

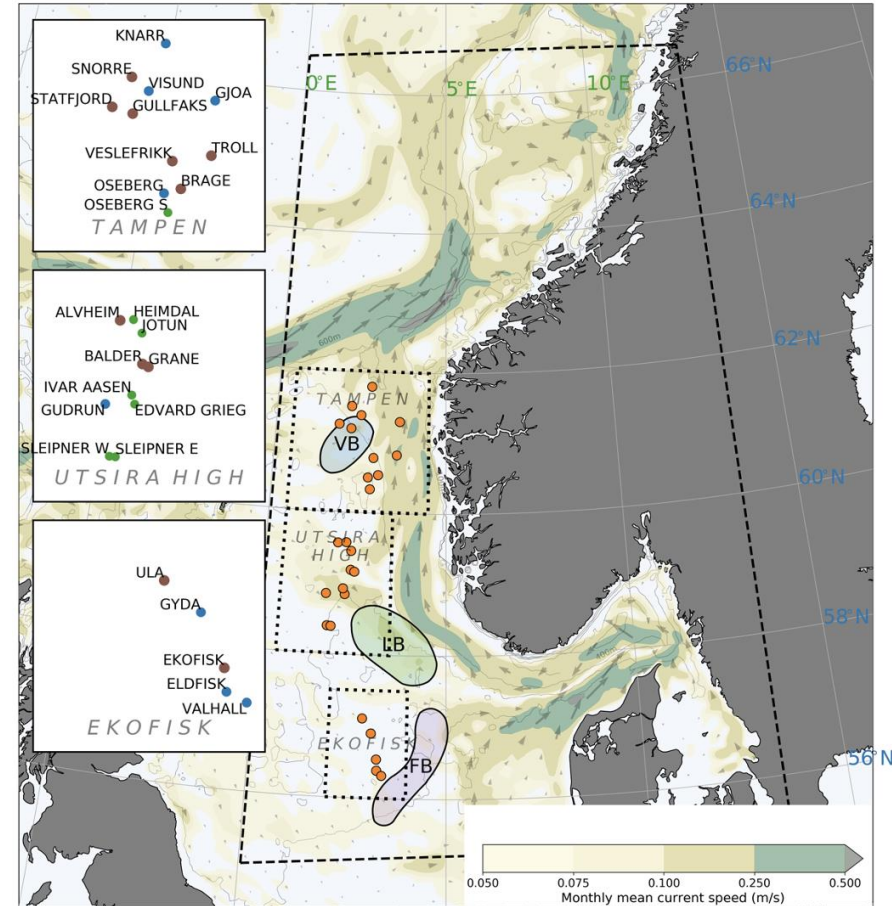


ZOOPLANKTON-BASED MONITORING EKOFISK 2021

Bjørn Henrik Hansen (SINTEF Ocean), Dag Altin (BioTrix), Marvin Choquet (NORD University), Bjørn Einar Grøsvik (HI), Lisbet Sørensen (SO) & Raymond Nepstad (SO)

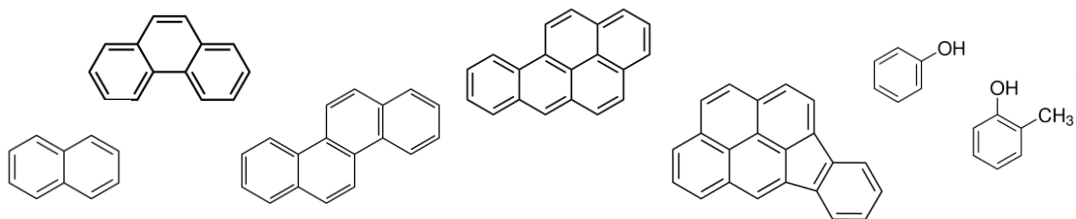
Main aim

- Assess the potential for produced water (PW) discharges to bioaccumulate in pelagic copepods in the Ekofisk region
- Provide data from the field to compare with PW discharge simulations using DREAM-MER
- This was assessed by sampling copepods near the Ekofisk platform and analyzing samples for PAHs and alkyl-phenols



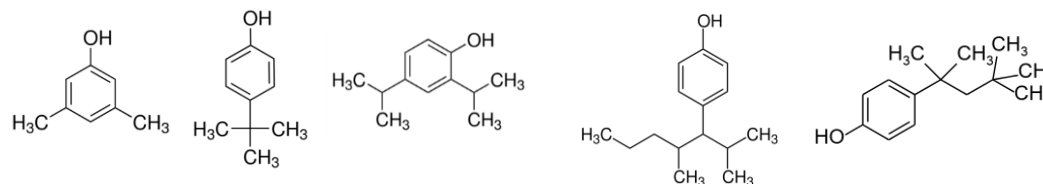
POLYCYCLIC AROMATIC HYDROCARBONS (44)

- Benzothiophene
- C₀-C₄-naphthalenes
- Biphenyl
- Acenaphthylene
- Acenaphthene
- Dibenzofuran
- C₀-C₃-fluorene
- Anthracene
- C₀-C₄-phenanthrene
- C₀-C₄-dibenzothiophenes
- Fluoranthene
- C₀-C₃-fluoranthenes/pyrenes
- Benz(a)anthracene
- C₀-C₃-chrysene
- Benzo(b)fluoranthene
- Benzo(k)fluoranthene
- Benzo(e)pyrene
- Benzo(a)pyrene
- Perylene
- Indeno(1,2,3-cd)pyrene
- Dibenz(ah)anthracene
- Benzo(ghi)perylene



ALKYLATED PHENOLS (31)

- Phenol
- 2-methylphenol
- 4-methylphenol
- 4-ethylphenol
- 2,4-dimethylphenol
- 3,5-dimethylphenol
- 4-N-propylphenol
- 2,4,6-trimethylphenol
- 2,3,5-trimethylphenol
- 4-N-nutylphenol
- 4-tert-butylphenol
- 4-isopropyl-3-methylphenol
- 2-tert-butyl-4-methylphenol
- 4-N-pentylphenol
- 4-tert-butyl-2-methylphenol
- 4-N-hexylphenol
- 2,5-diisopropylphenol
- 2,6-diisopropylphenol
- 2-tert-butyl-4-ethylphenol
- 6-tert-butyl-2,4-dimethylphenol
- 4-N-heptylphenol
- 2,6-dimethyl-4-(1,1-dimethylpropyl)phenol
- 4-(1-ethyl-1-methylpropyl)-2-methylphenol
- 4-N-octylphenol
- 4-tert-octylphenol
- 2,4-di-sec-butylphenol
- 2,6-di-tert-butylphenol
- 4-N-nonylphenol
- 2-methyl-4-tert-octylphenol
- 2,6-di-tert-butyl-4-methylphenol
- 4,6-di-tert-butyl-2-methylphenol



Sampled copepods

- 545 animals sampled for species and stage determination
 - 544 *Calanus finmarchicus*
 - 1 *Calanus helgolandicus*
- Approx. 90% Stage CV and 10% adults
- 13 ± 2 % lipid content (w.w)



Map of stations

ST 07 (Vikingbanken)

ST 06 (Egersundbanken, referanse)

Ekofisk

ST 05

ST 04

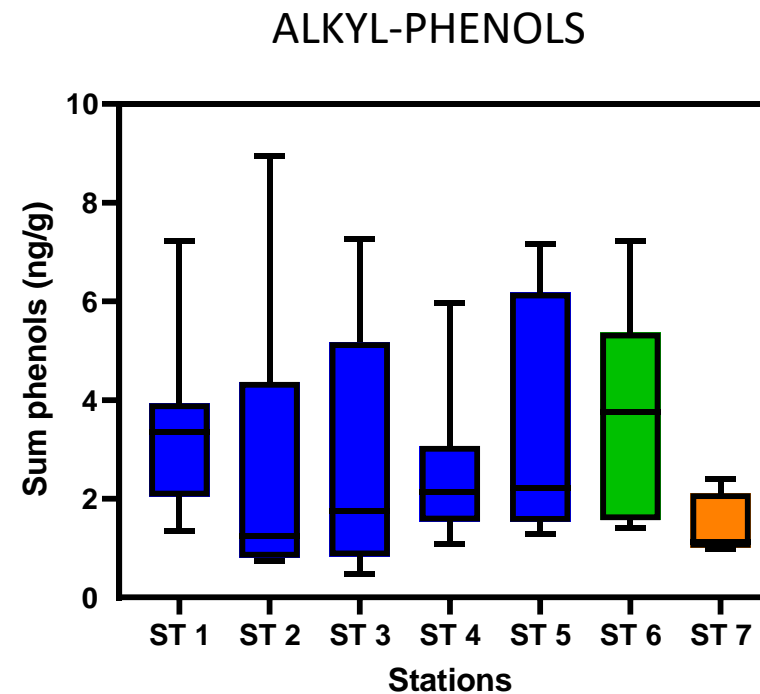
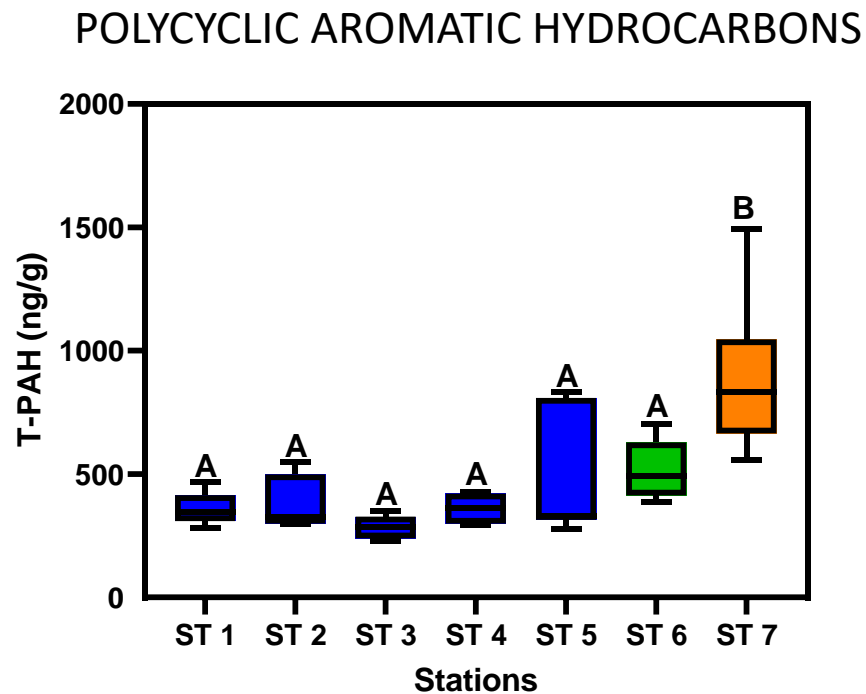
ST 03

ST 02

ST 01

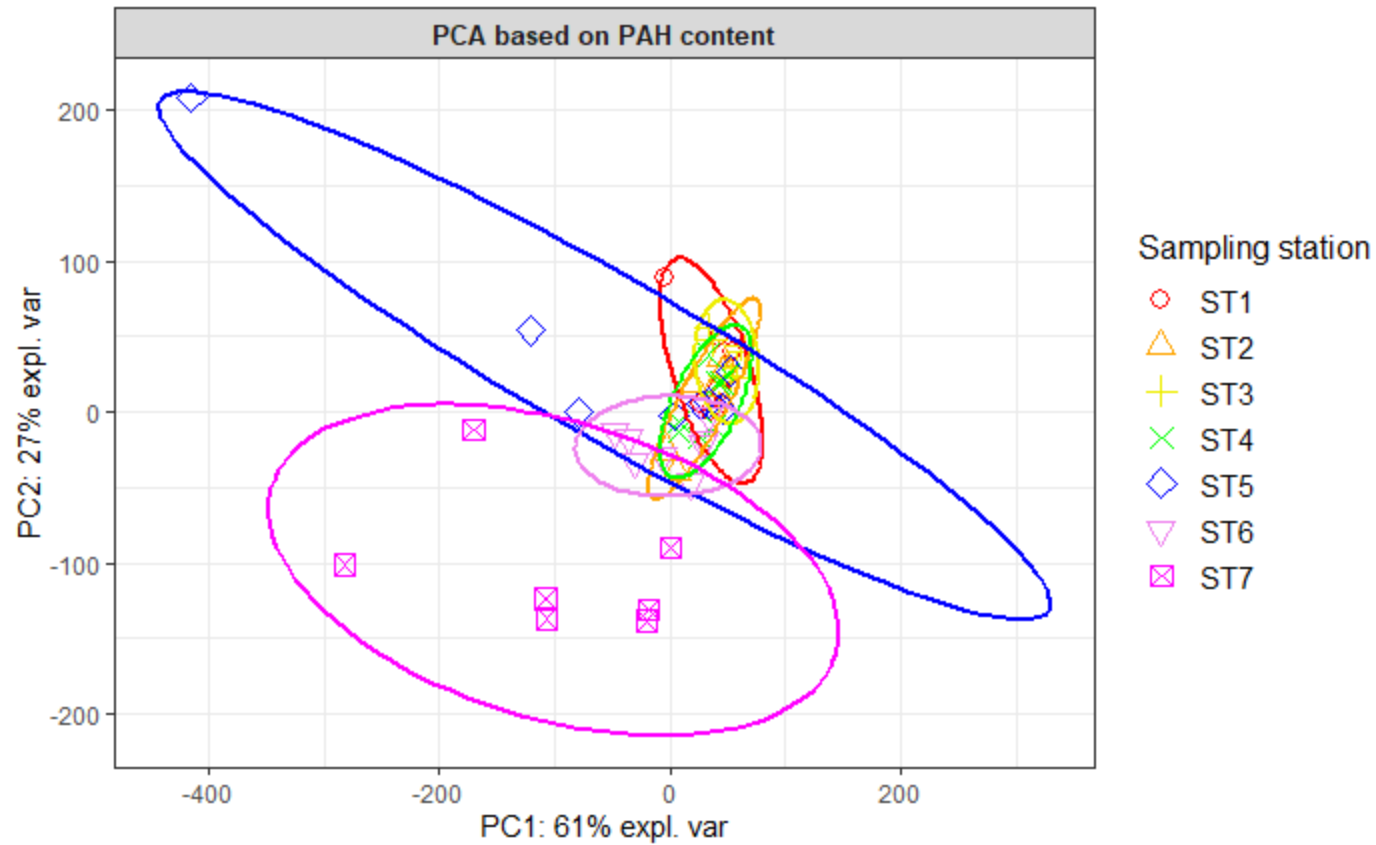


PAH and alkyl-phenol body burden



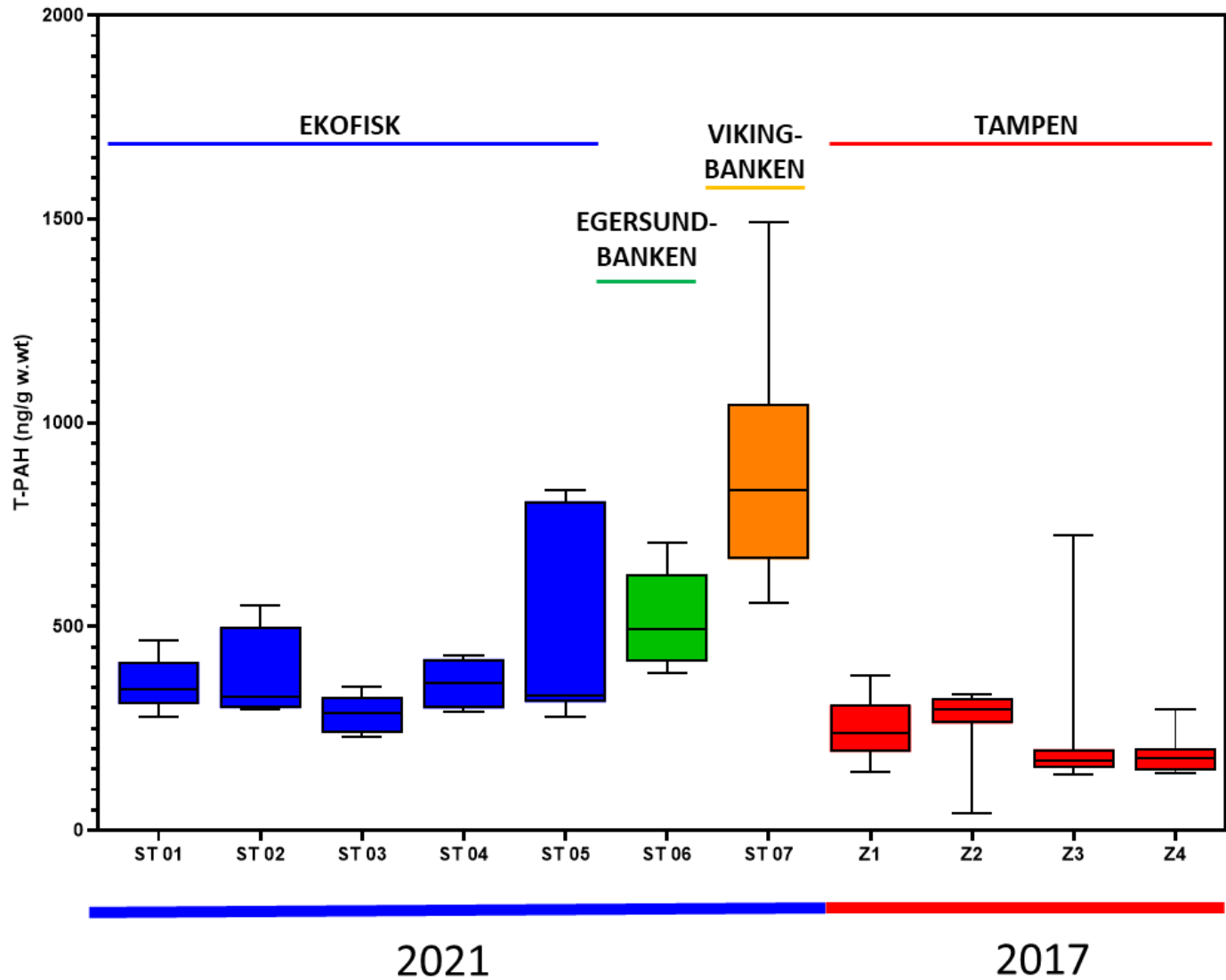
Station 7 (Vikingbanken) significantly higher levels of PAHs than the other stations

PAH PROFILES: Ekofisk 2021 stations

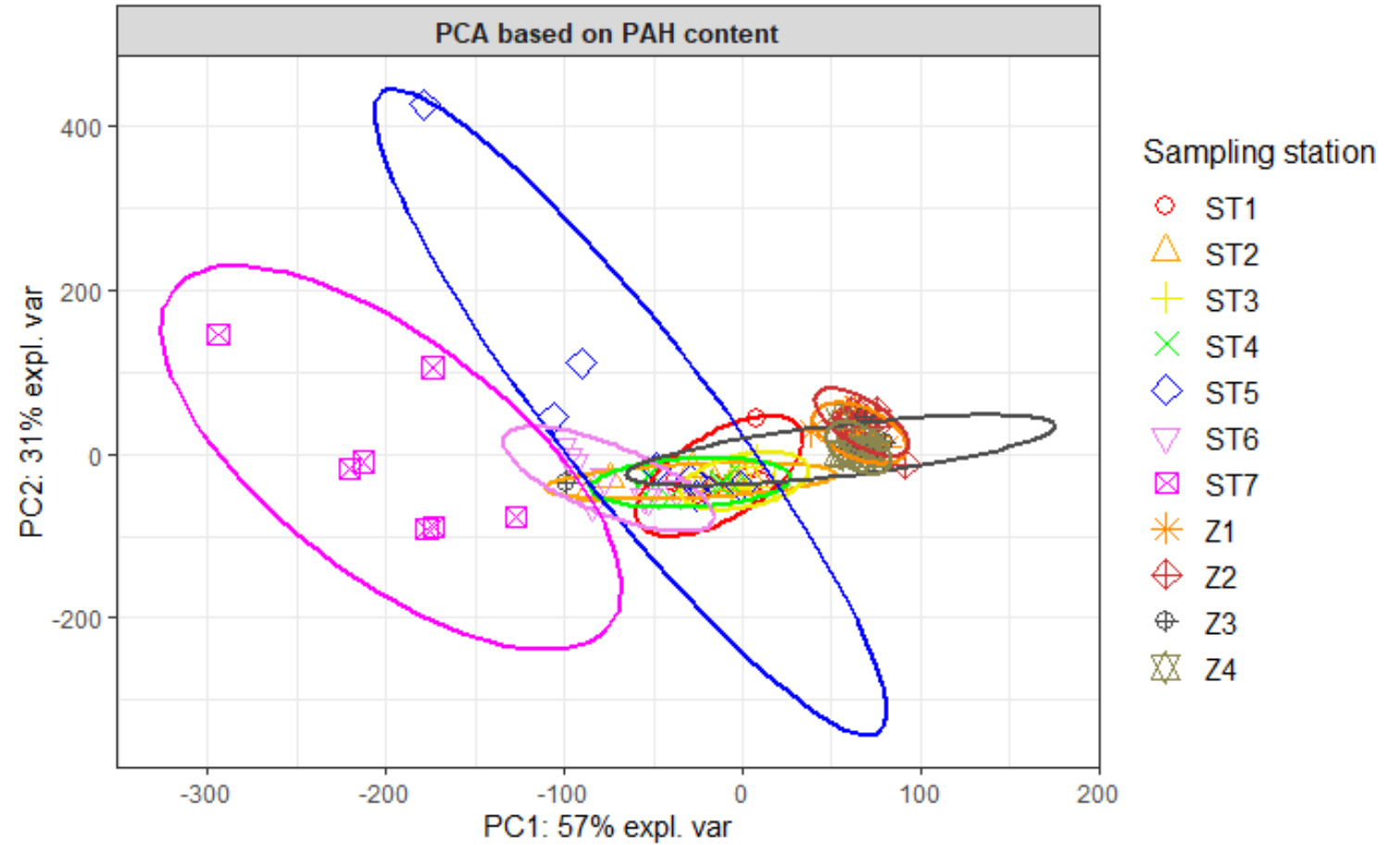


Vikingbanken (ST 07) stands out, and to some extent ST 05 (Ekofisk).

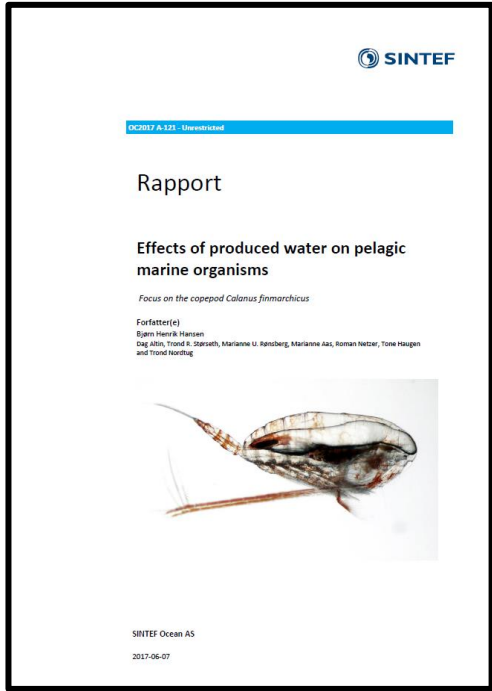
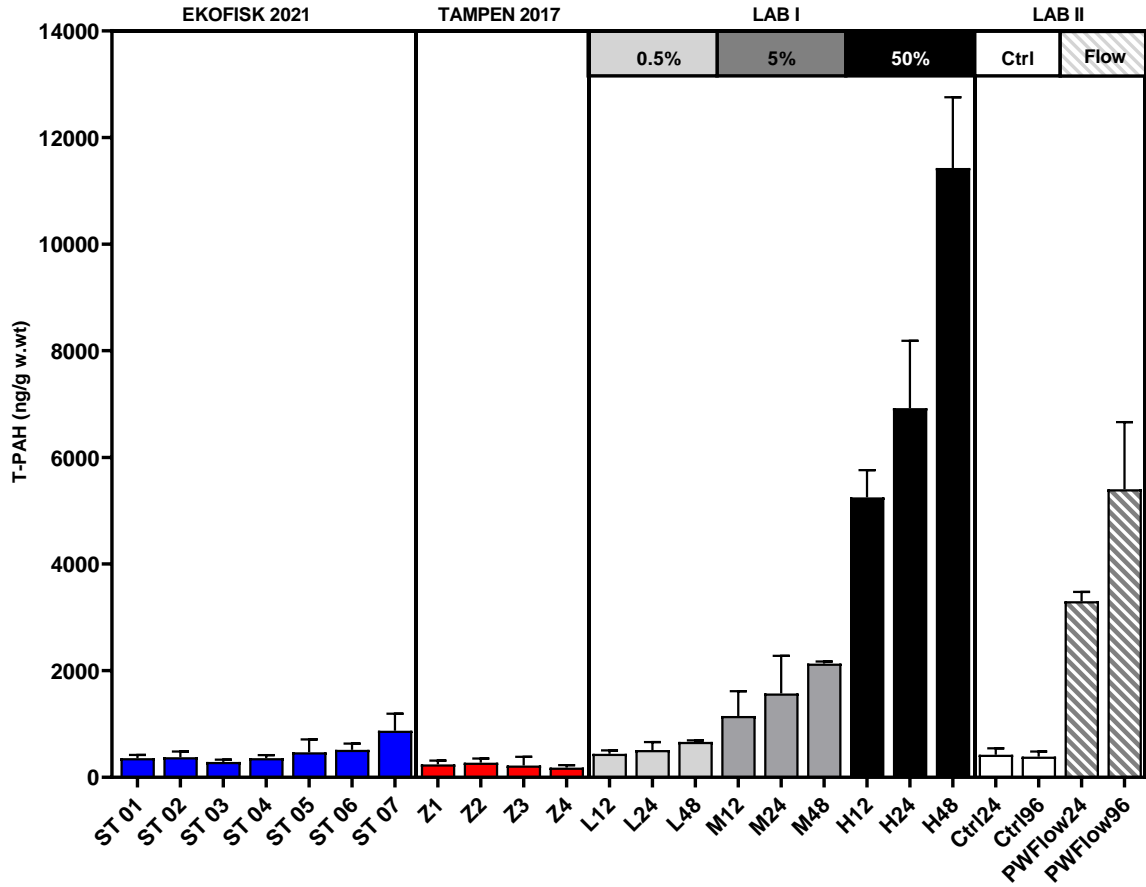
T-PAH: Zooplankton survey 2017 vs 2021



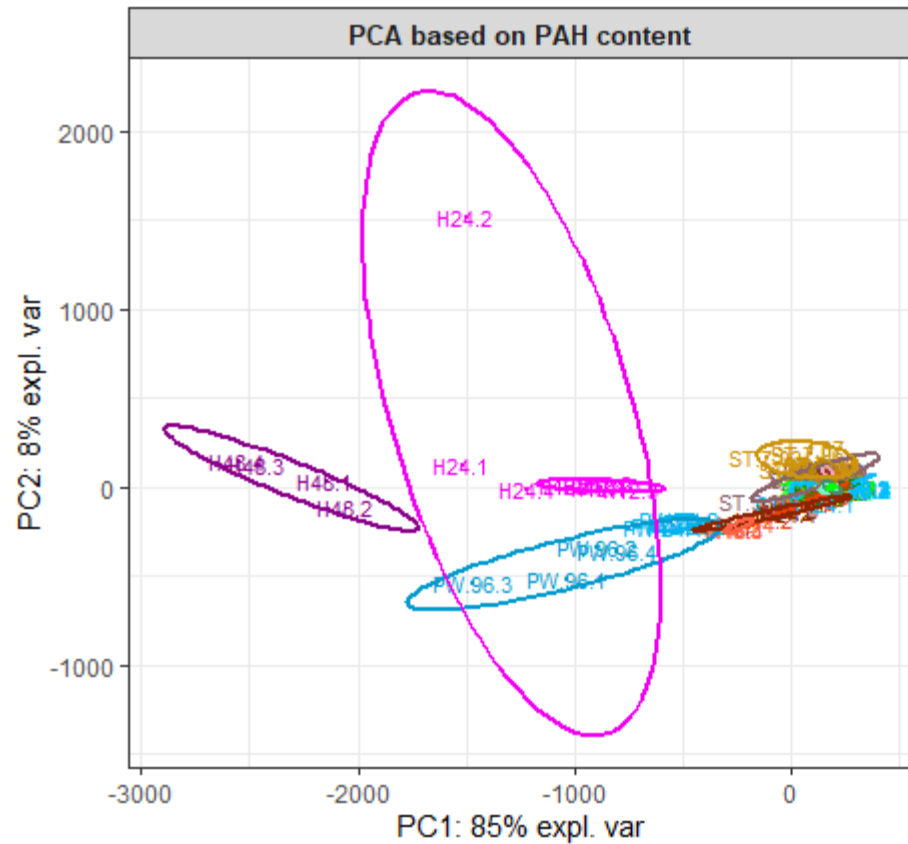
PAH PROFILES: Zooplankton survey 2017 vs 2021



T-PAH: Ekofisk vs Tampen vs lab studies

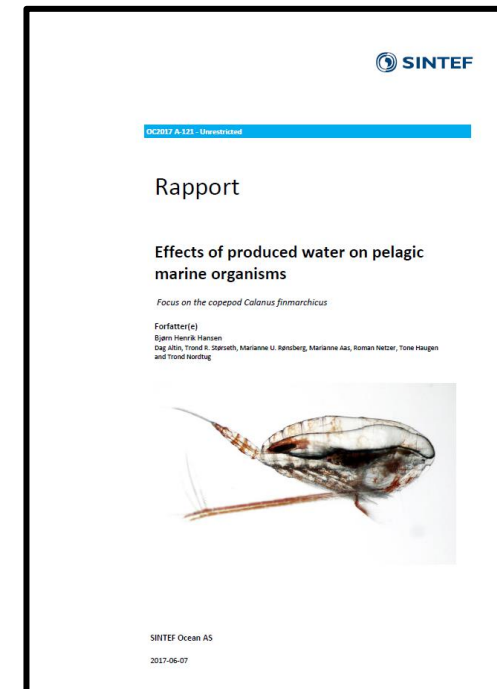


PAH PROFILES: Ekofisk vs Tampen vs lab studies

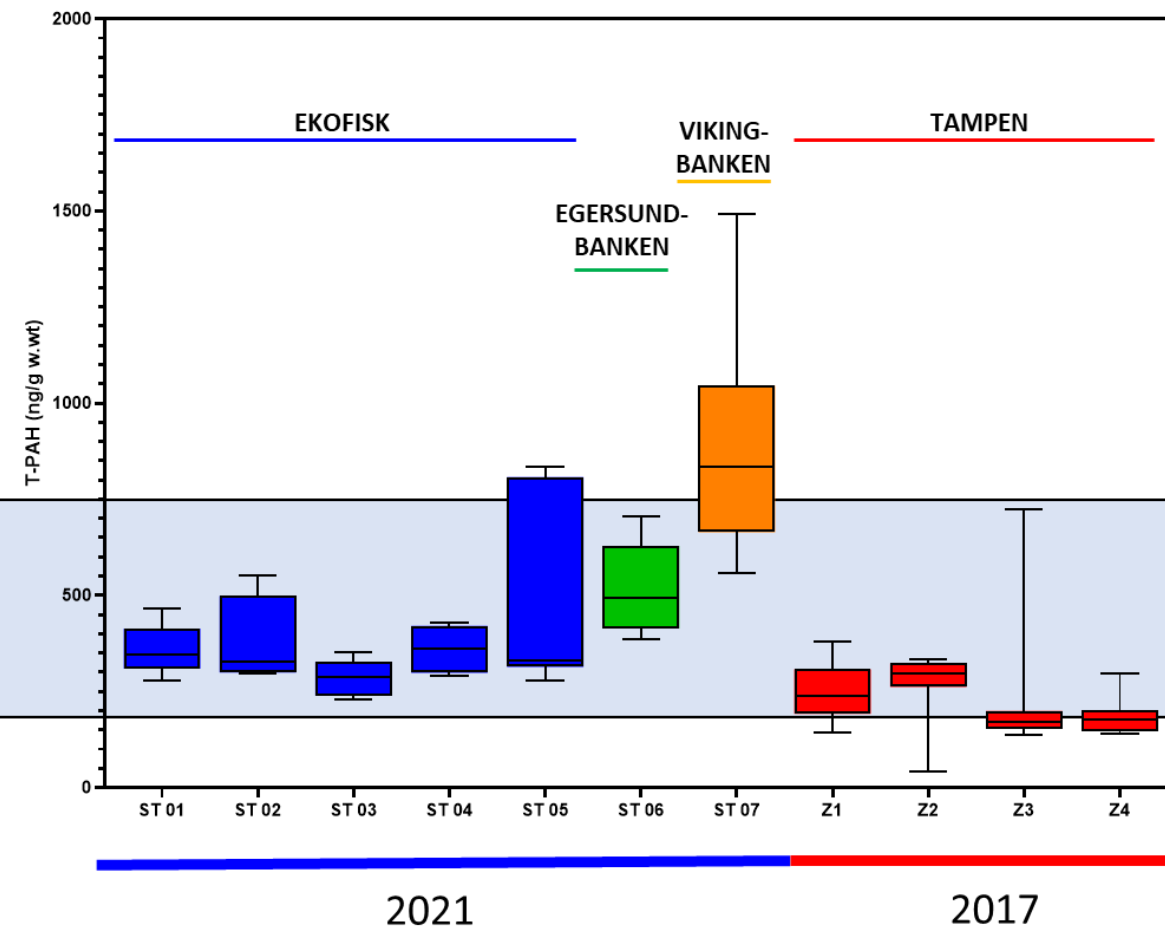
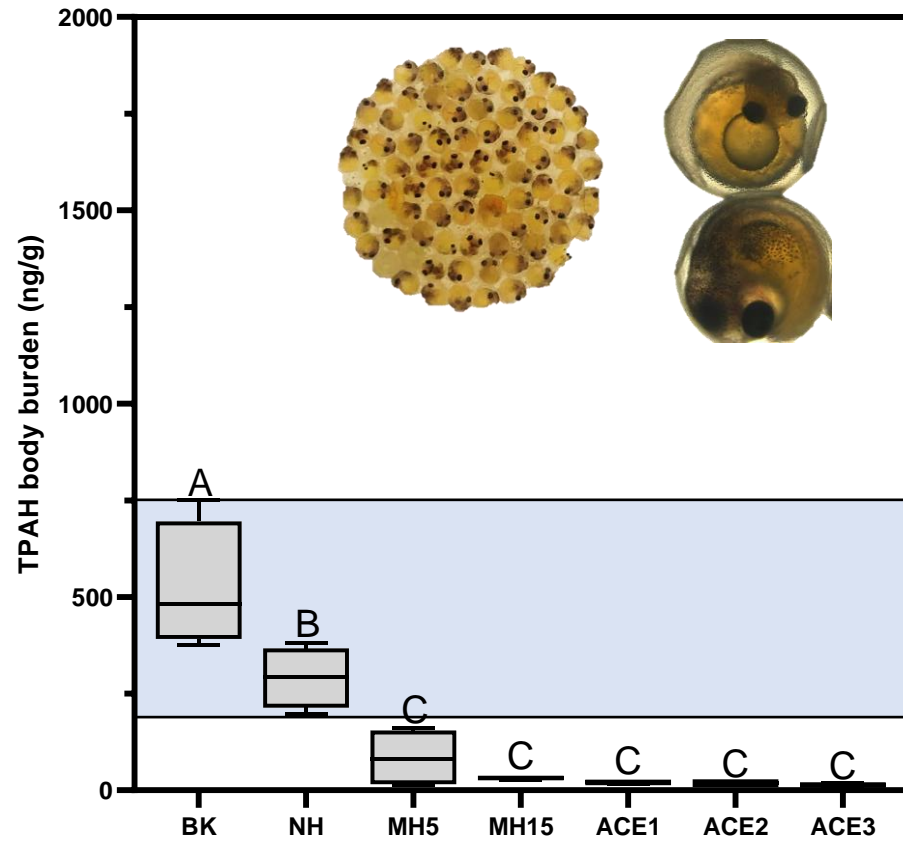


Sampling station

- | | |
|---------------|----------|
| ● Ctrl-12 | ● Low-48 |
| ● Ctrl-24 | ● Med-12 |
| ● Ctrl-48 | ● Med-24 |
| ● DCM-12 | ● Med-48 |
| ● DCM-24 | ● ST1 |
| ● DCM-48 | ● ST2 |
| ● FlowCtrl-24 | ● ST3 |
| ● FlowCtrl-96 | ● ST4 |
| ● FlowPWR-24 | ● ST5 |
| ● FlowPWR-96 | ● ST6 |
| ● High-12 | ● ST7 |
| ● High-24 | ● Z1 |
| ● High-48 | ● Z2 |
| ● Low-12 | ● Z3 |
| ● Low-24 | ● Z4 |



Comparison to lumpfish embryos (INSERT)



Preliminary conclusions

- Average T-PAH body burdens for 2021 survey (ST 01-07) in the range 288-876 ng/g
 - Highest at Vikingbanken, and somewhat higher at Ekofisk station 5
 - Comparable concentrations in reference station (Egersundbanken)
 - Higher PAH body burdens in 2021 survey than in 2017 (average: 184-275 ng/g)
- Body burdens of alkylated phenols much lower than PAHs and no differences between station
- Compared to lab-studies with PW, T-PAH body burdens at Ekofisk (and Tampen) are lower than body burdens associated with toxicity on *C. finmarchicus*
- *PAH body burdens in copepods from Ekofisk are in the same range as lumpfish embryos exposed in the Trondheim harbour for 17 days*

Acknowledgements

