

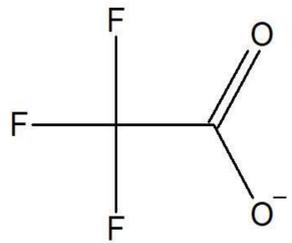
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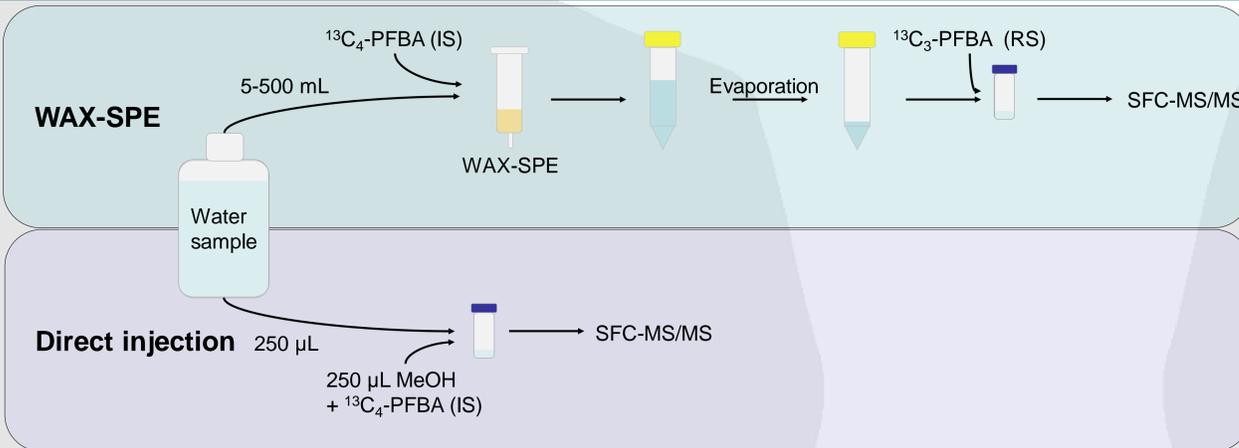
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## Introduction

Trifluoroacetic acid (TFA) is a persistent perfluoroalkyl acid (PFAA) found globally. Concentrations of TFA have been frequently reported in various environmental matrices including precipitation, surface water, groundwater and air. One well-known source of TFA is the atmospheric degradation of hydrofluorocarbons and hydrochlorofluorocarbons. However, other sources, some of which are not known, may play a relevant role in the high concentrations being observed in the environment. Extraction of TFA from water samples has been frequently done by weak anion exchange solid-phase extraction (WAX-SPE). However, analysis of TFA is often obstructed by elevated blank concentrations and mass labelled standards are not commonly used. Semi-quantification of TFA using mass-labelled perfluorobutanoic acid (PFBA) as internal standard that are added to the sample prior to extraction with WAX-SPE may result in over- or underestimation of TFA concentrations due to different extraction- and ionization efficiencies of TFA and PFBA. In this study, a method based on direct injection analysis with supercritical fluid chromatography (SFC) was applied for the determination of TFA in water samples ( $n=33$ ) connected to suspected point sources in Sweden. The recoveries of spiked test samples and the measured concentrations of TFA were compared between the direct injection method and the WAX-SPE method.

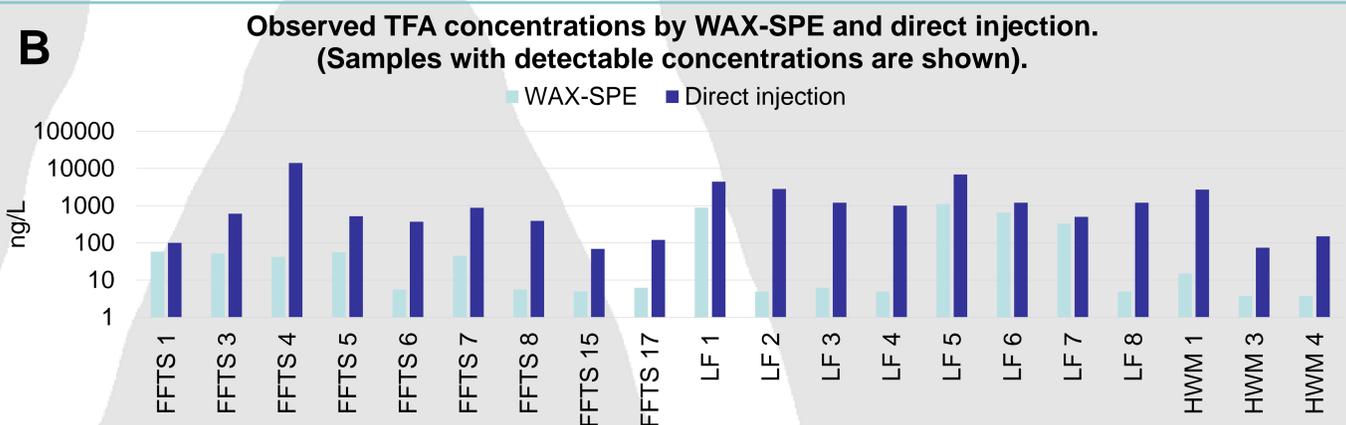
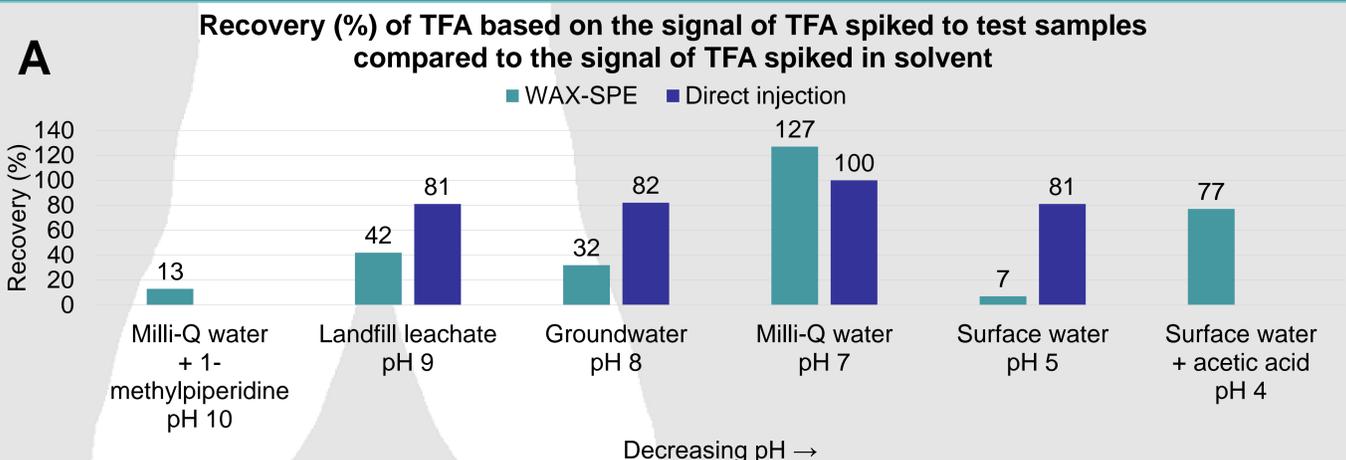


## Sample preparation and analysis



## Results

- The recovery of TFA by WAX-SPE varied from 7 to 42% (Figure A).
- The recovery of the direct injection was  $81 \pm 0.4\%$  ( $19 \pm 0.4\%$  ion suppression).
- The recovery of TFA by WAX-SPE did not seem to be related solely to the pH of the sample but the combination of the pH and sample matrix.
- The concentrations of TFA observed with direct injection was up to 600 times higher compared to concentrations observed with WAX-SPE (Figure B).
- The detection frequency of TFA in the 33 samples was 61% by direct injection and only 30% by WAX-SPE.
- TFA was detected in 20 out of 33 samples (by direct injection) at concentrations ranging from <34 to 14 000 ng/L (median concentration 110 ng/L).
- The highest concentration of TFA (14 000 ng/L) was found in water from a rock shelter with previous usage of AFFF in sprinkler systems.
- TFA was generally more frequently detected at higher concentrations in landfill leachate (<34-6 900 ng/L) indicating that leaching from landfills may be a relevant source for TFA into the environment.



## Conclusions

- The recovery of the direct injection method only suffered from ion suppression while the recovery of the WAX-SPE method seem to be dependent on several factors including pH and sample matrix causing losses during sample extraction.
- WAX-SPE resulted in an underestimation of TFA due to losses during sample preparation that are not compensated for by using mass labelled PFBA.
- Firefighting training sites, landfills and hazardous waste management facilities may be relevant sources for TFA to the environment.
- Analysis by direct injection was shown to be an adequate method for measuring TFA in samples from point sources.

## TFA in water connected to suspected point sources (results by direct injection)

Site	n	Sample matrix and sample description	Concentration range (ng/L)
Firefighting training sites (FFTSs)	20	Groundwater and surface water collected at and downstream of five sites with known usage of AFFFs.	<34-14 000
Landfills (LFs)	9	Landfill storm water and leachate collected at three different landfills.	<34-6 900
Hazardous waste management facility (HWM)	4	Surface water collected at the outlet and downstream from a hazardous waste management facility.	<34-2 700

## Acknowledgements

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