



Hvilke CO₂ nivå kan anbefales i oppdrett av laks i RAS?

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CtrlAQUA



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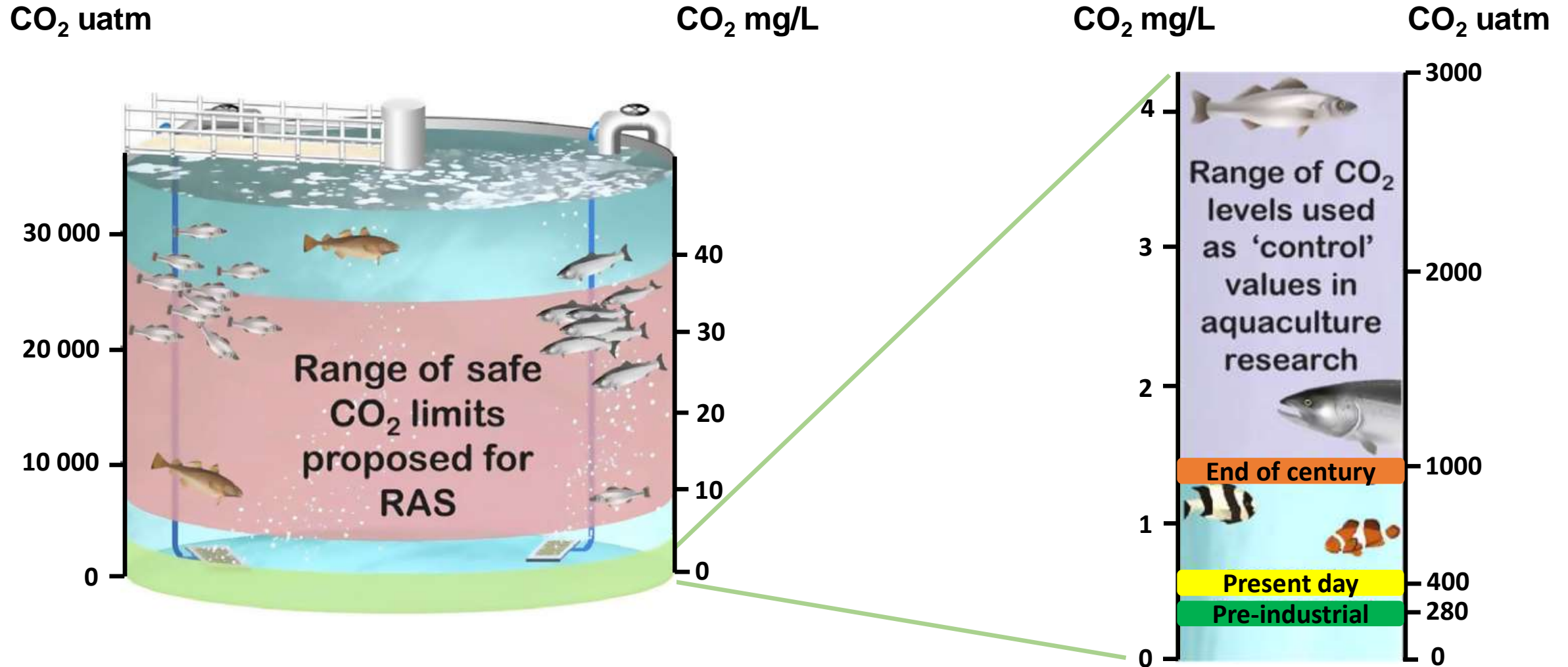
Stor takk til alle brukerpartnere og forskere som har bidratt



Oversikt

- Hva mener vi med høye CO₂ nivå
- Effekter av forhøyet CO₂ hos post-smolt i RAS
- Kan vi fastslå klare grenseverdier?

Hva mener vi med høye CO₂ nivå - 2 virkeligheter



□ 10 -40 mg/L tilsvarer ca. 17 - 70 ganger atmosfærisk nivå av CO₂

High CO₂ levels - physiological responses

Dissolved CO₂ accumulates in RAS

Fish exposed to high CO₂ shows:

- Lower: Feed intake, growth and oxygen consumption
- Higher: Nephrocalcinosis (deposits in kidneys) & cataracts
- Impaired ion regulation and acid-base disturbances

“Safe” levels for Atlantic salmon:

< 15 - 20 mg/L

Is tolerance for CO₂ in brackish RAS different?



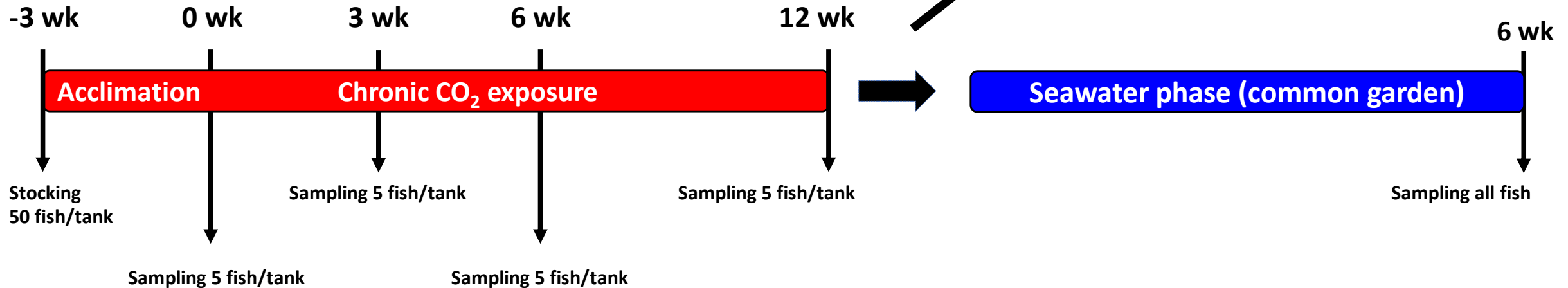
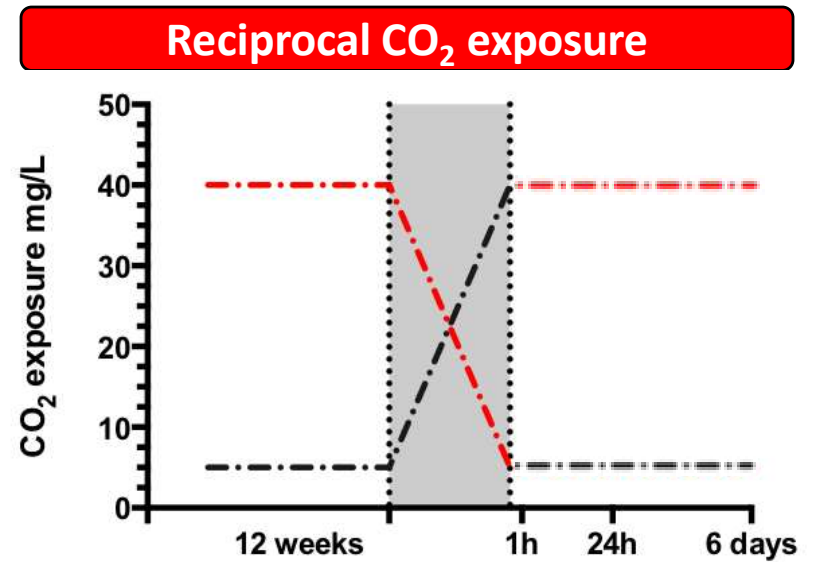
Photos: NOFIMA

Experimental design

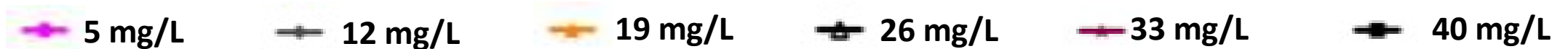
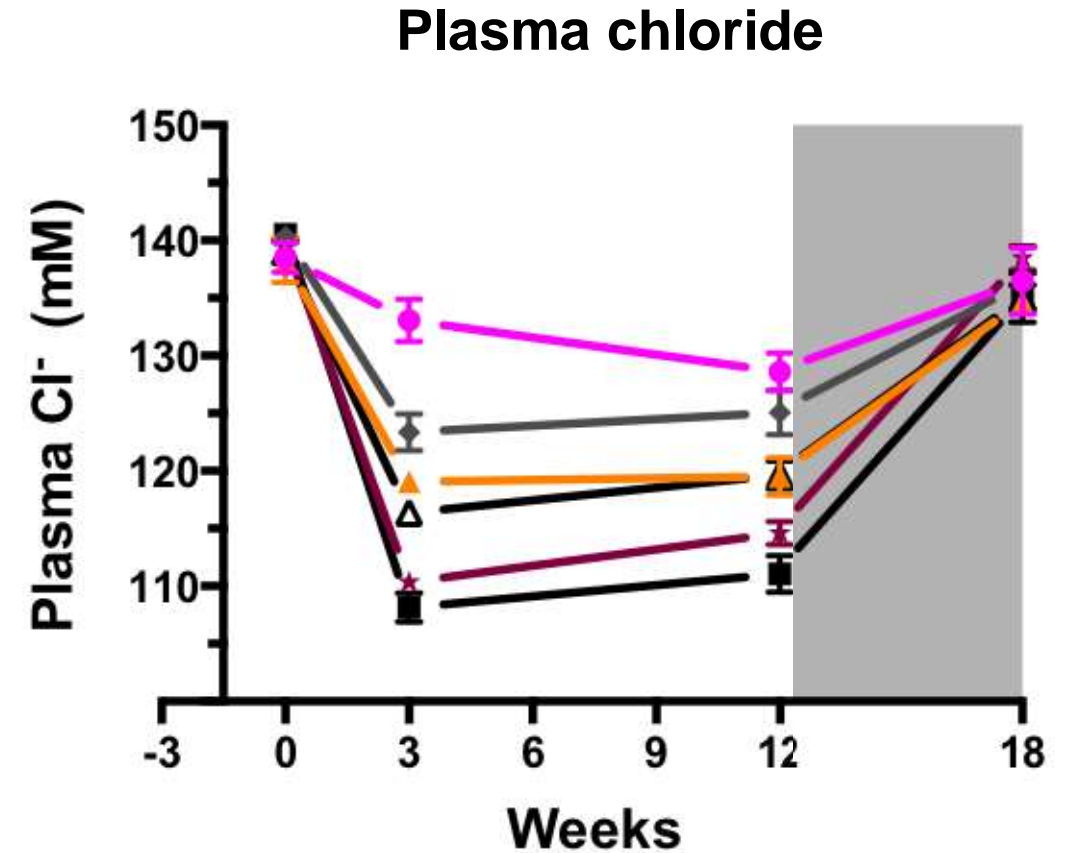
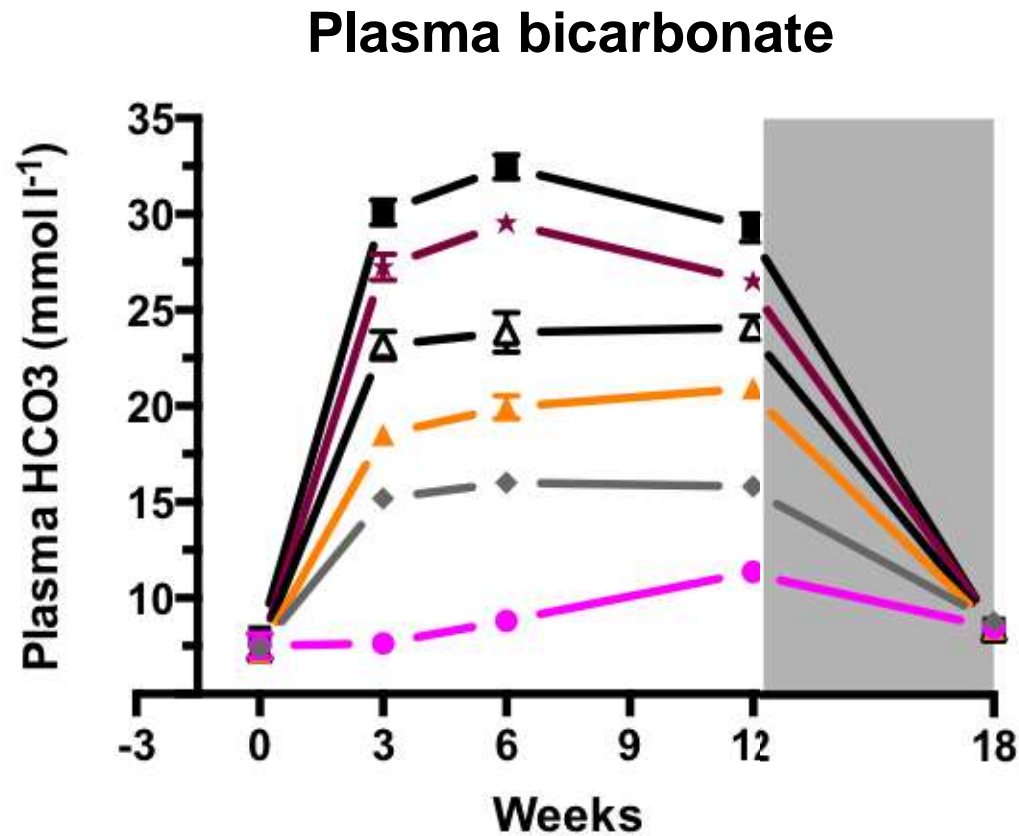
CO ₂ exposure	
mg/L	μatm
5	2500
12	6000
19	9000
26	13000
33	16000
40	20000

Water quality:

- Oxygen >85 %
- Salinity 12 ppt
- Temperature 12-13°C
- pH 6.7 – 7.7
- Alkalinity 116 – 165 mg/L



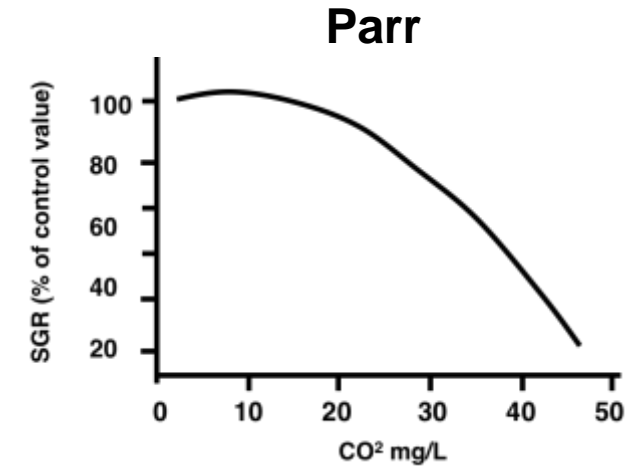
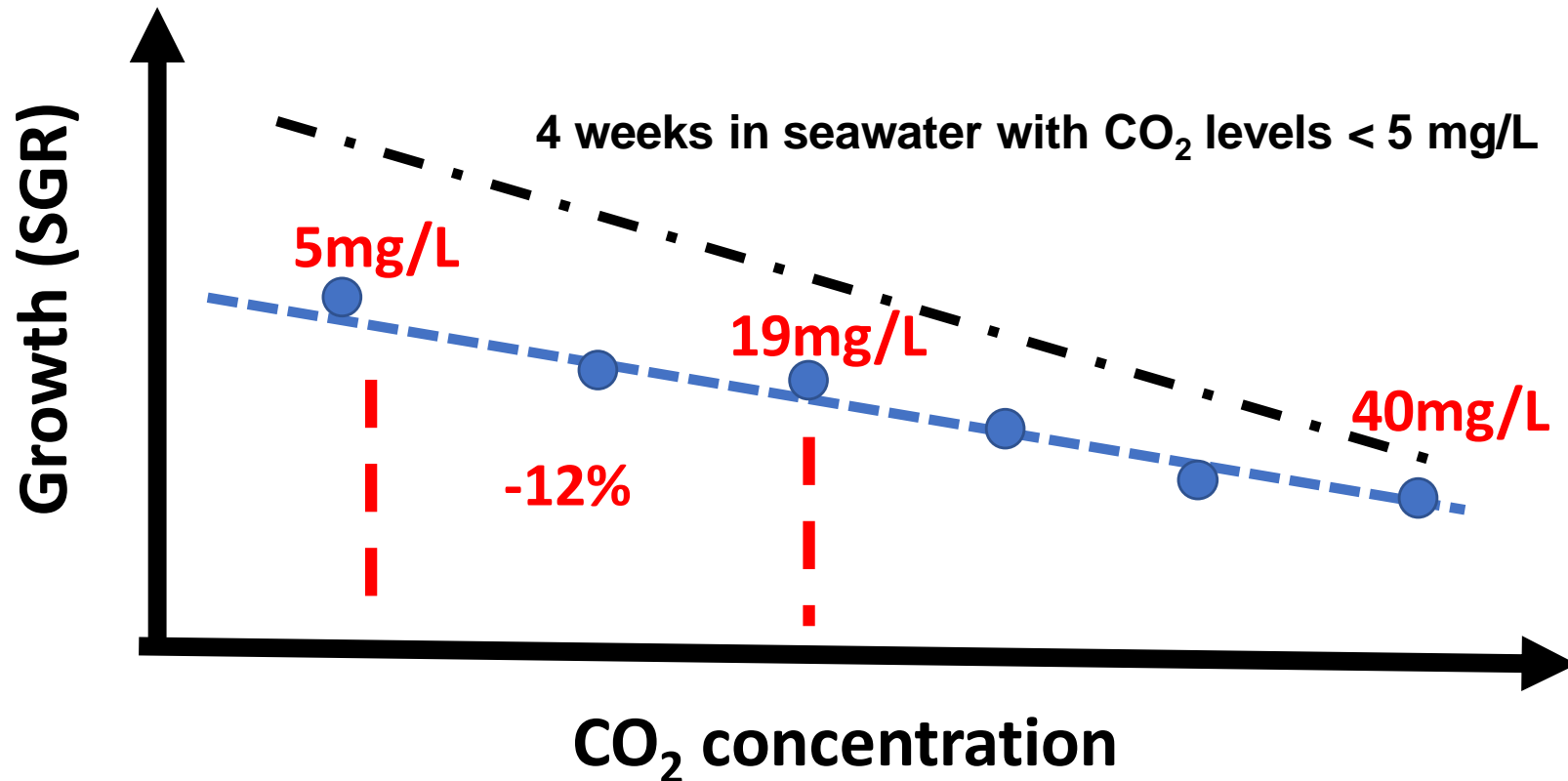
Physiological responses - long term



Negative effects of elevated pCO₂ on fish growth

10% growth reduction for every 10 mg/L increase in pCO₂

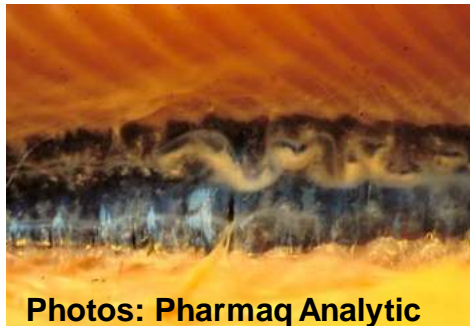
Negative growth effects of elevated pCO₂ in RAS persisted following transfer to seawater



Health & welfare

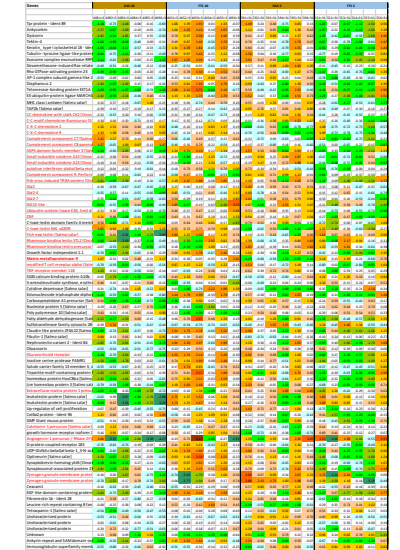
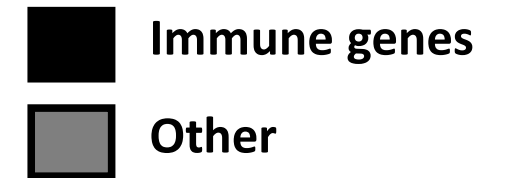
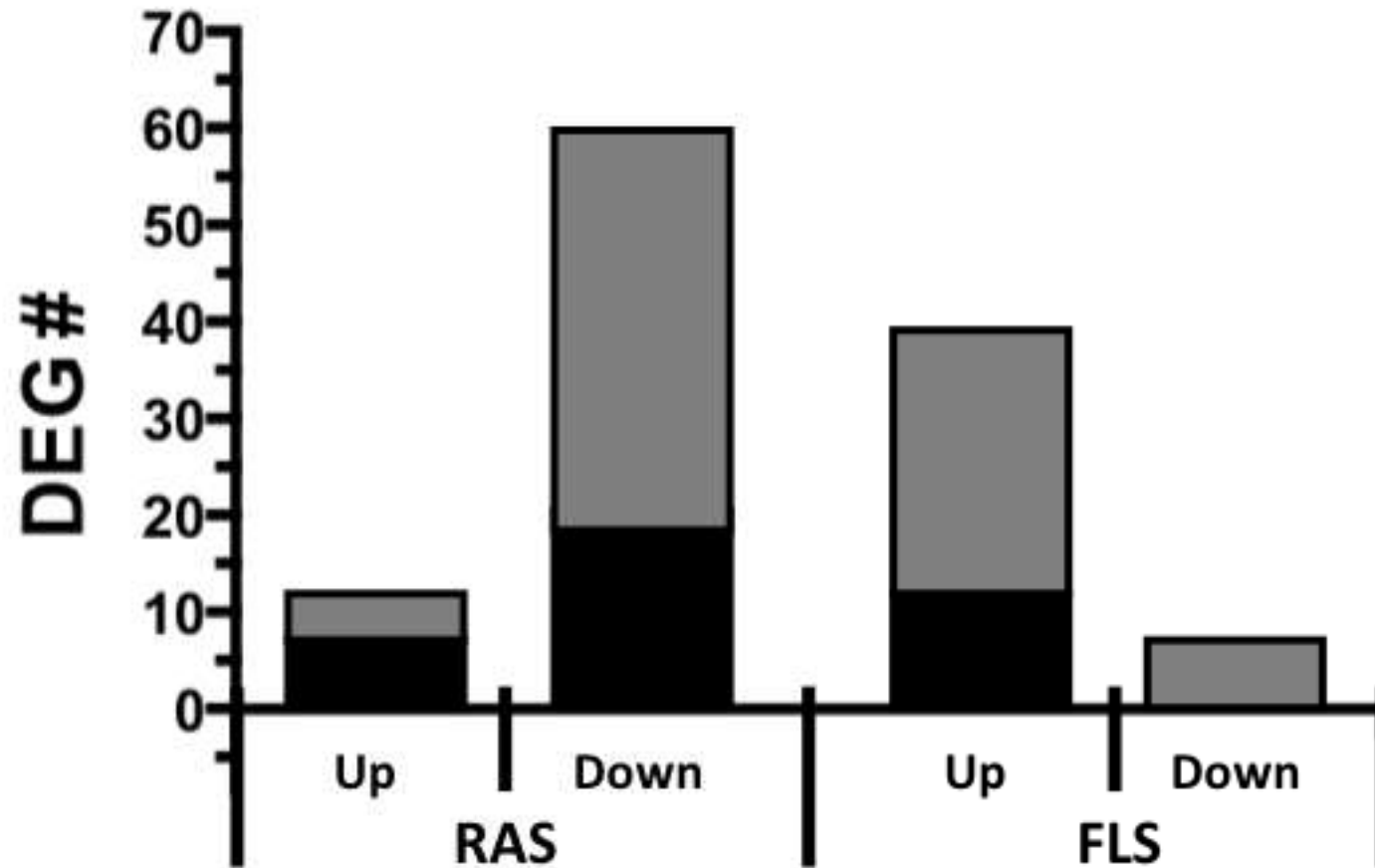
No observed effects on:

- hematocrit
- cortisol and glucose
- eye cataracts
- welfare score (skin & fins)
- nephrocalcinosis



Health & welfare

Gill: 40 mg/L and 5 mg/L treatments
Low DEG / gene suppression in RAS

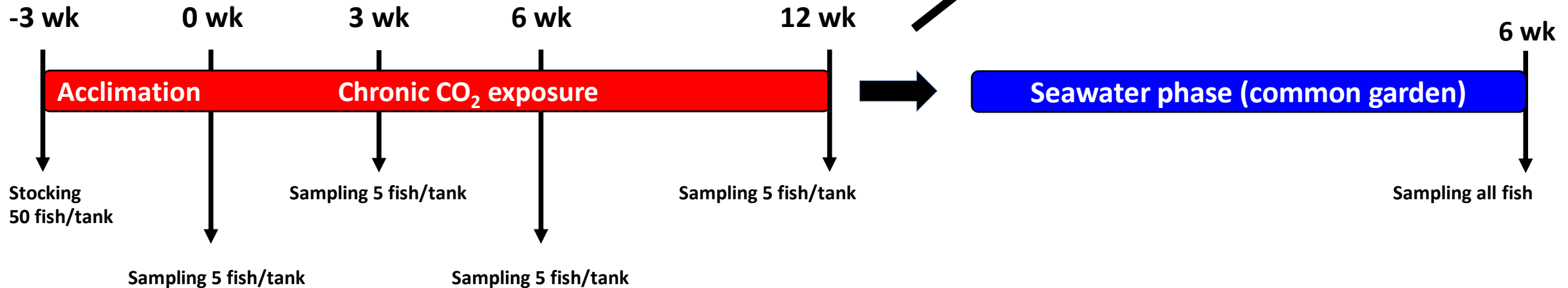
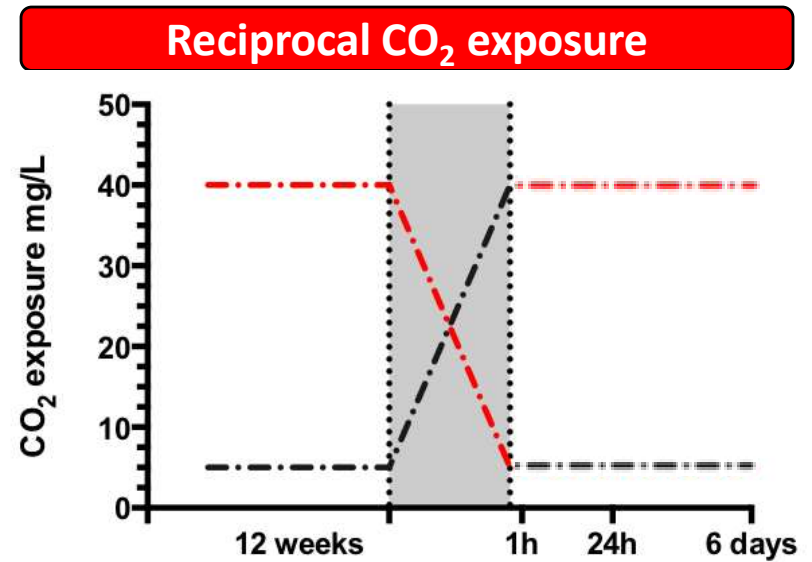


Experimental design

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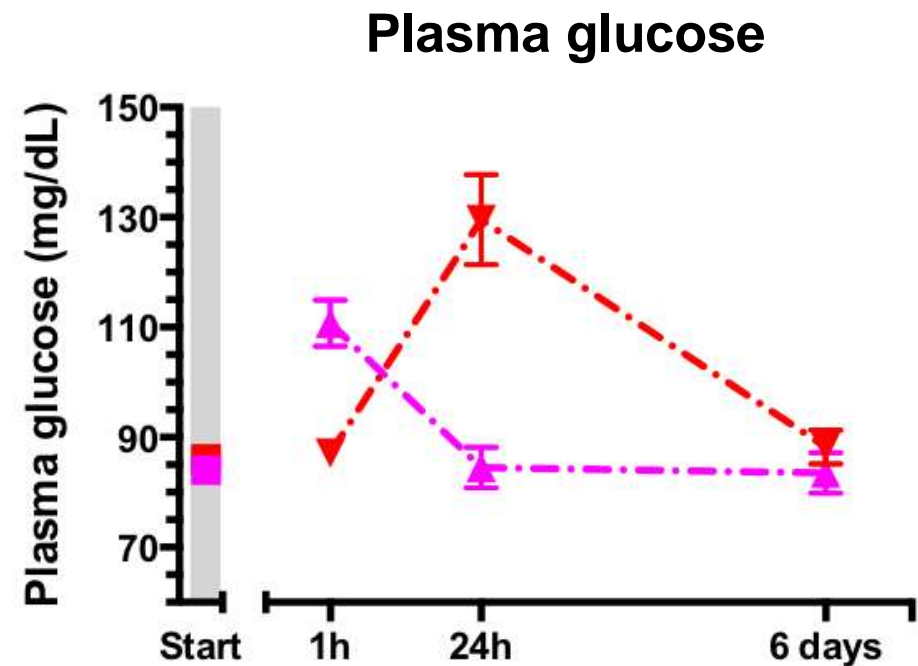
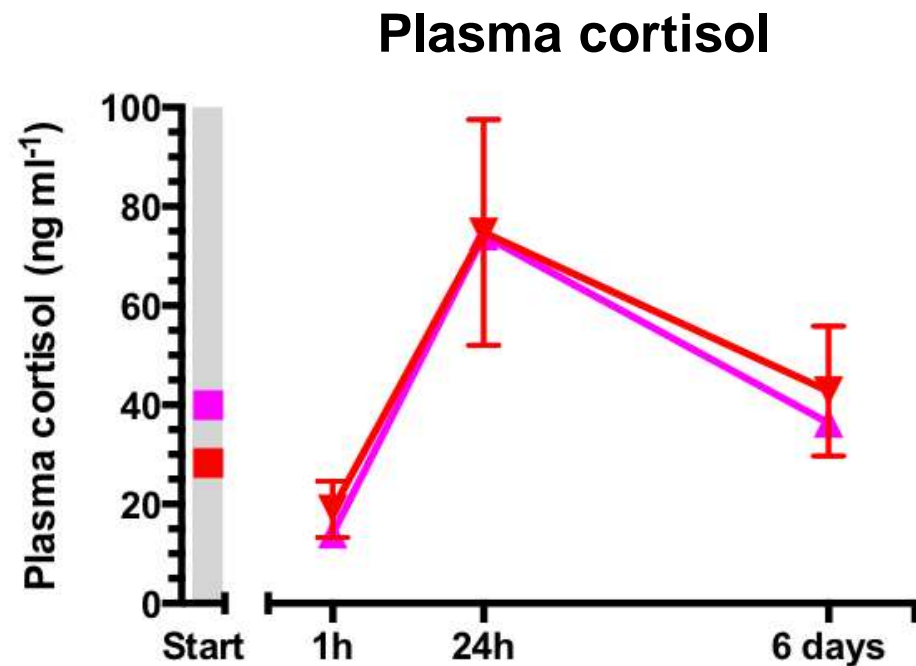
- Oxygen >85 %
- Salinity 12 ppt
- Temperature 12-13°C
- pH 6.7 – 7.7
- Alkalinity 116 – 165 mg/L



Post-smolts rapidly acclimate to large changes in pCO₂

Rapid changes in pCO₂ elicits clear transient stress responses measured as plasma cortisol and glucose.

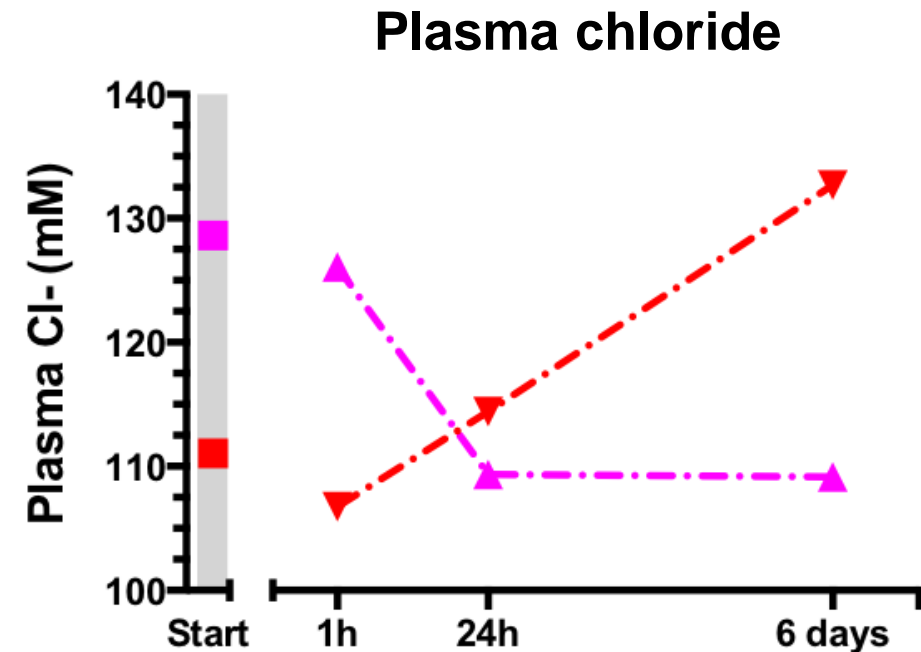
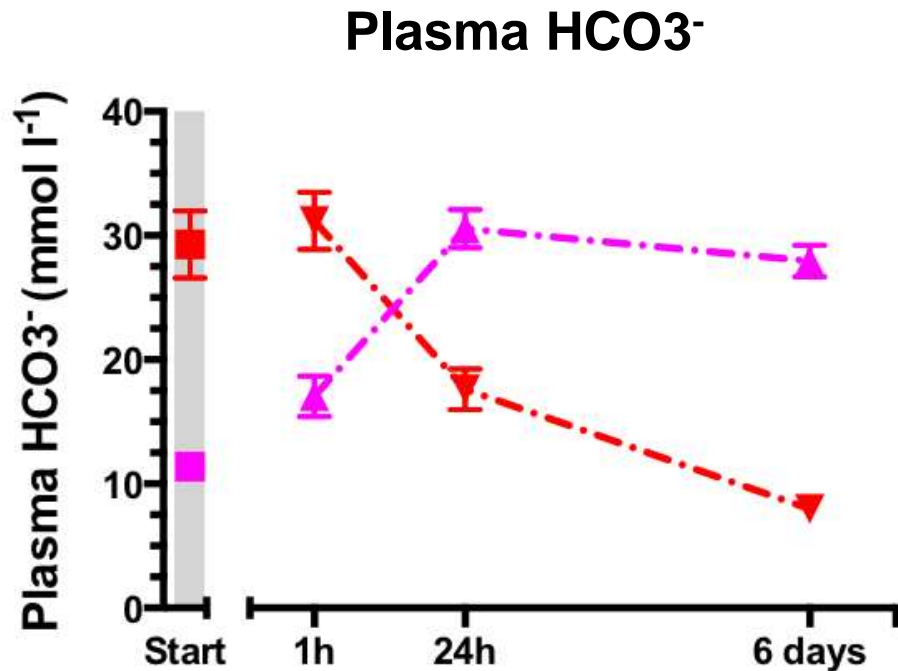
■ 5 mg/l ■ 40 mg/l ▲ 5 to 40 mg/l ▼ 40 to 5 mg/l



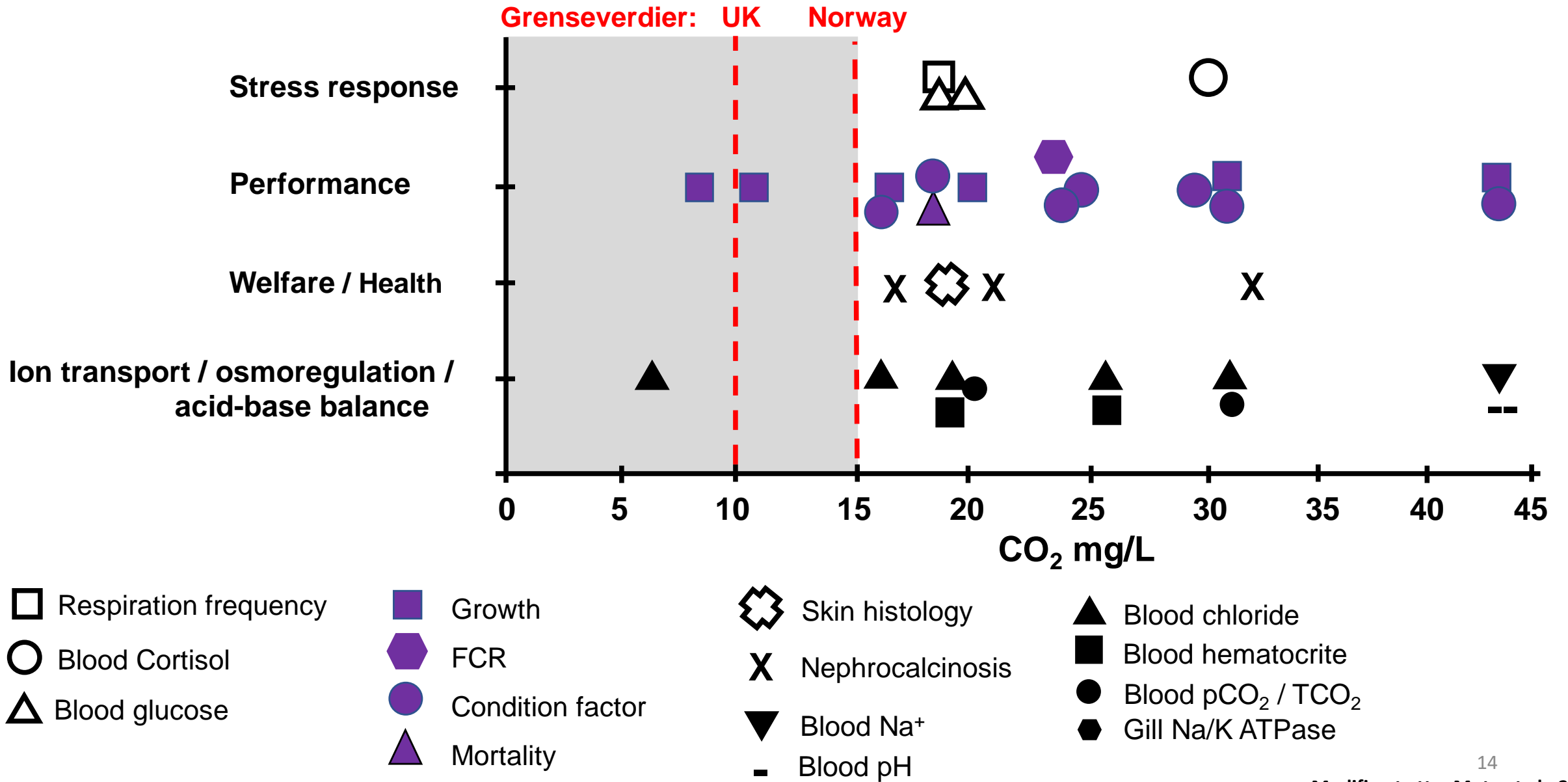
Post-smolts rapidly acclimate to large changes in pCO₂

Rapid changes in pCO₂ elicits clear transient compensatory responses measured as plasma HCO₃⁻ and chloride.

■ 5 mg/l ■ 40 mg/l ▲ 5 to 40 mg/l ▼ 40 to 5 mg/l



Summary main effects, parr, smolt, post-smolts



Takk for oppmerksomheten

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