

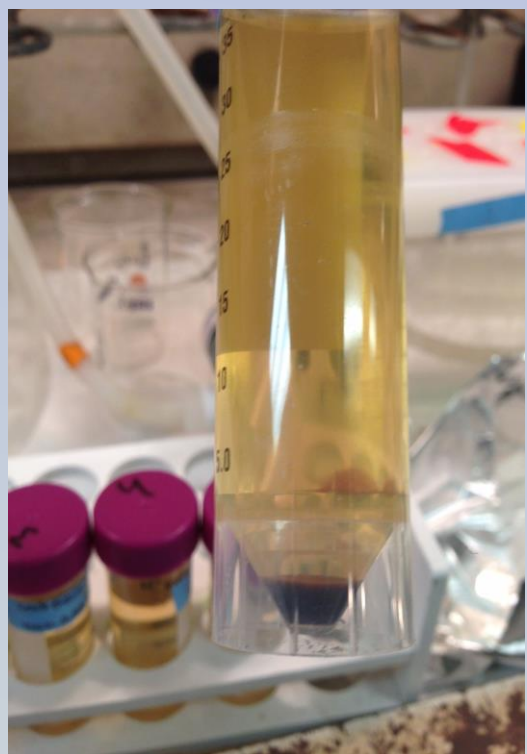
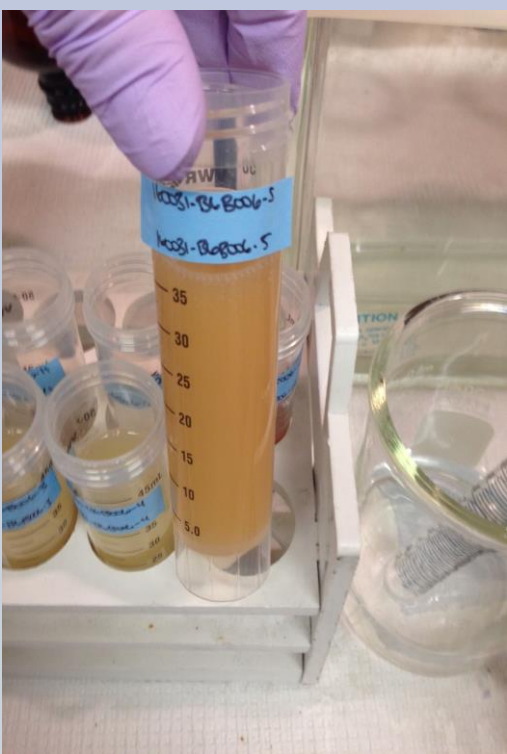
## Introduction

Although PFAS are not currently regulated under the Safe Drinking Water Act, their presence is increasingly becoming a concern due to their persistence in the environment and probable adverse health effects. Provisionary state levels for PFOA range from 0.04ppb for New Jersey to 2ppb for North Carolina, while the federal provisional health advisory (PHA) for PFOS and PFOA has been set at 0.2ppb and 0.4ppb, respectively. As beer is approximately 95% water, the quality of water is paramount in the brewing process. Water quality can vary depending on the water source and brewery treatment process. Using a market-basket approach, we collected a selection of both domestic and international beers and ciders in an effort to profile the occurrence and distribution of PFAS.

## Methodology

The samples were prepared using a weak acid solution to precipitate the proteins, then extracted through a conditioned, weak-anion solid phase extraction cartridge. Samples were analyzed for selected PFAS via liquid chromatography, tandem-mass spectrometry (LC-MS/MS), using isotope dilution and internal standard techniques.

### Before and After Protein Precipitation



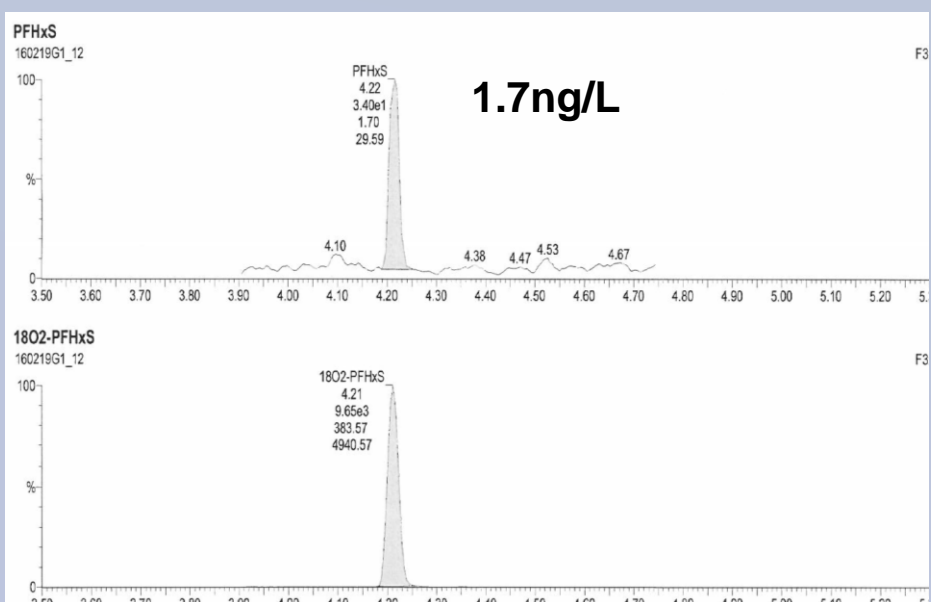
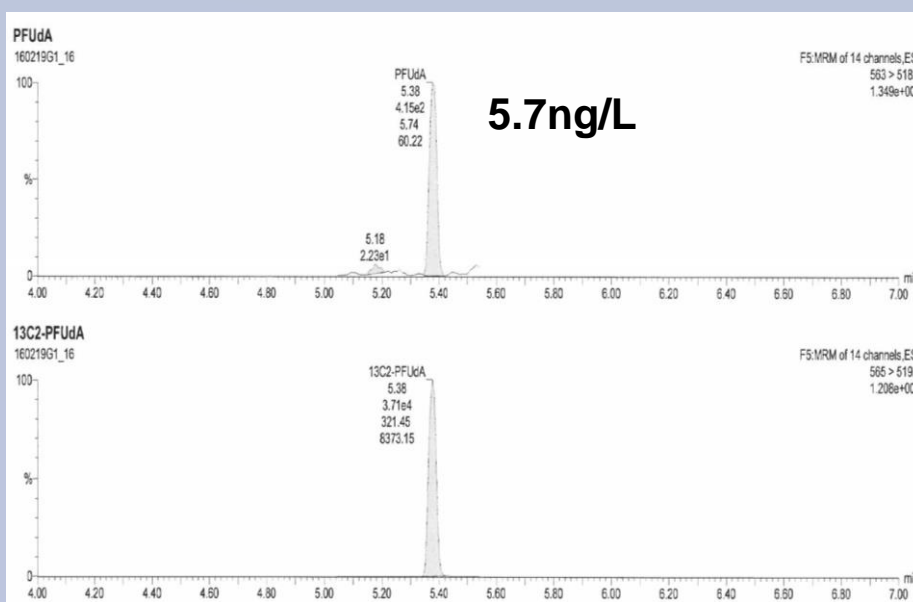
### Solid Phase Extraction



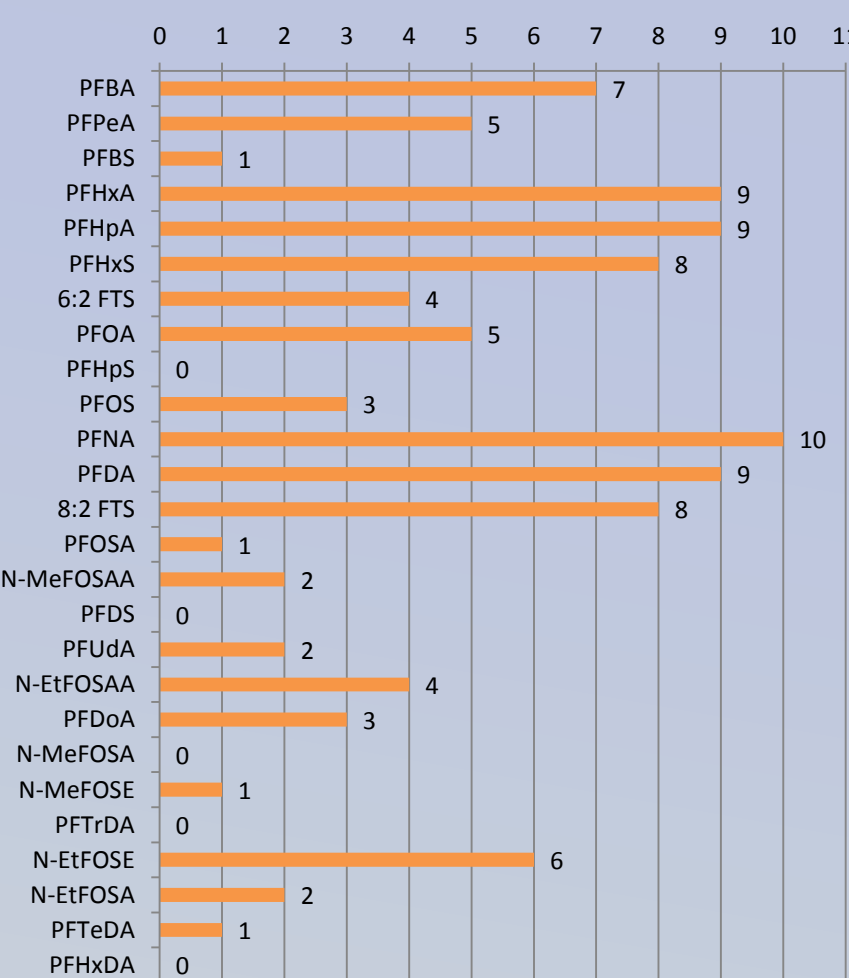
## Instrumentation



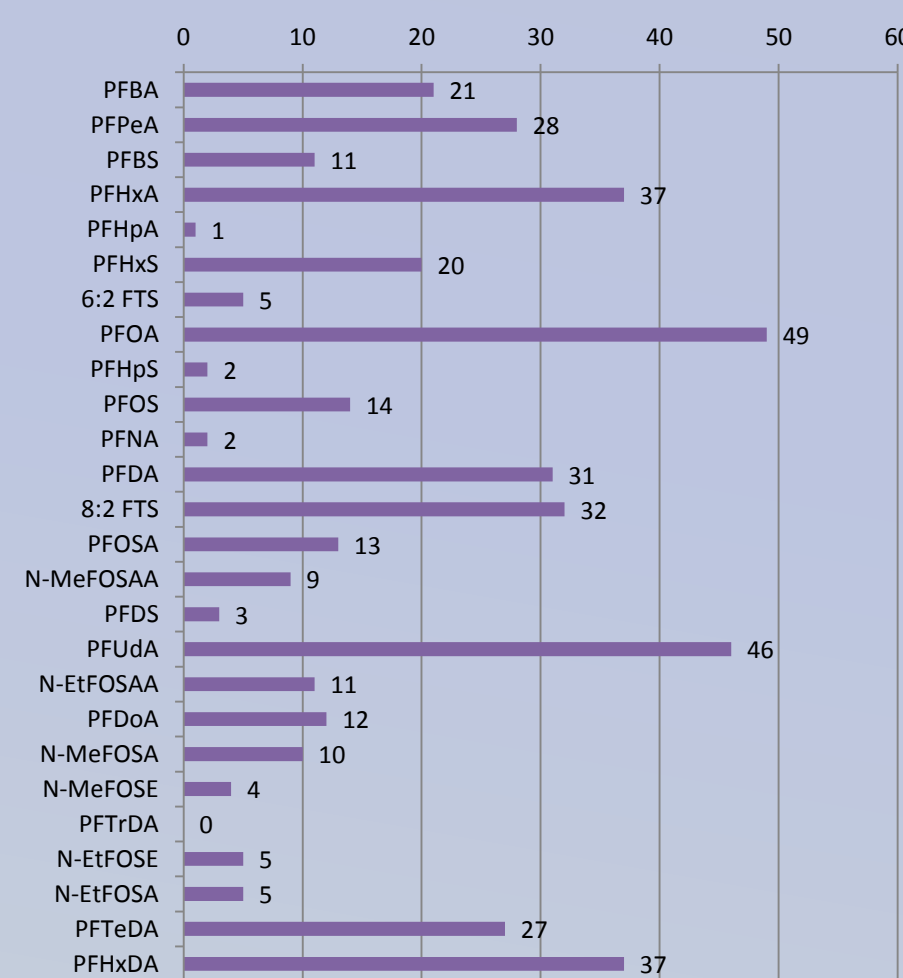
## Chromatogram Examples



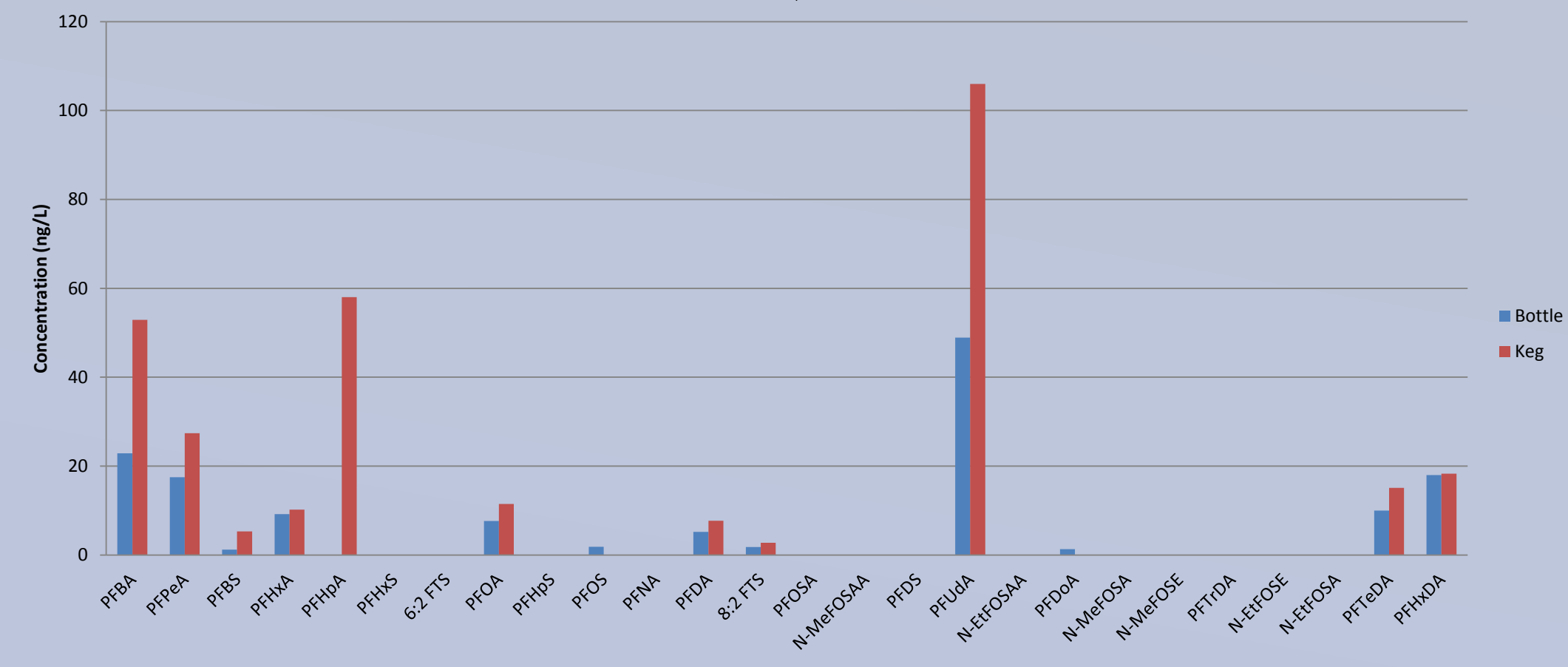
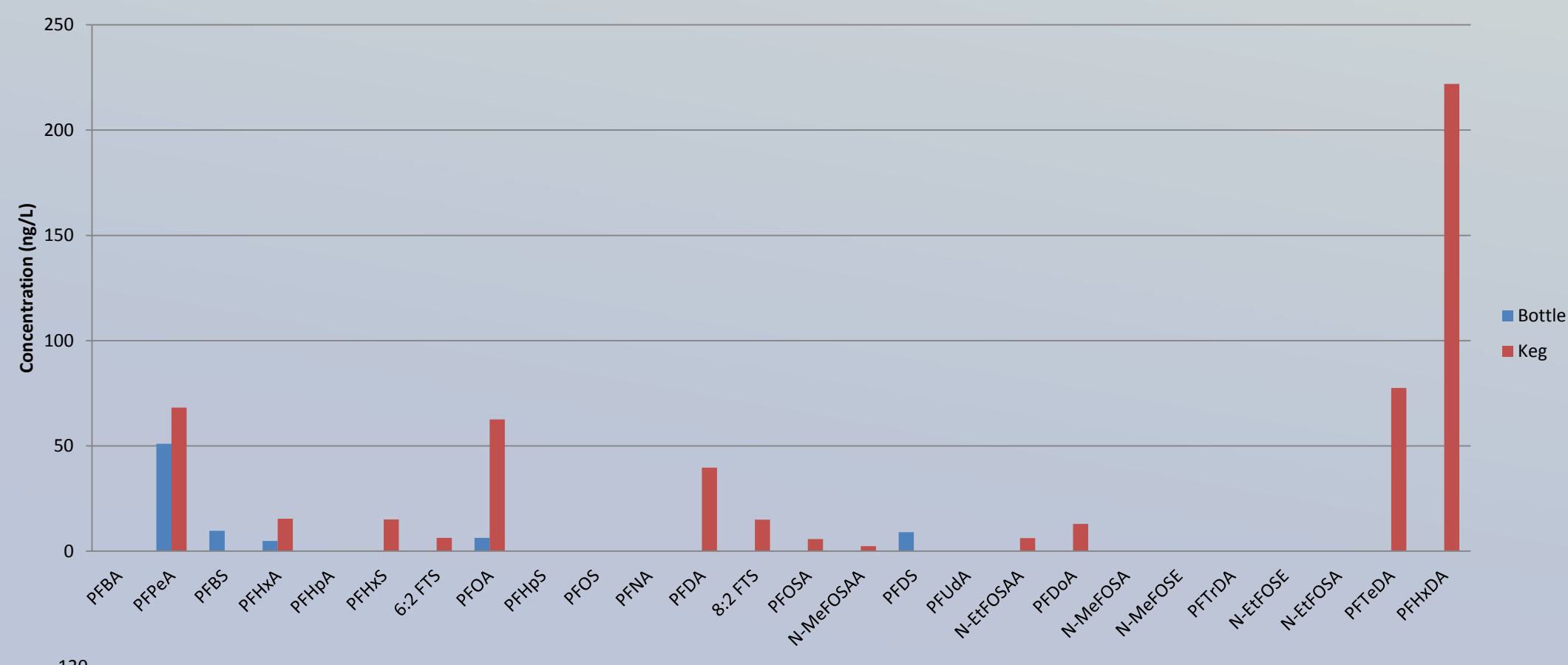
## PFAS Occurrence in Cider



## PFAS occurrence in Beer



## The difference in PFAS Concentration between Keg and Bottled Beer



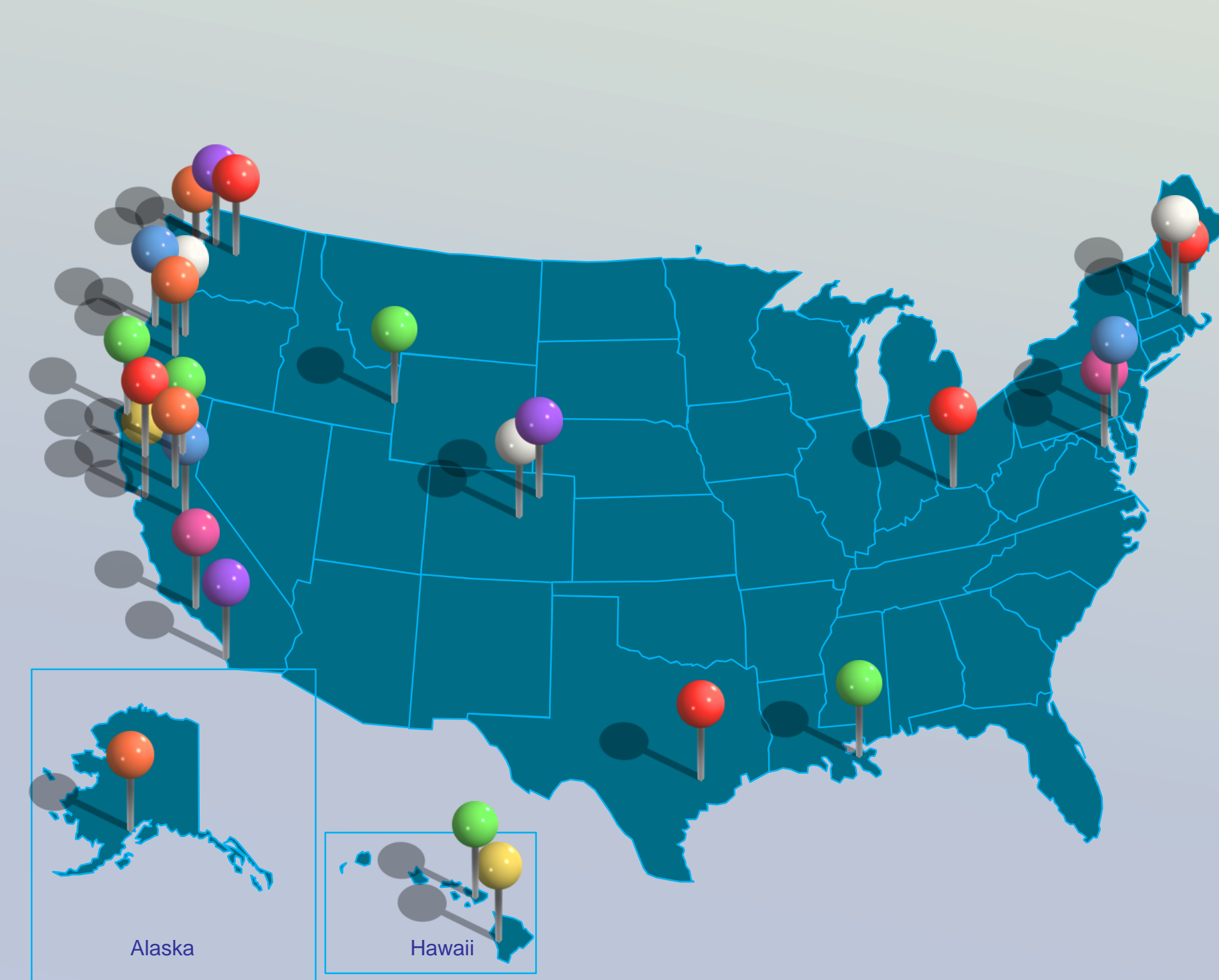
## Comparison of Cider and Beer Concentrations

Compound	Cider Conc. (ng/L)	Beer Conc. (ng/L)
PFBA	6.90	21.05
PFPeA	0.89	14.22
PFBS	0.28	0.53
PFHxA	2.70	3.55
PFHpA	0.78	0.60
PFHxS	1.51	1.04
6:2 FTS	0.23	0.15
PFOA	0.87	3.13
PFHpS	0.00	0.38
PFOS	0.24	0.62
PFNA	0.39	0.04
PFDA	2.84	2.51
8:2 FTS	1.20	1.34
PFOSA	0.55	0.90
N-MeFOA	0.02	0.08
PFDS	0.00	0.22
PFUDA	0.37	15.11
N-EtFOA	0.11	0.21
PFDoA	0.13	0.57
N-MeFOA	0.00	0.70
N-MeFOSE	7.51	2.41
PFTyDA	0.00	0.00
N-EtFOSE	32.71	0.37
N-EtFOA	0.80	0.16
PFTeDA	0.18	2.00
PFHxDA	0.00	9.01

## Average PFAS Concentration in U.S. vs International Beers

Compound	U.S. Avg (ng/L)	Int'l Avg (ng/L)
PFBA	16.98	25.12
PFPeA	10.96	17.49
PFBS	0.78	0.28
PFHxA	4.81	2.28
PFHpA	1.21	0.00
PFHxS	1.34	0.74
6:2 FTS	0.31	0.00
PFOA	2.94	3.33
PFHpS	0.12	0.64
PFOS	0.51	0.74
PFNA	0.07	0.00
PFDA	3.89	1.13
8:2 FTS	1.75	0.93
PFOSA	0.92	0.88
N-MeFOA	0.14	0.01
PFDS	0.32	0.11
PFUDA	21.42	8.81
N-EtFOA	0.30	0.11
PFDoA	0.76	0.39
N-MeFOA	0.93	0.47
N-MeFOSE	0.46	4.36
PFTyDA	0.00	0.00
N-EtFOSE	0.32	0.42
N-EtFOA	0.32	0.00
PFTeDA	3.41	0.59
PFHxDA	8.34	9.69

## Brewery Locations of Domestic Beers and Ciders Tested



## Conclusions

After testing a diverse selection of beers and ciders from a variety of regions around the United States and the world, we discovered a predominance of carboxylic acids over sulfonates, as well as the presence of both short and long chain PFAS. Although ciders exhibited lower levels than beers on average, ciders had multiple positives for both N-EtFOSE and N-MeFOSE, which were not seen in the beer samples tested. PFUDA was found at a significantly increased level in U.S. Beers when compared to the international beers we tested, but no other significant differences were found. The concentration variances between kegged beer and bottled beer could be due to additional contact time with machinery during the kegging process or from draft equipment as additional PFAS occurrences were observed only in the kegged beer. Additional testing of draft beer, possibly bypassing standard draft equipment, is recommended. Even taking the greatest PFAS concentrations into consideration, all beers and ciders tested were well below any provisional federal health advisories.