

Perfluorinated Compounds in Environmental Samples Collected from the Estuarine and Coastal Areas of Korea

Jonathan E. Naile¹, Jong Seong Khim², Sung Joon Song², Tiejyu Wang³, Chunli Chen³, Wei Luo³, Bong-Oh Kwon⁴, Jinsoon Park⁴, Chul-hwan Koh⁴, Paul D. Jones¹, Yonglong Lu³, John P. Giesy^{1,5}

¹Department of Veterinary Biomedical Sciences & Toxicology Centre, University of Saskatchewan, Saskatoon, SK, Canada

²Division of Environmental Science and Ecological Engineering, Korea University, Seoul, Korea

³State Key Laboratory of Urban and Regional Ecology, Research Center for Eco-environmental Sciences, Chinese Academy of Science, Beijing, China

⁴School of Earth and Environmental Sciences (Oceanography), Seoul National University, Seoul, Korea

⁵Department of Zoology, Center for Integrative Toxicology, Michigan State University, East Lansing, MI, USA

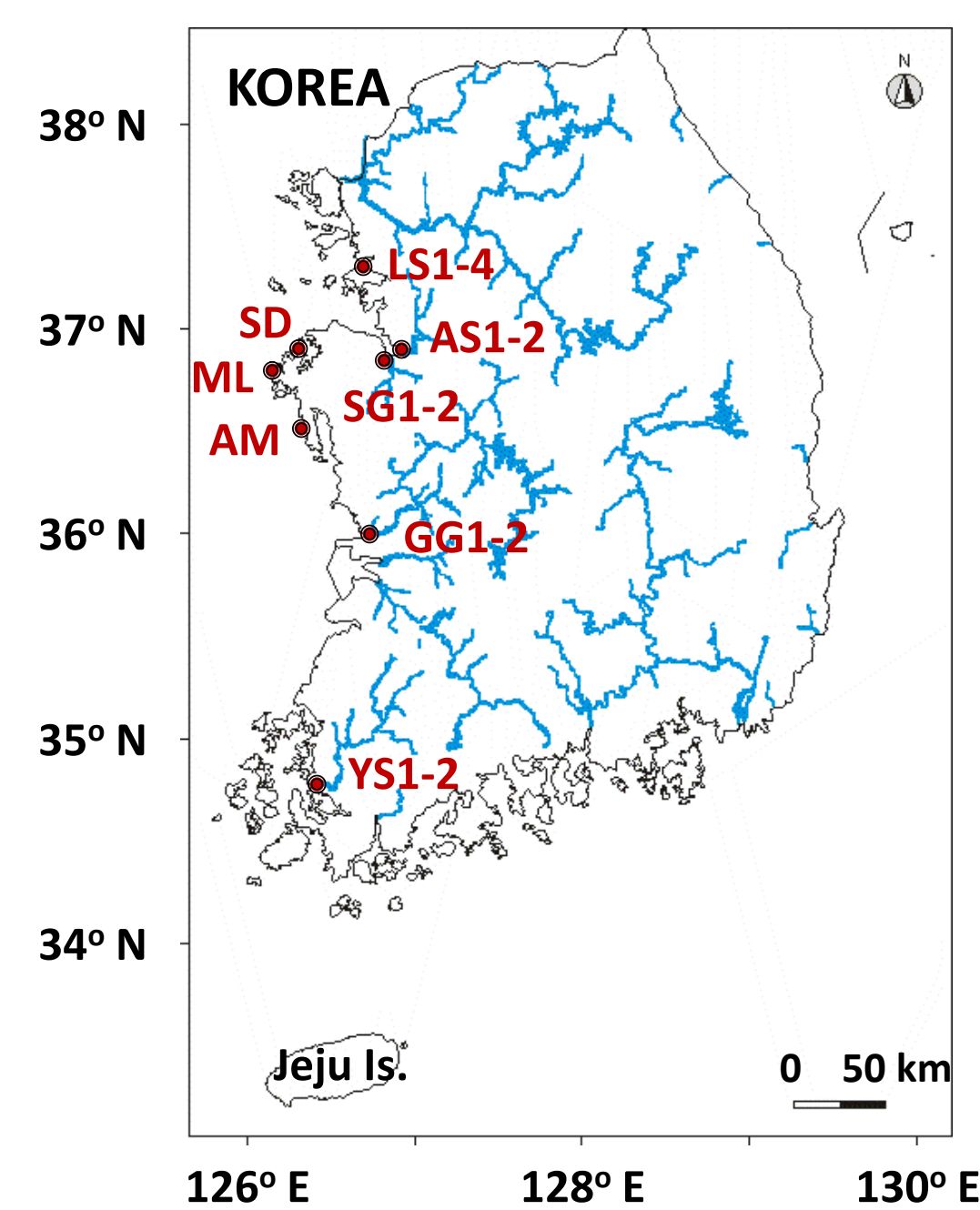
ABSTRACT

The western coast of Korea is an industrialized and highly urbanized region of Asia that is home to millions of people and is vital for both industry and tourism alike. PFCs have been found in relatively great concentrations throughout the region. A detailed sampling of western Korea was undertaken to determine the extent of perfluorinated compounds (PFCs) pollution in a region that is known to have used PFCs extensively, and to shed light on their sources and transport throughout the region. Soil (n=13), sediment (n=14), water (n=14), and biological (n=76) samples were collected during the summer of 2009. Relatively great concentrations of PFCs were significantly concentrated in some biological and water samples, while concentrations of PFCs in soils and sediments were generally low. The most widely detected compound for both biological and water samples was found to be perfluorooctanesulfonate (PFOS). Concentrations of PFOS detected in biological and aqueous samples were both less than those estimated to cause toxicity. However, in both cases concentrations were within a factor of 10 to possible toxicity threshold values. Overall, the detection of PFCs at relatively great concentrations in various environmental matrices from this region of Korea suggests that further study and characterization of these chemicals and their potential risk to both humans and wildlife is needed.

BACKGROUNDS

- PFCs are made up of a carbon-fluorine tail and polar head group
- PFCs are resistant to hydrolysis, photolysis, metabolism, and biodegradation
- Wide range of applications from surfactants, to fire-fighting, and pharmaceuticals
- Globally ubiquitous in both remote and urban environments
- Large scale production of PFOS based products in North America phased out starting in 2000
- Still, widespread distribution of PFCs without exception in Korea

INTRODUCTION



- Highly developed region of Korea
- Municipal and industrial areas
- Previously PFCs polluted regions and areas
- Relatively high concentrations of PFCs found in 2008
- Relatively little is known about possible sources, distribution, and fate among environmental matrices
- Monitoring performed in 2009 with sample locations in 2008 (second year of an ongoing study)

METHODS & QA/QC

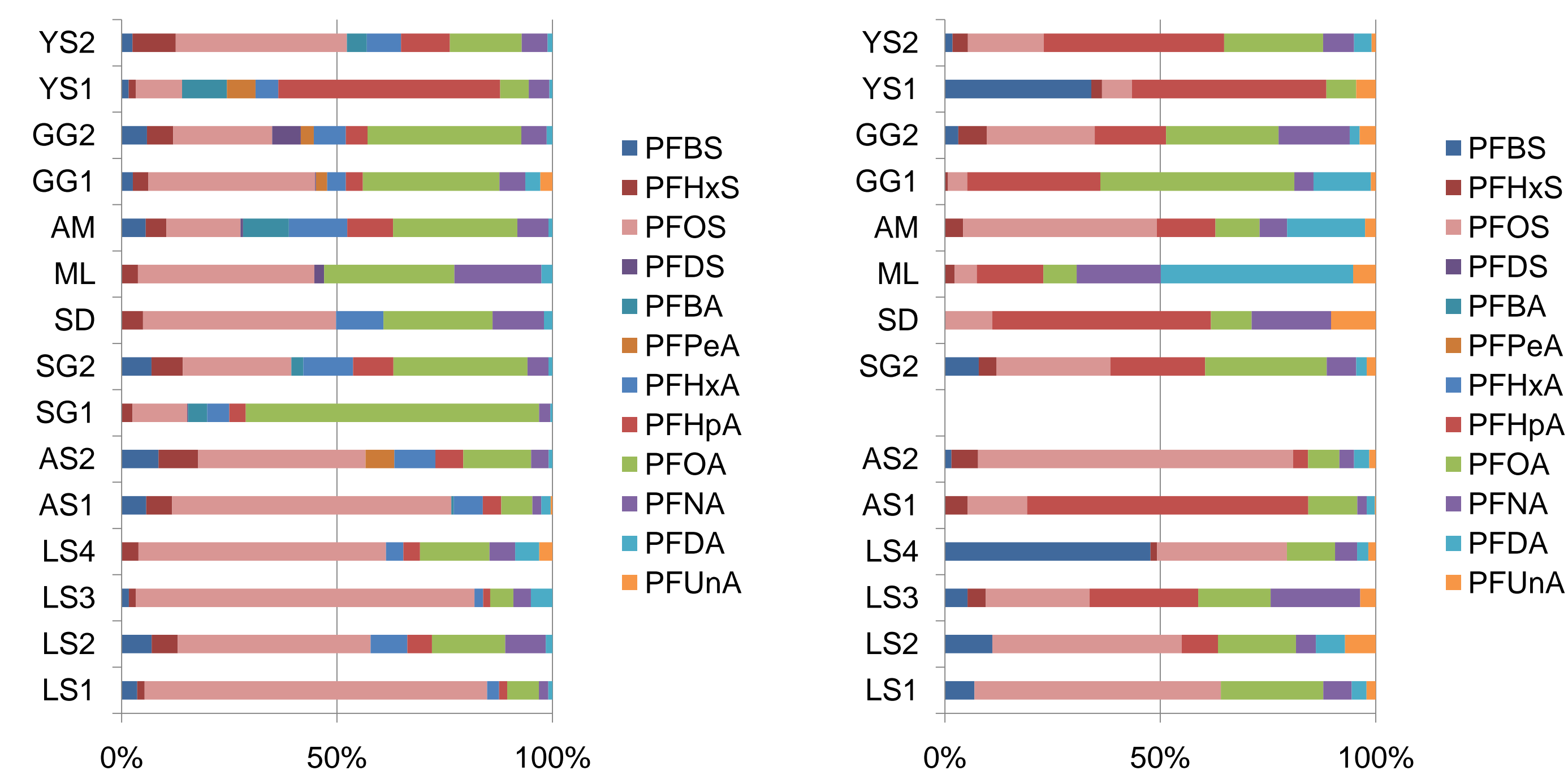
- Water, soil, sediment, and biota samples collected from 8 estuarine and costal areas
- Samples collected during June of 2009, after one year of 2008 sampling
- Samples extracted using SPE methods to optimize recovery and minimize contamination
- Negative ESI-HPLC-MS/MS operated in MRM was used for data analysis quantification
- Use of Teflon related materials avoided during all steps of sample collection and analysis
- A second column inserted directly upstream of the HPLC injector port to separate any possible contamination coming from the eluents or instrument
- Recoveries for all 12 compounds generally good and >70%

RESULTS & DISCUSSION

- In general PFCs occurrence in 2009 samples were smaller than those in 2008 samples
- Overall, PFCs in water decreased from 2008 to 2009, reflecting lesser contamination
- Only PFOS and PFOA detected in soil and sediment samples, consistent between 2008 and 2009
- Greater PFCs accumulation in 2009 biota samples compared to 2008

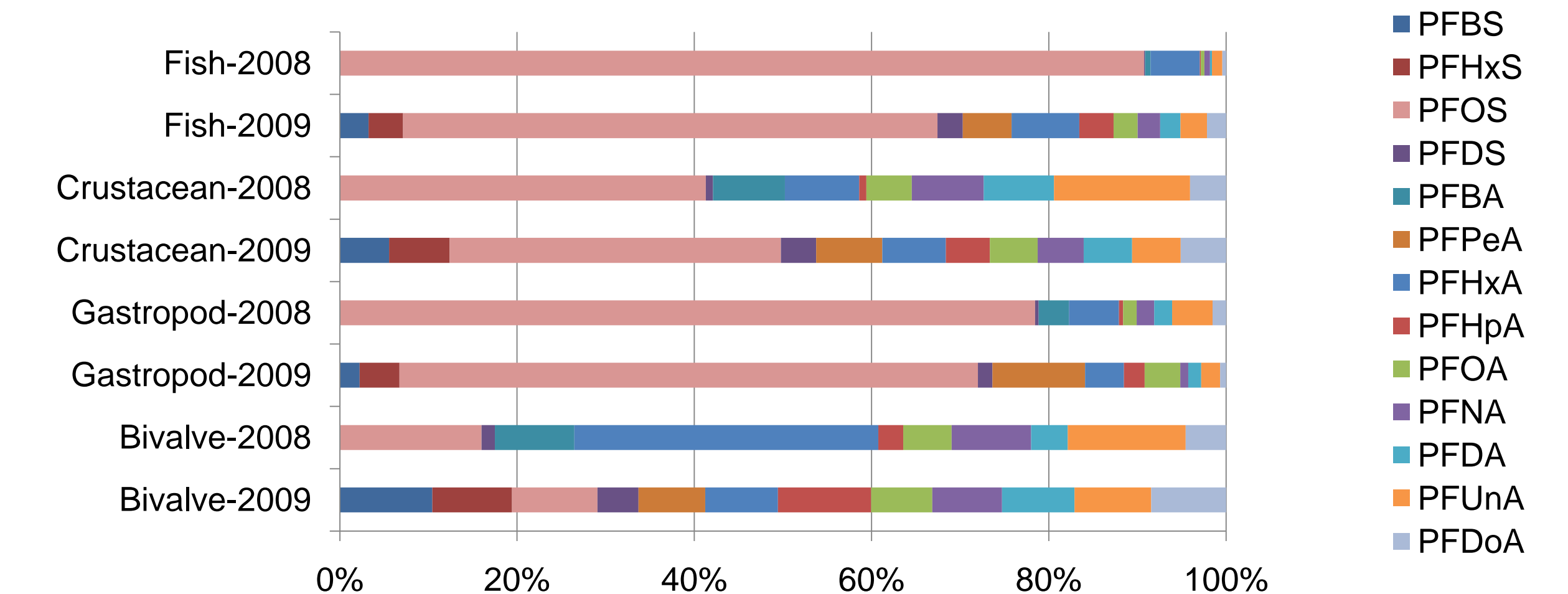
Samples & Compounds	2009 Samples				2008 Samples			
	Water	Soil	Sediment	Biological	Water	Soil	Sediment	Biological
sampling location (n)	14	13	12	12	15	11	12	9
samples analyzed (n)	14	13	14	76	15	11	12	21
samples detected (n)								
PFBS	9(64)	0(0)	0(0)	66(87)	11(73)	0(0)	0(0)	0(0)
PFHxS	11(79)	0(0)	0(0)	76(100)	15(100)	0(0)	0(0)	0(0)
PFOS	14(100)	4(31)	7(50)	71(93)	15(100)	4(36)	3(25)	21(100)
PFDS	0(0)	0(0)	0(0)	23(30)	5(33)	0(0)	0(0)	9(43)
PFBA	0(0)	0(0)	0(0)	0(0)	6(40)	0(0)	0(0)	0(0)
PFPeA	0(0)	0(0)	0(0)	64(84)	4(27)	0(0)	0(0)	0(0)
PFHxA	0(0)	0(0)	0(0)	69(91)	14(93)	1(9)	0(0)	17(81)
PFHpA	12(86)	0(0)	0(0)	54(71)	13(87)	3(27)	2(17)	4(19)
PFOA	14(100)	2(15)	6(43)	57(75)	15(100)	2(18)	1(8)	9(43)
PFNA	13(93)	0(0)	0(0)	67(88)	15(100)	1(9)	0(0)	1(4.8)
PFDA	11(79)	0(0)	0(0)	70(92)	15(100)	5(45)	3(25)	19(90)
PFUnA	14(100)	0(0)	0(0)	73(96)	3(20)	2(18)	3(25)	19(90)
PFDoA	0(0)	0(0)	0(0)	58(76)	0(0)	1(9)	1(8)	5(24)
Mean	8(54)	0(4)	1(7)	58(76)	10(67)	1(13)	1(8)	8(38)

- Composition of PFCs in water varied greatly from between 2008 and 2009
- PFOS and PFOA were found to be the predominant PFCs, which was consistent between 2008 and 2009



RESULTS & DISCUSSION (continued)

- Composition of PFCs in biota samples varied greatly between species
- Composition of PFCs in biota samples were significantly different in 2008 compared to 2009



REVIEW of PFOS in WATER from Asia

- In general PFCs concentrations in water decreased from 2008 to 2009, (see below, conc.=ng/L)
- PFCs in Korea slightly greater than those in China and Japan, and sometimes exceeded WQC values

