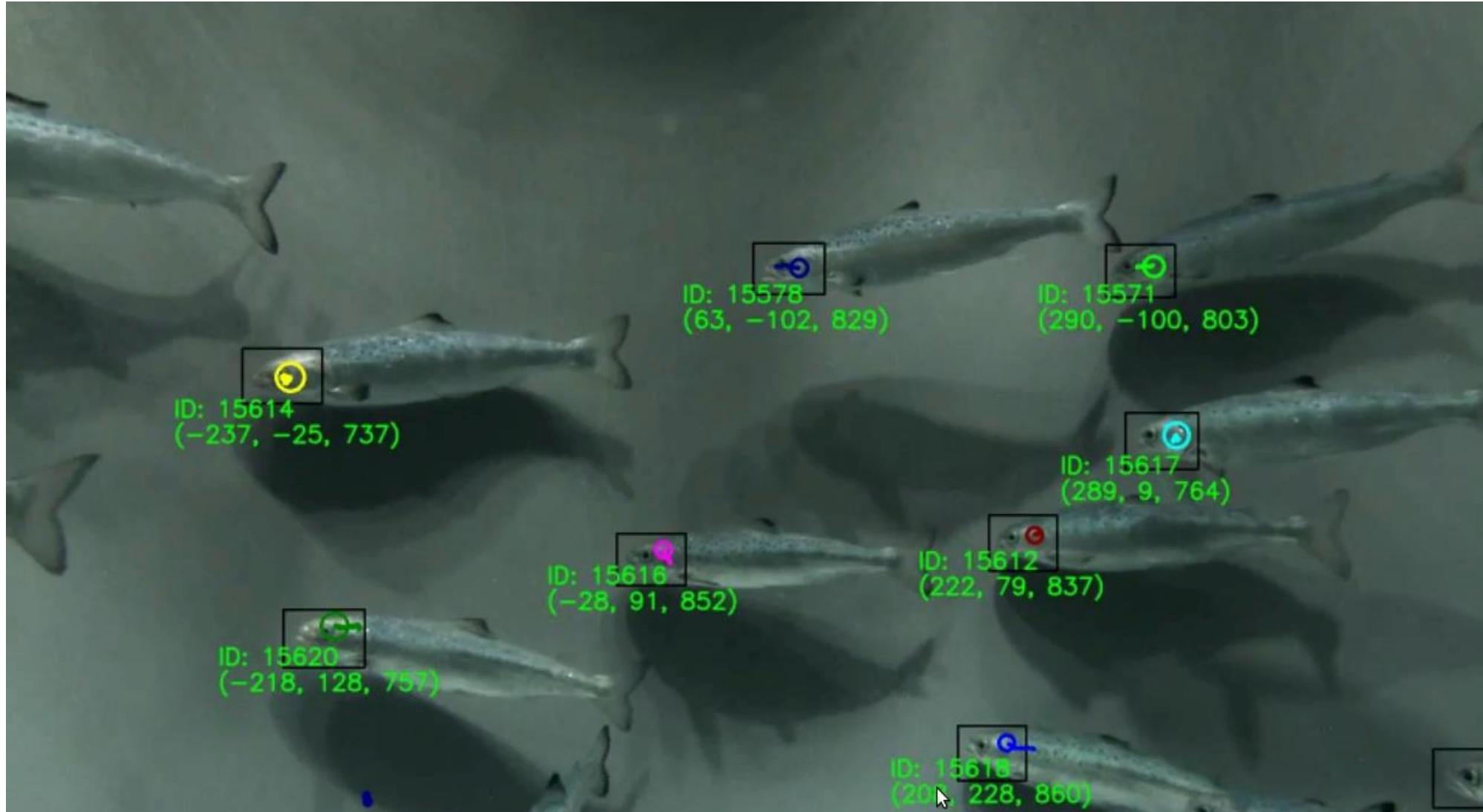
Behavior under H$_2$S exposure

Behavioral response

| Speed | Pattern | Dispersion |

[a]   [b]   [c]
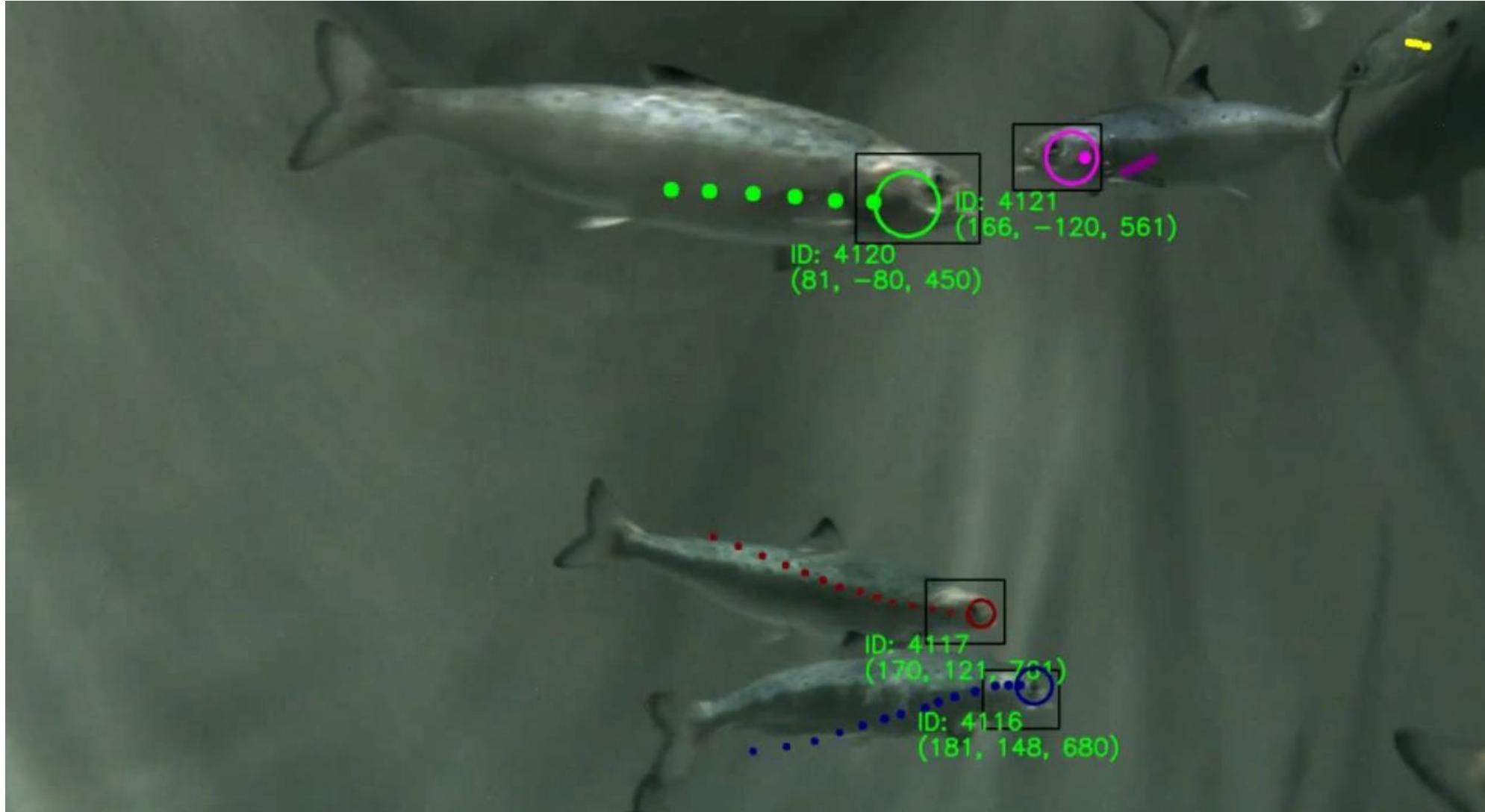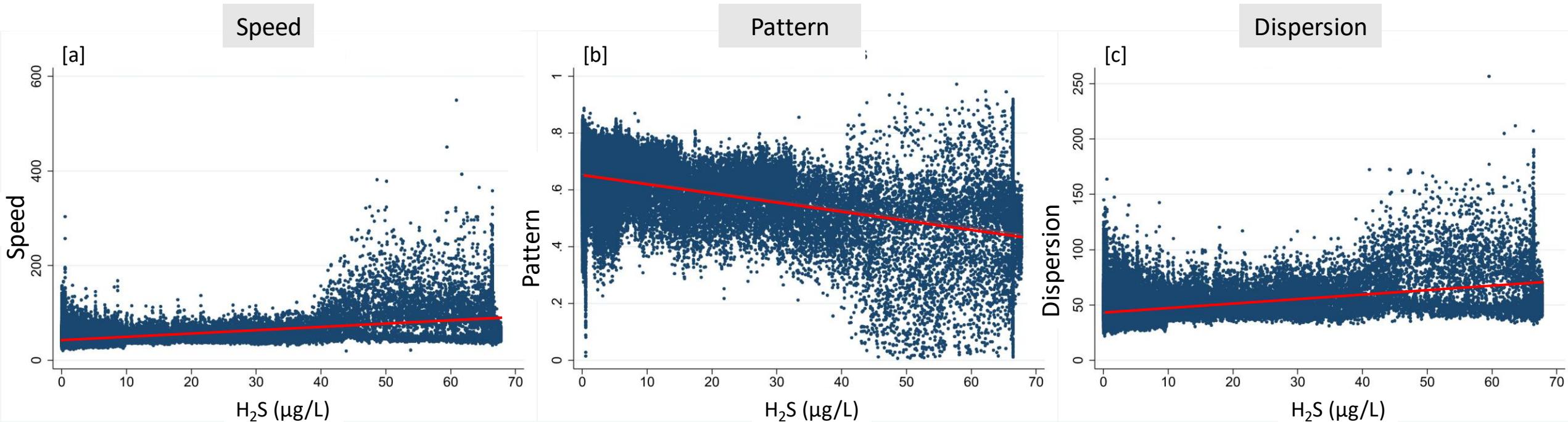
Linear regression

Speed [inversely transformed (-1/X)]				
	Coeff	p	r²	n
H₂S	0.000240	< 0.001	0.19	170'355
H₂S # H₂S	-0.000001	< 0.001		

Beta regression

Pattern			
	Coeff	p	n
H₂S	-0.008617	< 0.001	170'355
H₂S # H₂S	-0.000087	< 0.001	

Linear regression

Dispersion [inversely transformed (-1/X)]				
	Coeff	p	r²	n
H₂S	0.000214	< 0.001	0.13	169'224
H₂S # H₂S	-0.000001	< 0.001		

Behavioral response
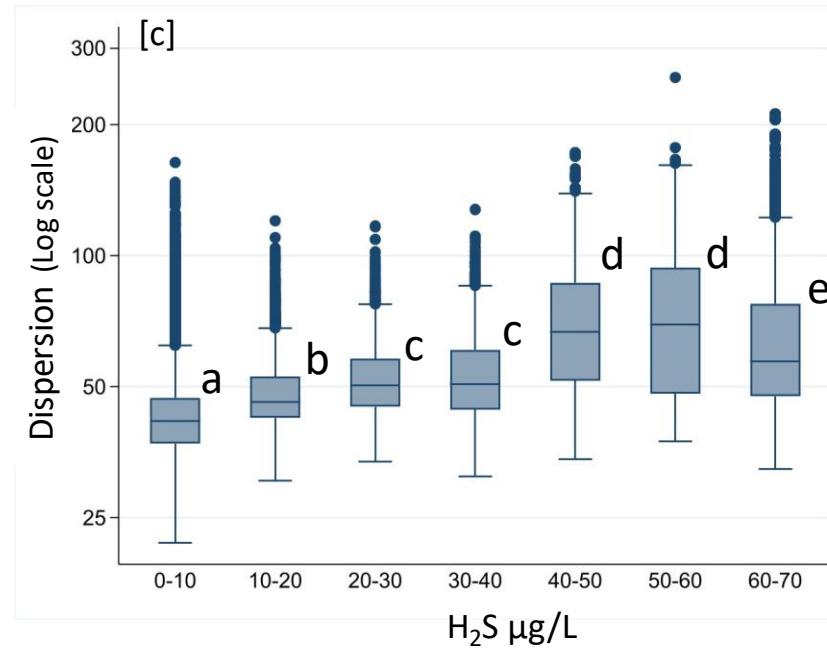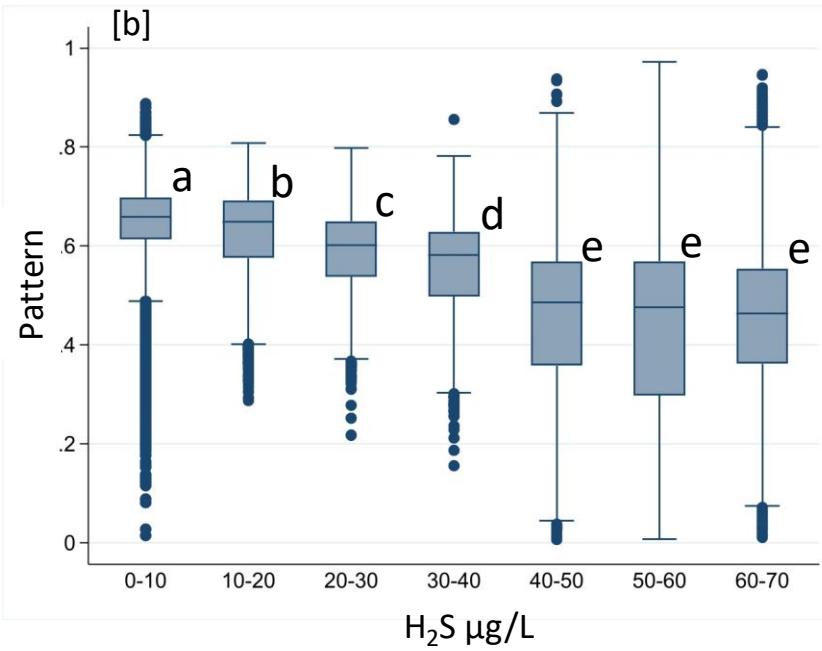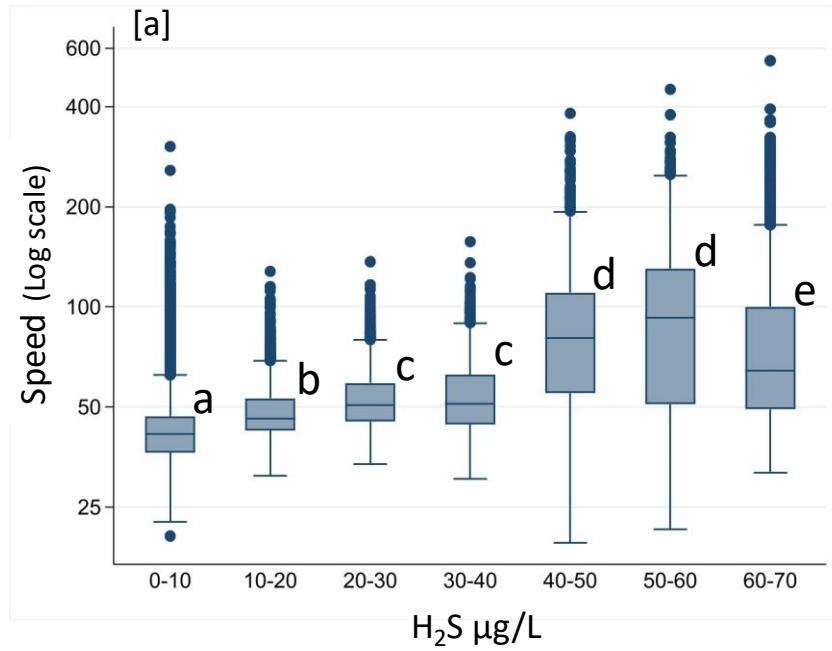
Speed				
H$_2$S (µg/L)	Mean	SD	Change	n
0-10	42.68	9.48	-	150312
10-20	49.12	9.84	+15.1%	5868
20-30	53.35	11.40	+8.6%	3603
30-40	54.70	13.82	+2.5%	3341
40-50	90.28	44.70	+65.1%	1745
50-60	100.73	53.55	+11.6%	1689
60-70	81.51	45.90	-19.1%	3797

Pattern				
H$_2$S (µg/L)	Mean	SD	Change	n
0-10	0.6515	0.07	-	150312
10-20	0.627	0.09	-3.7%	5868
20-30	0.589	0.08	-6.1%	3603
30-40	0.559	0.09	-5.1%	3341
40-50	0.458	0.17	-18.2%	1745
50-60	0.436	0.19	-4.6%	1689
60-70	0.460	0.16	+5.5%	3797

| Dispersion				
H$_2$S (µg/L)	Mean	SD	Change	n
0-10	43.05	9.04	-	150289
10-20	48.83	9.48	+13.4%	5868
20-30	52.73	10.78	+8.0%	3603
30-40	53.69	12.62	+1.8%	3341
40-50	71.43	24.30	+33.0%	1514
50-60	74.55	29.42	+4.4%	1317
60-70	65.27	24.34	-12.4%	3292

- **Critical H$_2$S** concentration is Atlantic salmon is estimated at **≈60 ug/L***

  Video monitoring can **detect** changes in swimming behaviour at **lower H$_2$S** concentrations

* Bergstedt et al., 2023

Stress response - water cortisol
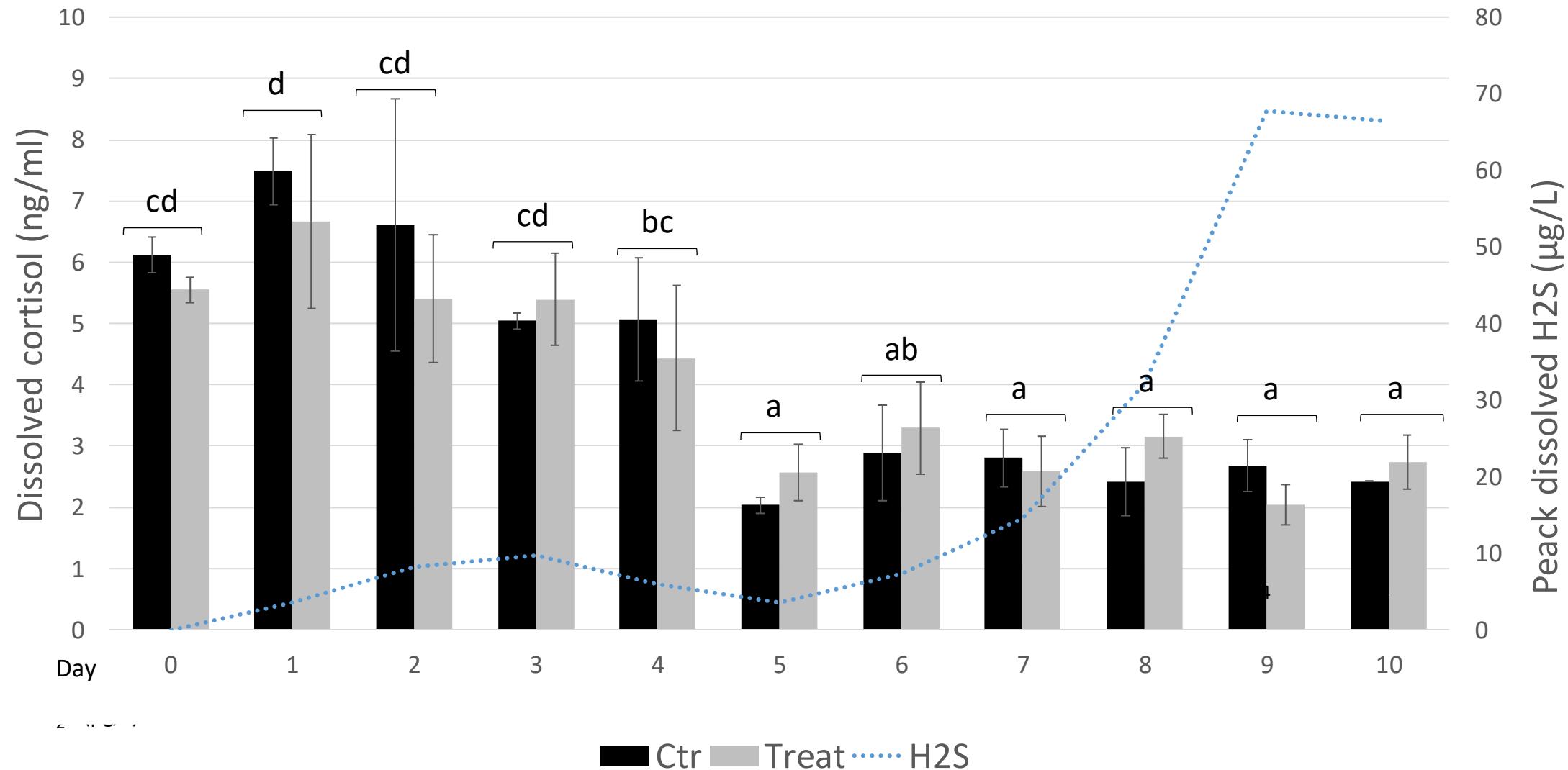
Conclusions

Dissolved **H2S induces** a response in swimming behaviour characterized from

i) higher speed
ii) erratic pattern
iii) loss of schooling behaviour

Early warning
- Changes in swimming behaviour occur before critical H_2S threshold
- More sensitive than water cortisol

Acknowledgements
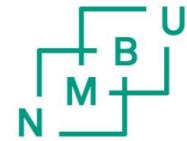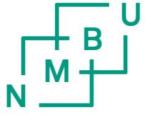
Thank you for the attention

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