

Effects of Particles from Road Tunnels Construction on Post-Smolts Atlantic Salmon

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Statens vegvesen

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WHAT IS THE PROBLEM?

1 Particles disposal



In Norway, **bedrocks** from road tunneling may be disposed in **fjords** nearby, which can be used as a **migration corridor for salmon**, and/or host salmon farms.

Effects on salmonids

We need to know if and how the **salmons are affected by the particles disposed**, so that better strategies for particles disposal management can be adopted.

2

METHODOLOGY

EXPOSURE SYSTEM

- Particles < 100µm, from Åseral bedrock
- Pumps to keep particles in suspension
- 900 L seawater (Sal. 33), duplicates
- Daily dosing of particles
- Renewal every 7 days
- Test duration: 21d exposure + 7d depuration

- **Genotoxicity**
- **Physiological endpoints**
- **Biochemical endpoints**
- **Chemicals**

- **Osmoregulation**
- **Histology**
- **Neurotoxicity**
- **Histology**

- Smolts (130 ± 14 g)
- Sampling days 0, 7, 14, 21, 28, n=8
- Ethics on animal use

- 4, 40, 400 mg TSS/L nominal
- ~ 4, 12 and 110 mg TSS/L measured
- Naturally eroded particles control (NEP; 400 mg/L nominal, 19 mg/L measured)
- Daily dosing renewal

- **TSS, turbidity**
- **pH, DO, sal, temp**
- **Particle size distribution**
- **Analysis of chemicals**

RESULTS

Keeping the **levels of TSS** in solution is very challenging (Table 1)

Treatment	7 days solution	Fresh solution
CTR	3.5 ± 1.9	3.5 ± 1.6
NEP (400)	12 ± 2.8	25.2 ± 3.6
Åseral 4 (C1)	4 ± 2.4	3.8 ± 1.1
Åseral 40 (C2)	8.7 ± 4	15 ± 2.6
Åseral 400 (C3)	59.3 ± 17.5	158.4 ± 28.4

Table 1. TSS concentration (mg TSS/L ± SD) in the experimental media after 7 days exposure, and 1 hour after medium renewal (fresh)

At the **highest particle concentration** (C3, measured 110 mg/L), **fish did not increase in weight**. But recovery was quick, as they grew during the depuration period (Figure 1)

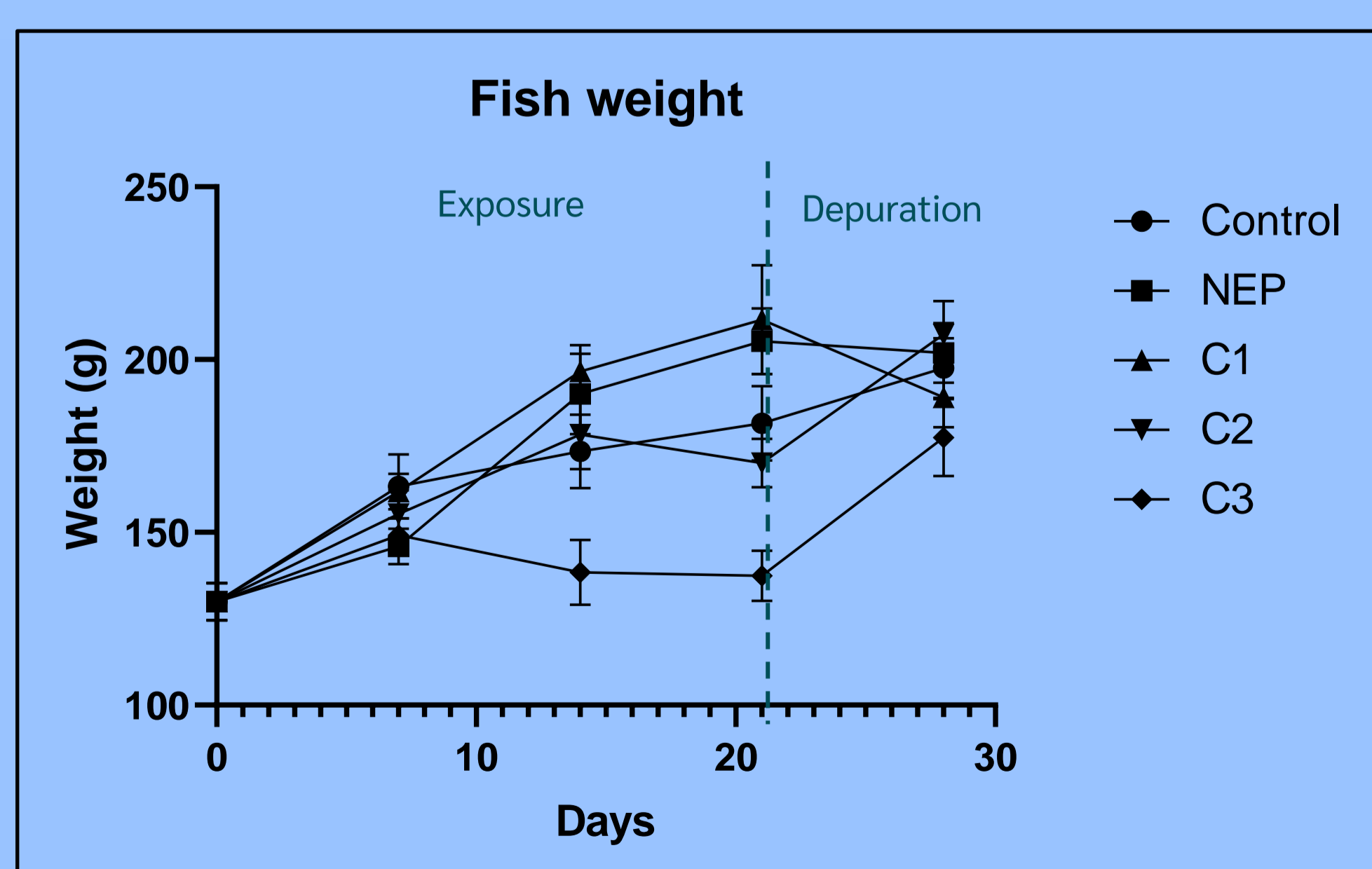


Figure 1. Effects of particles on fish growth (mean ± SD; n=8) during the exposure (21 days) and depuration (7 days) phases.

On Day 21 (**last exposure day**), a series of **morphological and fitness impairments were observed in fish exposed to C3**. They include deformities in the caudal fin (Figure 2), big gallbladder, empty intestine and white faeces, and erratic swimming.

Histological analysis showed that **gills were not affected** by the particles at the end of exposure (D21), despite effects on growth and fitness.

Biomarker analyses is ongoing to elucidate the modes of action of particles (and/or associated chemicals) that could have led to the effects on growth, morphology and behaviour.



Figure 2. Morphological aspect of a healthy fish (A), and the caudal fin morphology of smolts exposed for 21 days to 110 mg TSS/L (B) and after recovery in clean seawater for 7 days (C).

HIGHLIGHTS

- Long-term exposure important, as the effects were noticed from D14;
- Adverse effects seen only at the highest concentration (nominal 400 TSS mg/L, measured ~ 110 mg/L);
- Particles from tunnel construction seem to be more toxic than natural particles;
- Smolts seem to have good capacity for recovery after disposal of particles is ceased.

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