

NOTE

31. August 2011.

To: Climate and Pollution Agency (Klif),
att. Jon L. Fuglestad, reference number 5011011, TA-number 2841/2011.
From: Norwegian Institute for Water Research (NIVA),
Merete Schøyen.
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Perfluoroalkyl compounds (PFCs) in cod blood and liver from the Inner Oslofjord (2009)

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Introduction

Perfluoroalkyl compounds (PFCs) have been analysed in whole blood from 25 Atlantic cod (*Gadus morhua*) sampled in the Inner Oslofjord in 2009 (Appendix A). PFCs in cod liver from 20 of these individuals were analysed and reported within the Oslo and Paris Commissions (OSPARs) Coordinated Environmental Monitoring Programme (CEMP) (Green *et al.* 2010 and Appendix B). Age, weight and length of each fish can be found in Appendix C. The results for blood and liver are compared in this note.

Background

Analyses of PFCs in cod liver have been included in the Norwegian CEMP-programme since 2005. Because of PFCs intrinsic properties and association with protein in the blood, we wanted to compare the levels of PFCs in blood and liver for possibly being able to assess what is the most appropriate matrix to monitor the PFCs.

Methods

All analyses of whole blood and liver of cod were done at NIVA. The analyses of PFCs includes the following compounds: perfluorooctanonic sulphonate (PFOS), perfluorooctane sulphonamid (PFOSA), perfluorononanoic acid (PFNA), perfluorobutane sulphonate (PFBS), perfluoroheptanoic acid (PFHpA), perfluorohexanoic acid (PFHxA) and perfluorooctanoic acid (PFOA). Perfluorohexanoic sulphonate (PFHxS), perfluorodecanoic acid (PFDcA), perfluoroundecanoic acid (PFUdA) and perfluorodecanoic sulphonate (PFDcS) were analysed in cod blood only.

Limits of detection (LOD) were in the range of 0.1-1 ng/ml wet weight (w. w). A 0.5 ml sample of whole blood was used for analyses. Internal standards and 2 ml 50 % formic acid were added to each sample which was then placed in an ultrasonic bath for 15 min. After centrifugation, the supernatant was eluted through a WAX-SPE-column. After several purification steps the PFC-compounds were eluted with 2 % NH₄OH in MeOH. The extract was concentrated to 250 µl. Then, 20 mM aqueous ammonium acetate was added and the sample further purified by adding EnviroCarb and acetic acid. The analysis

of the extract was conducted using LC/MS-MS with negative ionization. As a part of quality control, three random samples were spiked with PFC-compounds and analysed in parallel with the samples. Three blank samples that contained all the chemicals were used in the analyses except the heparin solution. Elevated reporting limits for PFOA are caused by relatively high background in the blank samples.

LOD of cod liver were in the range of 2-7 ng/g w. w. and were higher than in blood due to matrix effects. PFCs were determined using liquid-chromatography coupled to tandem LC/MS-MS operated in negative electro-spray-ionisation (ESI) mode using multiple reaction monitoring (Green *et al.* 2010).

Results and discussion

The concentrations of PFCs in blood are reported in ng/ml w.w. and PFCs in liver are reported in ng/g w.w. Both units are equivalent to parts per billion (ppb) (Table 1, Appendix A and B).

Table 1. PFCs in blood (ng/ml w.w.) and liver (ng/g w.w.) in cod from the Inner Oslofjord 2009. Cod liver number 3, 5, 6, 10 and 13 were missing. PFHxS, PFDcA, PFUdA and PFDcS are additional analyses in blood only. The median included the LOD-value.

Cod no.	Blood (ng/ml w.w.)											Liver (ng/g w.w.)						
	PFOS	PFOSA	PFNA	PFBS	PFHpA	PFHxA	PFOA	PFHxS	PFDcA	PFUdA	PFDcS	PFOS	PFOSA	PFNA	PFBS	PFHpA	PFHxA	PFOA
1	22	283	5.2	<0.2	<0.2	<0.2	<4	0.19	5.0	8.0	<0.5	42	44	<2	<2	<3	<3	<2
2	33	164	1.8	<0.2	<0.2	<0.2	<4	<0.1	6.9	9.7	<0.5	44	36	<2	<2	<3	<3	<2
3	25	247	3.0	<0.2	<0.2	<0.2	<4	0.15	5.1	8.5	1.4							
4	32	297	3.9	<0.2	<0.2	<0.2	<4	0.16	7.8	12	0.55	28	45	<2	<2	<3	<3	<2
5	61	229	6.6	<0.2	<0.2	<0.2	<4	0.20	20	32	3.0							
6	42	228	4.8	<0.2	<0.2	<0.2	<4	0.22	7.0	13	1.6							
7	29	344	3.5	<0.2	<0.2	<0.2	<4	0.31	6.8	8.0	0.67	44	58	<2	<2	<3	<3	<2
8	25	87	2.1	<0.2	<0.2	<0.2	<4	0.11	6.8	10	<0.5	34	31	<2	<2	<3	<3	<2
9	38	196	6.0	<0.2	<0.2	<0.2	<4	0.23	8.8	15	0.8	79	40	<2	<2	<3	<3	<3
10	5	75	1.5	<0.2	<0.2	<0.2	<4	<0.1	0.9	1.5	<0.5							
11	16	496	0.7	<0.2	<0.2	<0.2	<4	<0.1	1.6	4.7	<0.5	10	38	<2	<2	<3	<3	<3
12	15	83	2.1	<0.2	<0.2	<0.2	<4	<0.1	4.4	10	<0.5	94	45	<2	<2	<4	<4	<2
13	42	216	3.5	<0.2	<0.2	<0.2	<4	0.11	9.1	13	0.81							
14	38	295	5.4	<0.2	<0.2	<0.2	<4	0.17	7.2	17	1.7	73	53	<2	<2	<3	<3	<2
15	13	219	0.6	<0.2	<0.2	<0.2	<4	<0.1	2.6	6.1	<0.5	46	59	<2	<2	<3	<3	<2
16	34	131	5.7	<0.2	<0.2	<0.2	<4	0.17	7.7	12	1.3	57	31	<2	<2	<3	<3	<2
17	18	235	0.6	<0.2	<0.2	<0.2	<4	<0.1	1.7	3.3	<0.5	34	87	<2	<2	<3	<3	<2
18	59	137	6.2	<0.2	<0.2	<0.2	<4	<0.1	11	16	0.69	86	17	<2	<2	<3	<3	<2
19	40	134	3.6	<0.2	<0.2	<0.2	<4	<0.1	8.9	15	0.78	94	29	<3	<2	<3	<3	<3
21	42	208	3.2	<0.2	<0.2	<0.2	<4	0.11	7.5	15	1.1	79	30	<3	<2	<3	<3	<3
21	61	184	4.9	<0.2	<0.2	<0.2	<4	<0.1	11	14	1.6	67	79	<3	<2	<3	<3	<3
22	29	174	4.2	<0.2	<0.2	<0.2	<4	0.33	4.6	8.2	1.3	44	43	<3	<2	<3	<3	<3
23	38	230	6.0	<0.2	<0.2	<0.2	<4	<0.1	8.7	15	<0.5	69	62	<3	<2	<3	<3	<3
24	9.0	90	2.2	<0.2	<0.2	<0.2	4.9	<0.1	2.7	4.0	<0.5	27	39	<2	<2	<3	<3	<2
25	36	254	4.1	<0.2	<0.2	<0.2	<4	0.11	9.2	15	1.0	50	30	<2	<2	<3	<3	<2
Limit of detection	0.2	0.5	0.4	0.2	0.2	0.2	4	0.1	0.2	0.4	0.5	2-7	1-2	2-3	2	3-4	3-4	2-3
Median	33	216	3.6	0.2	0.2	0.2	4.9	0.2	7.0	12	1.1	48	42	2	2	3	3	2

PFOS

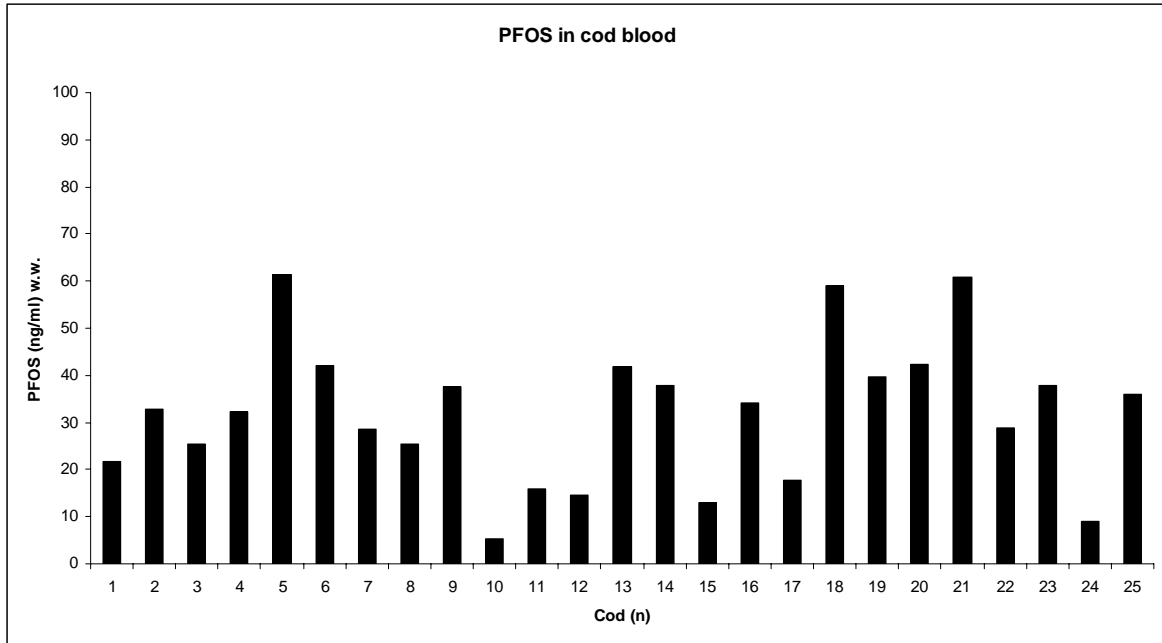


Figure 1. PFOS in cod blood from 25 individuals from the Inner Oslofjord sampled in 2009. Min/ max/ median concentrations: 5/ 61/ 33 ng/ml w.w. LOD: 0.2 ng/ml w.w.

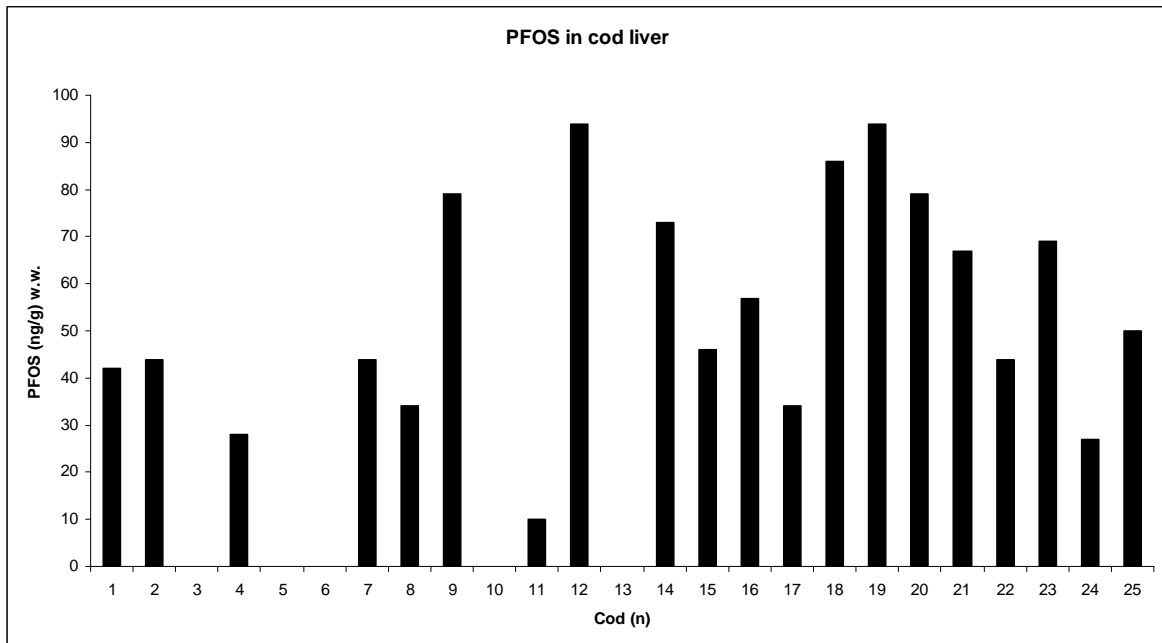


Figure 2. PFOS in cod liver from 20 individuals from the Inner Oslofjord sampled in 2009. Cod number 3, 5, 6, 10 and 13 were missing. Min/ max/ median concentrations: 10/ 94/ 48 ng/g w.w. LOD: 2-7 ng/g w.w.

PFOSA

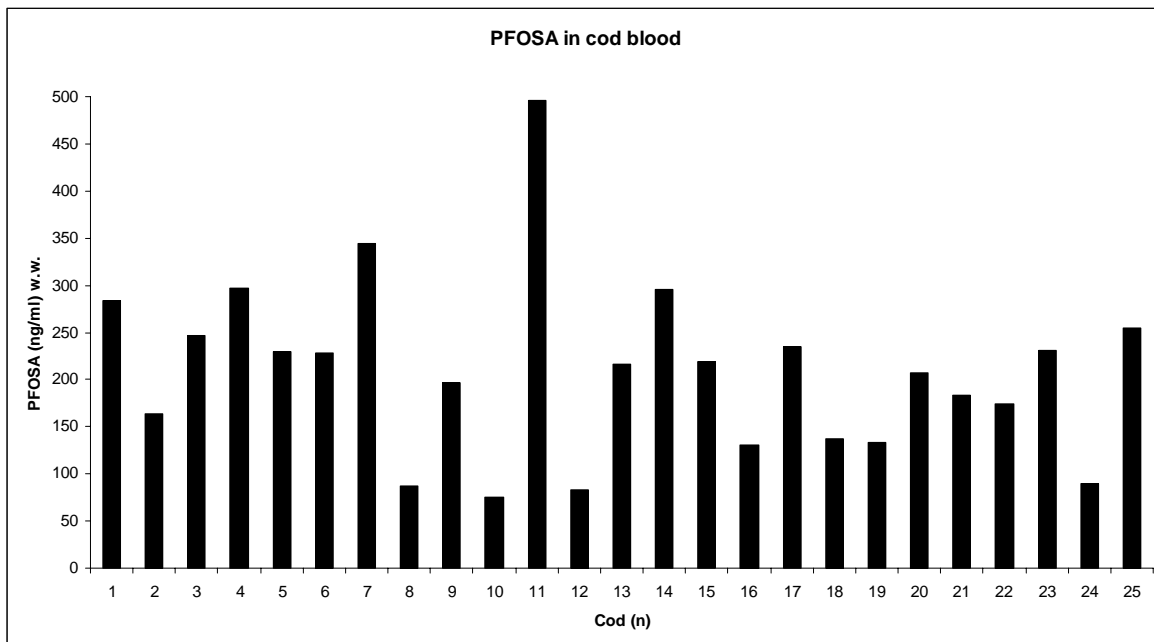


Figure 3. PFOSA in cod blood from 25 individuals from the Inner Oslofjord sampled in 2009. Min/ max/ median concentrations: 75/ 496/ 216 ng/ml w.w. LOD: 0.5 ng/ml w.w.

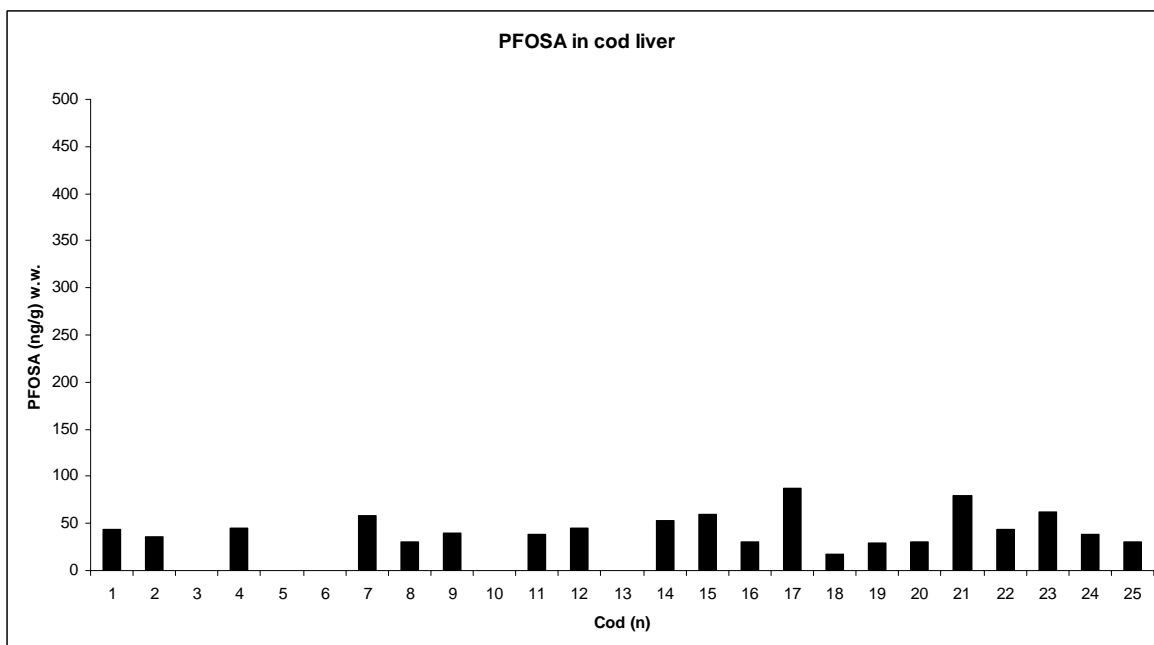


Figure 4. PFOSA (ng/g w.w.) in cod liver from 20 individuals from the Inner Oslofjord sampled in 2009. Cod number 3, 5, 6, 10 and 13 were missing. Min/ max/ median concentrations: 17/ 87/ 42 ng/g w.w. LOD: 1-2 ng/g w.w.

PFNA

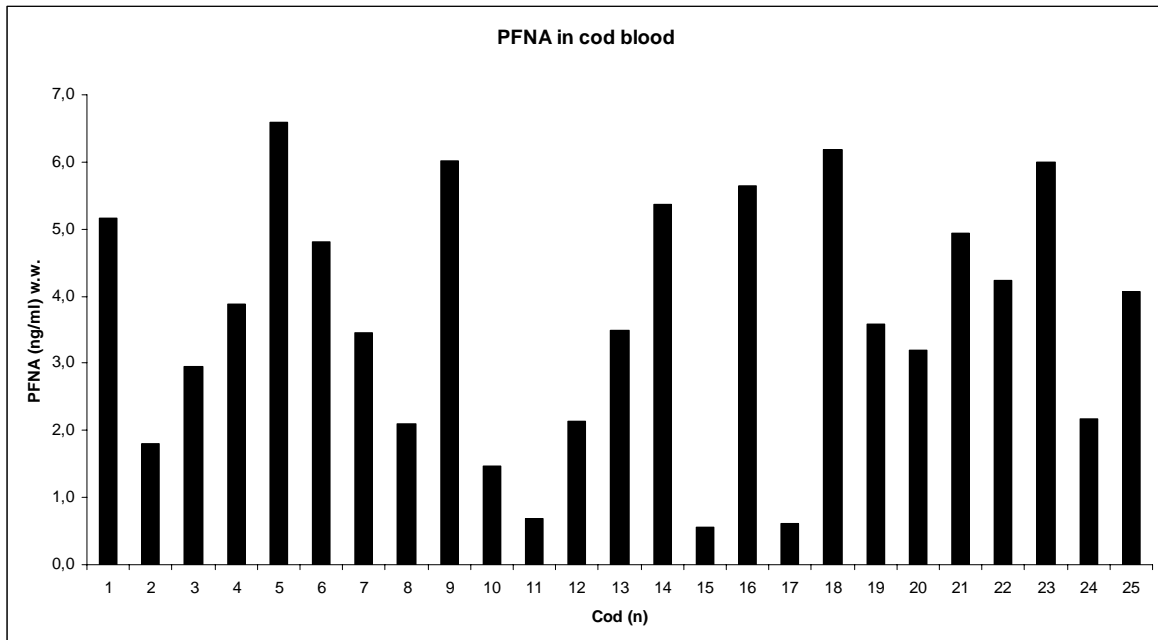


Figure 5. PFNA (ng/ml w.w.) in cod blood from 25 individuals from the Inner Oslofjord sampled in 2009. Min/ max/ median concentrations: 0.6 / 6.6/ 3.6 ng/ml w.w. LOD: 0.4 ng/ml w.w. PFNA could not be detected in cod liver.

PFHxS

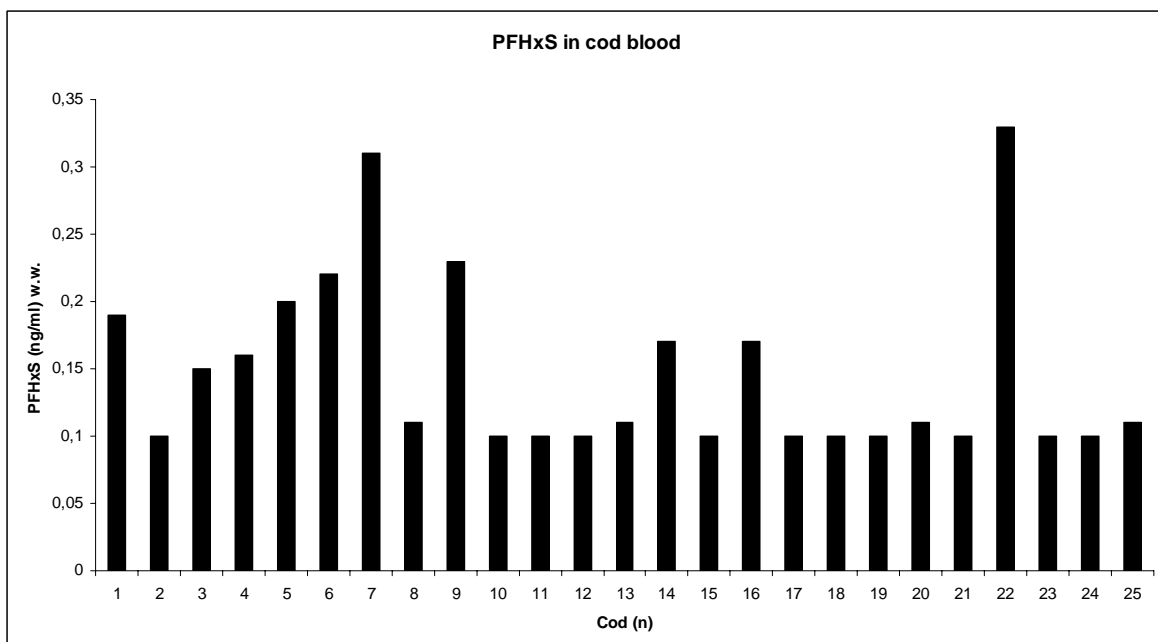


Figure 6. PFHxS (ng/ml w.w.) in cod blood from 25 individuals from the Inner Oslofjord sampled in 2009. Max/ median concentrations: 0.3/ 0.2 ng/ml w.w. LOD: 0.1 ng/ml w.w. The concentration of PFHxS was below the LOD in 11 individuals. PFHxS was not analysed in cod liver.

PFDCa

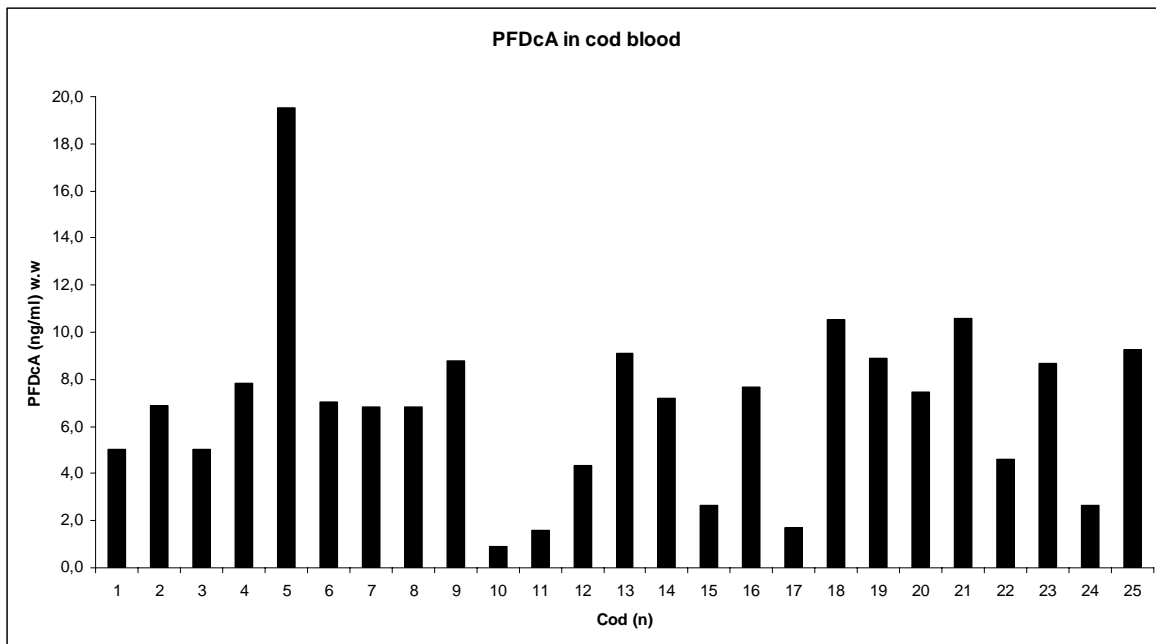


Figure 7. PFDCa (ng/ml w.w.) in cod blood from 25 individuals from the Inner Oslofjord sampled in 2009. Min/ max/ median concentrations: 0.9/ 20/ 7.0 ng/ml w.w. LOD: 0.2 ng/ml w.w. PFDCa was not analysed in cod liver.

PFUdA

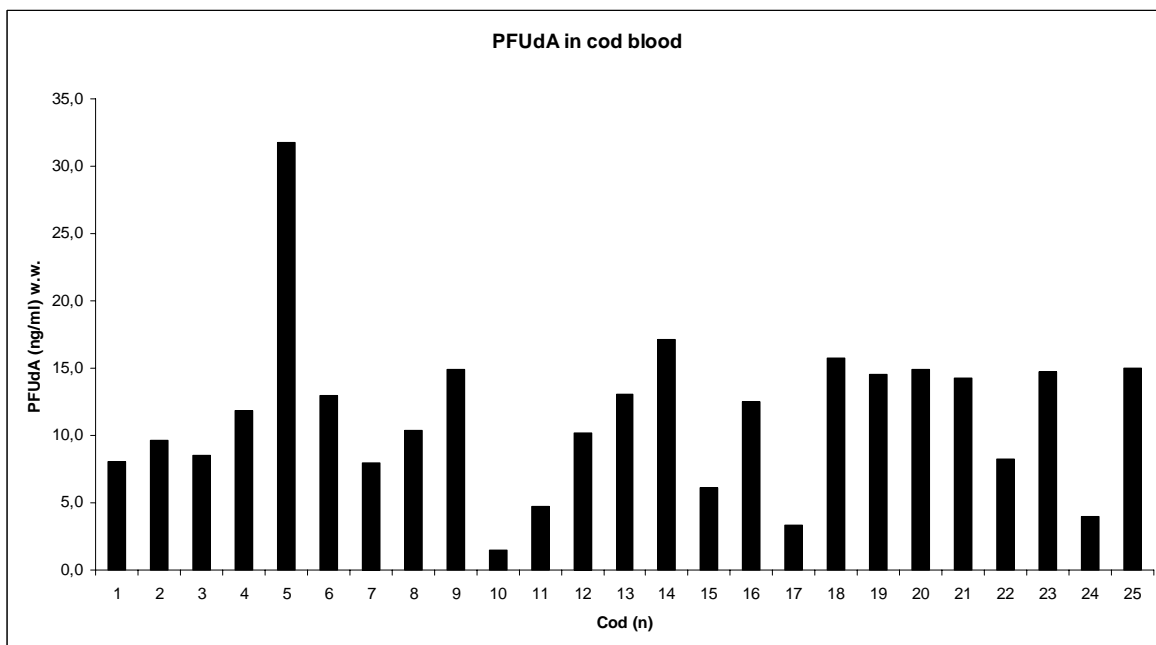


Figure 8. PFUdA (ng/ml w.w.) in cod blood from 25 individuals from the Inner Oslofjord sampled in 2009. Min/ max/ median concentrations: 1.5/ 32/ 12 ng/ml w.w. LOD: 0.4 ng/ml w.w. PFUdA was not analysed in cod liver.

PFDCs

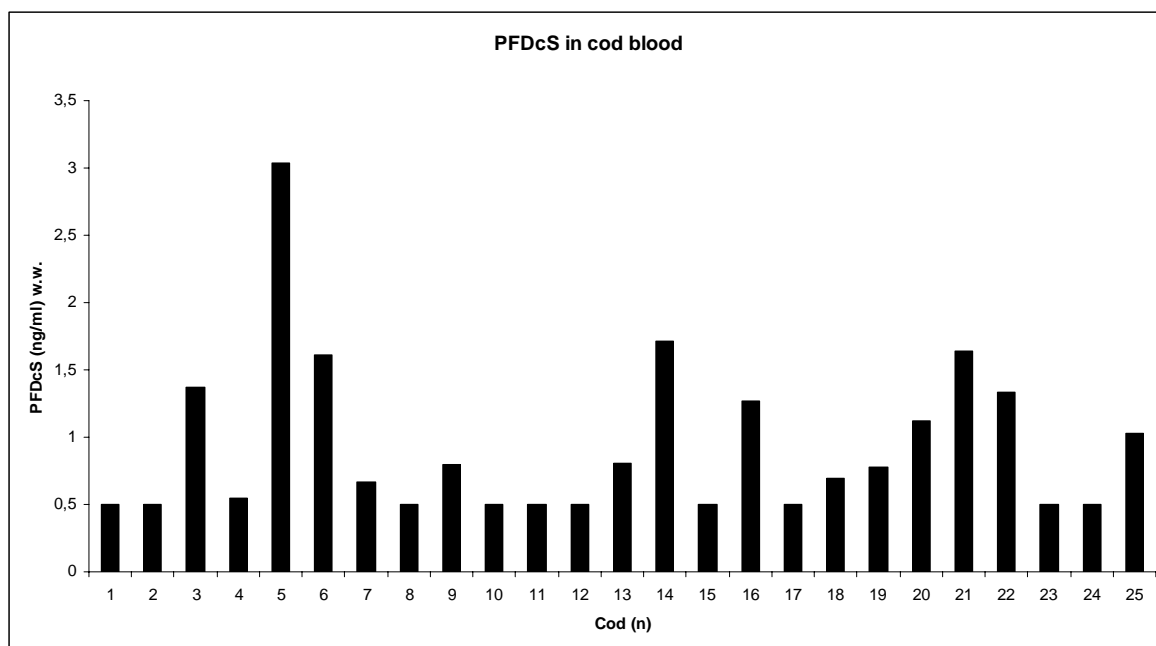


Figure 9. PFDCs (ng/ml w.w.) in cod blood from 25 individuals from the Inner Oslofjord sampled in 2009. Max/ median concentrations: 3.0/ 1.1 ng/ml w.w. LOD: 0.5 ng/ml w.w. The concentration of PFDCs was below the LOD in 10 individuals. PFDCs was not analysed in cod liver.

Blood

The results in cod blood showed that PFOS, PFOSA and PFNA were quantifiable. PFOSA was the most dominant PFC-compound and PFOS was the second dominant (Figure 10).

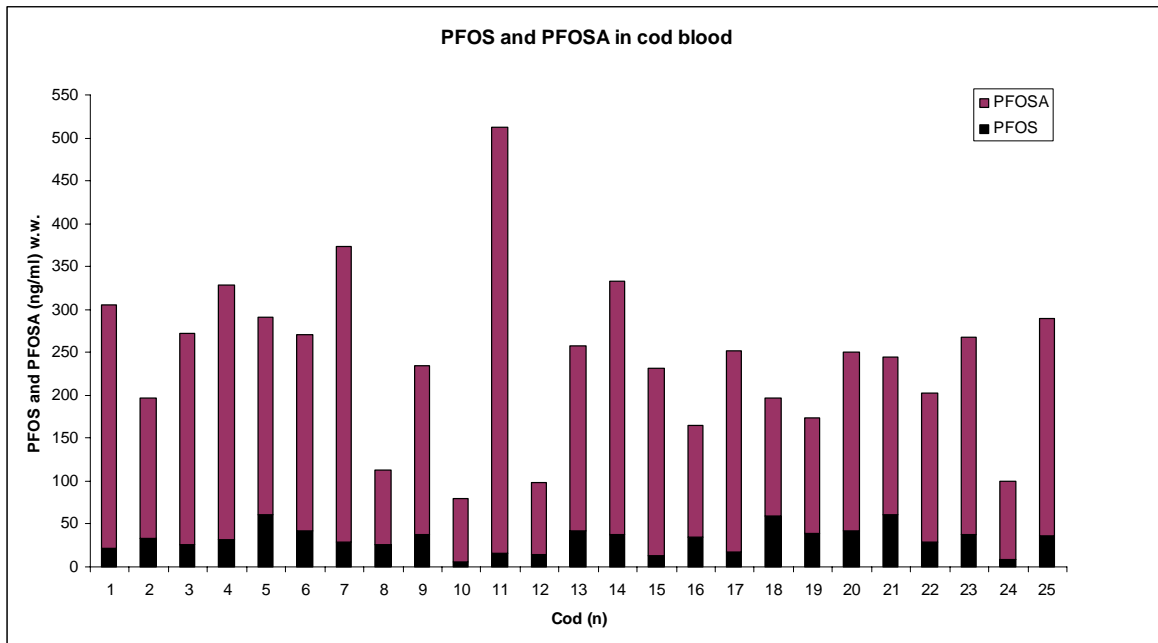


Figure 10. PFOS and PFOSA (ng/ml w.w.) in cod blood from 25 individuals from the Inner Oslofjord sampled in 2009. PFOSA was the most dominant PFC-compound.

The median concentrations were 33 ng/ml w.w. for PFOS, 216 ng/ml w.w. for PFOSA and 3.6 ng/ml w.w. for PFNA. The PFC-compounds PFBS, PFHpA and PFHxA were all below the LOD (<0.2 ng/ml w.w.). This was also the case for PFOA (LOD: <4 ng/ml w.w.) except for one cod (4.9 ng/ml w.w.). Quantifiable concentrations of PFHxS, PFDcA, PFUdA and PFDcS were also found. The median concentrations were 0.2 ng/ml w.w. for PFHxS, 7.0 ng/ml w.w. for PFDcA, 11.9 ng/ml w.w. for PFUdA and 1.1 ng/ml w.w. for PFDcS.

Liver

The results in cod liver showed that PFOS and PFOSA were quantifiable. PFOS was the most dominant PFC-compound found in cod liver in 2009 in the CEMP-programme (Green *et al.* 2010) (Figure 11).

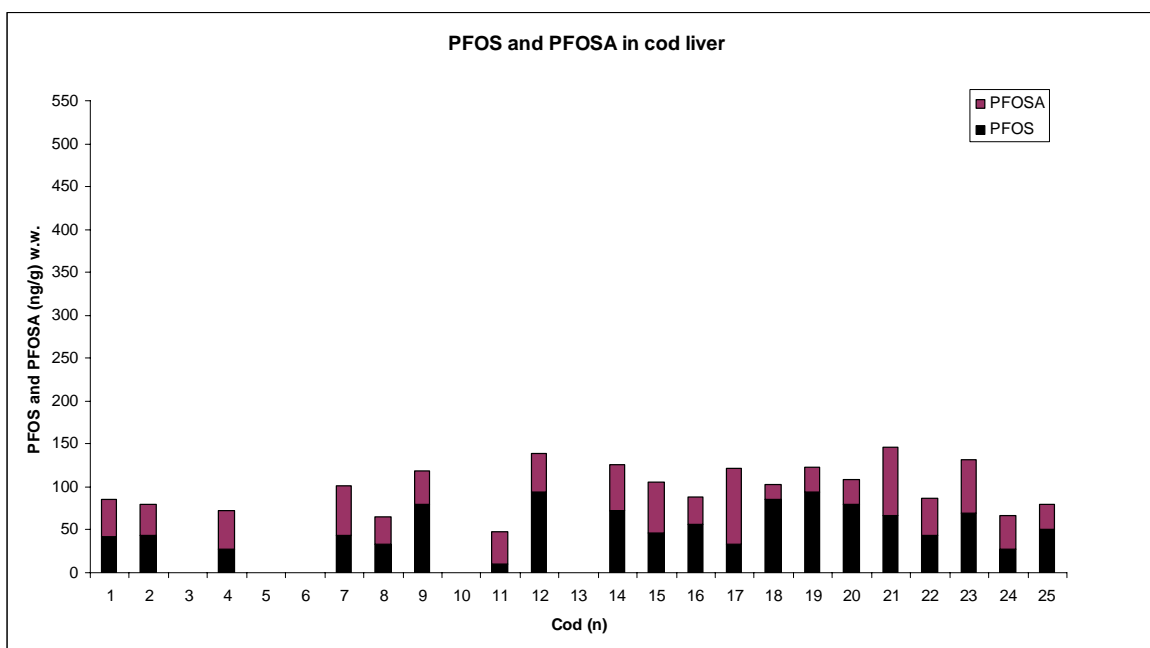


Figure 11. PFOS and PFOSA (ng/g w.w.) in cod liver from 20 individuals from the Inner Oslofjord sampled in 2009. PFOS was the most dominant PFC-compound.

Analyses of PFCs in cod liver have been included in the Norwegian CEMP-programme since 2005 (Green *et al.* 2010). There were higher median values of PFOS in the Inner Oslofjord in 2009 (48 ng/g w.w.) than in 2008 (42 ng/g w.w.) and 2007 (11 ng/g w.w.). The median concentrations in 2006 and 2005 were 49 and 38 ng/g w.w., respectively. The median concentration of PFOS in the Inner Oslofjord in 2009 was clearly higher than for the other nine stations along the Norwegian coast: Færder in the Outer Oslofjord (29 ng/g w.w.), Kristiansand harbour in the southern part of Norway (9 ng/g w.w.), the Inner Sjørfjord (3.2 ng/g w.w.), Karihavet area on the west coast (8.9 ng/g w.w.), Munkholmen in the Trondheim harbour (4.3 ng/g w.w.), Stokken north of the Trondheimsfjord (9.1 ng/g w.w.), Bjørnerøya in the Lofoten area (6.8 ng/g w.w.), Tromsø harbour (6.3 ng/g w.w.) and Kvænangen north of Skjervøy (5.5 ng/g w.w.). Median concentrations of PFOS observed in cod from presumed reference stations like Svolvær in Lofoten, Kvænangen, and the Varangerfjord in the north part of Norway indicated that high background concentrations in only diffusely contaminated areas might be around 10 ng/g w.w. (Bakke *et al.* 2007).

The second most abundant PFC-compound in cod liver was PFOSA with a median concentration of 41.5 ng/g w.w. The concentrations of the remaining PFCs (PFNA, PFBS, PFHpA, PFHxA, PFOA) were all below the LOD ranged from 2-4 ng/g w.w.

Conclusion

- PFOS and PFOSA were detected in cod blood and liver from the Inner Oslofjord and were the two PFC-compounds that were comparable.
- PFOSA was the most dominant PFC-compound in cod blood and the median level was 6 times higher than PFOS.
- The median level of PFOSA in cod blood was about 5 times higher than in liver.
- The median level of PFOS in cod liver was about 1.5 times higher than in blood.
- PFOS, as well as PFOSA, were dominant in cod liver.
- PFNA was also detected in cod blood.

References

- Bakke, T., Fjeld, E., Skaare, B.B., Berge, J.A., Green, N., Ruus, A., Schlabach, M., Botnen, H. 2007. Kartlegging av metaller og utvalgte nye organiske miljøgifter 2007. Krom, arsen, perfluoralkylstoffer, dikoretan, klorbenzener, pentaklorfenol, HCBd og DEHP. (Mapping of metals and selected new organic contaminants 2006. Chromium, Arsenic, Perfluorated substances, Dichloroethane, Chlorinated benzenes, Pentachlorophenol, HCBd and DEHP). Climate and Pollution Agency (Klif) report no. 990/2007 (TA-2284/2007). NIVA report no. 5464-2007. 105 p. + annexes. ISBN number 978-82-577-5199-9.
- Green, N.W., Schøyen, M., Øxnevad, S., Ruus, A., Høgåsen, T., Beylich, B., Håvardstun, J., Rogne, Å.G., Tveiten, L. 2010. Coordinated environmental monitoring programme (CEMP). Hazardous substances in fjords and coastal waters – 2009. Levels, trends and effects. Climate and Pollution Agency, Statlig program for forurensningsovervåking (National programme for pollution monitoring), report no. 2566/2010, TA number. 2566/2010. NIVA project number O-10106, 80106, 26106, 27106 and 28106 and report number 1062-2010, 287 p. ISBN number 978- 82-577-5602-4.

Appendix A
PFCs (w. w.) in cod blood from 2009

Side nr. 12/20

ANALYSE RAPPORT

Norsk Gaustadalléen 21
Institutt 0349 Oslo
for Tel: 22 18 51 00
Vannforskning Fax: 22 18 52 00

Navn **PFC i torskblod**
Adresse

Deres referanse:	Vår referanse:	Dato
	Rekv,nr, 2011-707	19/09/2011
	O,nr, O 11257	

Prøvene ble levert ved NIVAs laboratorium av oppdragsgiver, og merket slik som gjengitt i tabellen nedenfor, Prøvene ble analysert med følgende resultater (analyseusikkerhet kan fås ved henvendelse til laboratoriet):

Prøvenr	Prøve merket	Prøvetakings-dato	Mottatt NIVA	Analyseperiode
1	1 hel blod, St30B CEMP	2009,11,10	2011,05,05	2011,07,22-2011,07,25
2	2 hel blod, St30B CEMP	2009,11,10	2011,05,05	2011,07,22-2011,07,25
3	3 hel blod, St30B CEMP	2009,11,10	2011,05,05	2011,07,22-2011,07,25
4	4 hel blod, St30B CEMP	2009,11,10	2011,05,05	2011,07,22-2011,07,25
5	5 hel blod, St30B CEMP	2009,11,10	2011,05,05	2011,07,22-2011,07,25
6	6 hel blod, St30B CEMP	2009,11,10	2011,05,05	2011,07,22-2011,07,25
7	7 hel blod, St30B CEMP	2009,11,10	2011,05,05	2011,07,22-2011,07,25

Analysevariabel	Prøvenr Enhhet	1	2	3	4	5	6	7
		PFBS i biol. mat. ng/ml	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2
PFHpA i biol. mat. ng/ml	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2
PFHxA i biol. mat. ng/ml	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2
PFNA i biol. mat. ng/ml	5,2	1,8	3,0	3,9	6,6	4,8	3,5	
PFOA i biol. mat. ng/ml	<4	<4	<4	<4	<4	<4	<4	<4
PFOSA i biol. mat. ng/ml	283	164	247	297	229	228	344	
PFOS i biol. mat. ng/ml	0,19	<0,1	0,15	0,16	0,2	0,22	0,31	
PFHxS i biol. mat. ng/ml	5	6,9	5,1	7,8	20	7	6,8	
PFDCa i biol. mat. ng/ml	8	9,7	8,5	12	32	13	8	
PFUDa i biol. mat. ng/ml	<0,5	<0,5	1,4	0,55	3	1,6	0,67	
PFDCs i biol. mat. ng/ml	0,19	<0,1	0,15	0,16	0,2	0,22	0,31	

Kommentarer

- 1 Forhøyet rapporteringsgrense for PFOA skyldes relativt høy bakgrunn i blindprøvene,

ANALYSE RAPPORT

Rekv,nr, 2011-707

(fortsettelse av tabellen):

Prøvenr	Prøve merket	Prøvetakings- dato	Mottatt NIVA	Analyseperiode
8	8 hel blod, St30B CEMP	2009,11,10	2011,05,05	2011,07,22-2011,07,25
9	9 hel blod, St30B CEMP	2009,11,10	2011,05,05	2011,07,22-2011,07,25
10	10 hel blod, St30B CEMP	2009,11,10	2011,05,05	2011,07,22-2011,07,25
11	11 hel blod, St30B CEMP	2009,11,10	2011,05,05	2011,07,22-2011,07,25
12	12 hel blod, St30B CEMP	2009,11,10	2011,05,05	2011,07,22-2011,07,25
13	13 hel blod, St30B CEMP	2009,11,10	2011,05,05	2011,07,22-2011,07,25
14	14 hel blod, St30B CEMP	2009,11,10	2011,05,05	2011,07,22-2011,07,25

Analysevariabel	Prøvenr Enhhet	8	9	10	11	12	13	14
PFBS i biol. mat.	ng/ml	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2
PFHpA i biol. mat.	ng/ml	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2
PFHxA i biol. mat.	ng/ml	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2
PFNA i biol. mat.	ng/ml	2,1	6,0	1,5	0,7	2,1	3,5	5,4
PFOA i biol. mat.	ng/ml	<4	<4	<4	<4	<4	<4	<4
PFOSA i biol. mat.	ng/ml	87	196	75	496	83	216	295
PFOS i biol. mat.	ng/ml	25	38	5	16	15	42	38
PFHxS i biol. mat.	ng/ml	0,11	0,23	<0,1	<0,1	<0,1	0,11	0,17
PFdCA i biol. mat.	ng/ml	6,8	8,8	0,9	1,6	4,4	9,1	7,2
PFUDA i biol. mat.	ng/ml	10	15	1,5	4,7	10	13	17
PFdCS i biol. mat.	ng/ml	<0,5	0,8	<0,5	<0,5	<0,5	0,81	1,7

ANALYSE RAPPORT

Rekv,nr, 2011-707

(fortsettelse av tabellen):

Prøvenr	Prøve merket	Prøvetakings- dato	Mottatt NIVA	Analyseperiode
15	15 hel blod, St30B CEMP	2009,11,10	2011,05,05	2011,07,22-2011,07,25
16	16 hel blod, St30B CEMP	2009,11,10	2011,05,05	2011,07,22-2011,07,25
17	17 hel blod, St30B CEMP	2009,11,10	2011,05,05	2011,07,22-2011,07,25
18	18 hel blod, St30B CEMP	2009,11,10	2011,05,05	2011,07,22-2011,07,25
19	19 hel blod, St30B CEMP	2009,11,10	2011,05,05	2011,07,22-2011,07,25
20	20 hel blod, St30B CEMP	2009,11,10	2011,05,05	2011,07,22-2011,07,25
21	21 hel blod, St30B CEMP	2009,11,10	2011,05,05	2011,07,22-2011,07,25

Analysevariabel	Prøvenr Enhhet	15	16	17	18	19	20	21
PFBS i biol. mat.	ng/ml	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2
PFHpA i biol. mat.	ng/ml	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2
PFHxA i biol. mat.	ng/ml	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2
PFNA i biol. mat.	ng/ml	0,6	5,7	0,6	6,2	3,6	3,2	4,9
PFOA i biol. mat.	ng/ml	<4	<4	<4	<4	<4	<4	<4
PFOSA i biol. mat.	ng/ml	219	131	235	137	134	208	184
PFOS i biol. mat.	ng/ml	13	34	18	59	40	42	61
PFHxS i biol. mat.	ng/ml	<0,1	0,17	<0,1	<0,1	<0,1	0,11	<0,1
PFDA i biol. mat.	ng/ml	2,6	7,7	1,7	11	8,9	7,5	11
PFUdA i biol. mat.	ng/ml	6,1	12	3,3	16	15	15	14
PFDCS i biol. mat.	ng/ml	<0,5	1,3	<0,5	0,69	0,78	1,1	1,6

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Rekv,nr, 2011-707

(fortsettelse av tabellen):

Prøvenr	Prøve merket	Prøvetakings- dato	Mottatt NIVA	Analyseperiode
22	22 hel blod, St30B CEMP	2009,11,10	2011,05,05	2011,07,22-2011,07,25
23	23 hel blod, St30B CEMP	2009,11,10	2011,05,05	2011,07,22-2011,07,25
24	24 hel blod, St30B CEMP	2009,11,10	2011,05,05	2011,07,22-2011,07,25
25	25 hel blod, St30B CEMP	2009,11,10	2011,05,05	2011,07,22-2011,07,25

Analysevariabel	Prøvenr Enhet	22	23	24	25
		PFBS i biol. mat. ng/ml	<0,2	<0,2	<0,2
PFHpA i biol. mat. ng/ml	<0,2	<0,2	<0,2	<0,2	
PFHxA i biol. mat. ng/ml	<0,2	<0,2	<0,2	<0,2	
PFNA i biol. mat. ng/ml	4,2	6,0	2,2	4,1	
PFOA i biol. mat. ng/ml	<4	<4	4,9	<4	
PFOSA i biol. mat. ng/ml	174	230	90	254	
PFOS i biol. mat. ng/ml	29	38	9,0	36	
PFHxS i biol. mat. ng/ml	0,33	<0,1	<0,1	0,11	
PFDCa i biol. mat. ng/ml	4,6	8,7	2,7	9,2	
PFUDA i biol. mat. ng/ml	8,2	15	4	15	
PFDCS i biol. mat. ng/ml	1,3	<0,5	<0,5	1	

Norsk institutt for vannforskning

Alfhild Kringstad

Appendix B

PFCs (w. w.) in cod liver from 2009 (see also Green *et al.* 2010)

Side nr. 16/20

Norsk Institutt for Vannforskning
 Gaustadalléen 21
 0349 Oslo
 Tel: 22 18 51 00
 Fax: 22 18 52 00

ANALYSE RAPPORT



Navn CEMP
 Adresse

Deres referanse:
AAK

Vår referanse:
Rekv.nr. 2009-2663
O.nr. O 29106ANA

Dato
19/09/2011

Prøvene ble levert ved NIVAs laboratorium av oppdragsgiver, og merket slik som gjengitt i tabellen nedenfor. Prøvene ble analysert med følgende resultater (analyseusikkerhet kan fås ved henvendelse til laboratoriet):

Prøvenr	Prøve merket	Prøvetakings-dato	Mottatt NIVA	Analyseperiode
1	30B Oslofjorden, fisk 1	2009.11.10	2009.11.18	1900.09.09-2010.08.06
2	30B Oslofjorden, fisk 2	2009.11.10	2009.11.18	1900.09.09-2010.08.06
3	30B Oslofjorden, fisk 3	2009.11.10	2009.11.18	1900.09.09-2010.08.06
4	30B Oslofjorden, fisk 4	2009.11.10	2009.11.18	1900.09.09-2010.08.06
5	30B Oslofjorden, fisk 5	2009.11.10	2009.11.18	1900.09.09-2010.08.06
6	30B Oslofjorden, fisk 6	2009.11.10	2009.11.18	1900.09.09-2010.08.06
7	30B Oslofjorden, fisk 7	2009.11.10	2009.11.18	1900.09.09-2010.08.06

Prøvenr	1	2	3	4	5	6	7
Analysevariabel							
Enhet							
Metode							
PFBS i biol. mat. µg/kg v.v. Intern*	<2	<2	m	<2	m	m	<2
PFHpA i biol. mat. µg/kg v.v. Intern*	<3	<3	m	<3	m	m	<3
PFHxA i biol. mat. µg/kg v.v. Intern*	<3	<3	m	<3	m	m	<3
PFNA i biol. mat. µg/kg v.v. Intern*	<2	<2	m	<2	m	m	<2
PFOA i biol. mat. µg/kg v.v. Intern*	<2	<2	m	<2	m	m	<2
PFOSA i biol. mat. µg/kg v.v. Intern*	44	36	m	45	m	m	58
PFOS i biol. mat. µg/kg v.v. Intern*	42	44	m	28	m	m	44

* : Metoden er ikke akkreditert.

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Rekv.nr. 2009-2663

(fortsettelse av tabellen):

Prøvenr	Prøve merket	Prøvetakings- dato	Mottatt NIVA	Analyseperiode
8	30B Oslofjorden, fisk 8	2009.11.10	2009.11.18	1900.09.09-2010.08.06
9	30B Oslofjorden, fisk 9	2009.11.10	2009.11.18	1900.09.09-2010.08.06
10	30B Oslofjorden, fisk 10	2009.11.10	2009.11.18	1900.09.09-2010.08.06
11	30B Oslofjorden, fisk 11	2009.11.10	2009.11.18	1900.09.09-2010.08.06
12	30B Oslofjorden, fisk 12	2009.11.10	2009.11.18	1900.09.09-2010.08.06
13	30B Oslofjorden, fisk 13	2009.11.10	2009.11.18	1900.09.09-2010.08.06
14	30B Oslofjorden, fisk 14	2009.11.10	2009.11.18	1900.09.09-2010.08.06

Prøvenr Analysevariabel Enhet Metode	8	9	10	11	12	13	14
PFBS i biol. mat. µg/kg v.v. Intern*	<2	<2	m	<2	<2	m	<2
PFHpA i biol. mat. µg/kg v.v. Intern*	<3	<3	m	<3	<4	m	<3
PFHxA i biol. mat. µg/kg v.v. Intern*	<3	<3	m	<3	<4	m	<3
PFNA i biol. mat. µg/kg v.v. Intern*	<2	<2	m	<2	<2	m	<2
PFOA i biol. mat. µg/kg v.v. Intern*	<2	<3	m	<3	<2	m	<2
PFOSA i biol. mat. µg/kg v.v. Intern*	31	40	m	38	45	m	53
PFOS i biol. mat. µg/kg v.v. Intern*	34	79	m	10	94	m	73

* : Metoden er ikke akkreditert.

ANALYSE RAPPORT



Rekv.nr. 2009-2663

(fortsettelse av tabellen):

Prøvenr	Prøve merket	Prøvetakings- dato	Mottatt NIVA	Analyseperiode
15	30B Oslofjorden, fisk 15	2009.11.10	2009.11.18	1900.09.09-2010.08.06
16	30B Oslofjorden, fisk 16	2009.11.10	2009.11.18	1900.09.09-2010.08.06
17	30B Oslofjorden, fisk 17	2009.11.10	2009.11.18	1900.09.09-2010.08.06
18	30B Oslofjorden, fisk 18	2009.11.10	2009.11.18	1900.09.09-2010.08.06
19	30B Oslofjorden, fisk 19	2009.11.10	2009.11.18	1900.09.09-2010.08.06
20	30B Oslofjorden, fisk 20	2009.11.10	2009.11.18	1900.09.09-2010.08.06
21	30B Oslofjorden, fisk 21	2009.11.10	2009.11.18	1900.09.09-2010.08.06

Prøvenr	15	16	17	18	19	20	21
Analysevariabel							
Enhet							
Metode							
PFBS i biol. mat. µg/kg v.v. Intern*	<2	<2	<2	<2	<2	<2	<2
PFHpA i biol. mat. µg/kg v.v. Intern*	<3	<3	<3	<3	<3	<3	<3
PFHxA i biol. mat. µg/kg v.v. Intern*	<3	<3	<3	<3	<3	<3	<3
PFNA i biol. mat. µg/kg v.v. Intern*	<2	<2	<2	<2	<3	<3	<3
PFOA i biol. mat. µg/kg v.v. Intern*	<2	<2	<2	<2	<3	<3	<3
PFOSA i biol. mat. µg/kg v.v. Intern*	59	31	87	17	29	30	79
PFOS i biol. mat. µg/kg v.v. Intern*	46	57	34	86	94	79	67

* : Metoden er ikke akkreditert.

ANALYSE RAPPORT



Rekv.nr. 2009-2663

(fortsettelse av tabellen):

Prøvenr	Prøve merket	Prøvetakings- dato	Mottatt NIVA	Analyseperiode
22	30B Oslofjorden, fisk 22	2009.11.10	2009.11.18	1900.09.09-2010.08.06
23	30B Oslofjorden, fisk 23	2009.11.10	2009.11.18	1900.09.09-2010.08.06
24	30B Oslofjorden, fisk 24	2009.11.10	2009.11.18	1900.09.09-2010.08.06
25	30B Oslofjorden, fisk 25	2009.11.10	2009.11.18	1900.09.09-2010.08.06

Analysevariabel	Enhet	Prøvenr Metode	22	23	24	25
PFBS i biol. mat.	µg/kg v.v.	Intern*	<2	<2	<2	<2
PFHpA i biol. mat.	µg/kg v.v.	Intern*	<3	<3	<3	<3
PFHxA i biol. mat.	µg/kg v.v.	Intern*	<3	<3	<3	<3
PFNA i biol. mat.	µg/kg v.v.	Intern*	<3	<3	<2	<2
PFOA i biol. mat.	µg/kg v.v.	Intern*	<3	<3	<2	<2
PFOSA i biol. mat.	µg/kg v.v.	Intern*	43	62	39	30
PFOS i biol. mat.	µg/kg v.v.	Intern*	44	69	27	50

* : Metoden er ikke akkreditert.

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Alfhild Kringstad

Appendix C

Sex, age, weight and length of cod from 2009 (see also Green *et al.* 2010)

Sample/ repl. no.	Sex F/M	Age year	Weight g	Length mm
1/1	M	4	2300	580
2/1	M	4	1800	550
3/1	F	1	379	345
4/1	F	4	1300	540
5/1	F	2	640	415
6/1	M	4	1400	525
7/1	F	4	950	470
8/1	F	2	950	445
9/1	M	3	950	445
10/1	F	3	700	445
11/1	F	6	6500	850
12/1	M	3	1100	470
13/1	M	2	800	440
14/1	M	2	850	440
15/1	M	4	1200	505
16/1	F	3	1700	560
17/1	M	4	1700	555
18/1	M		1400	505
19/1	F	3	1100	495
20/1	F	2	750	420
21/1	F	4	2700	610
22/1	F	2	950	475
23/1	M	4	1800	535
24/1	M	2	850	450
25/1	M	2	1000	480
Mean		3	1431	502
Minimum		1	379	345
Maximum		6	6500	850
St. Dev		1	1185	94
Count		24	25	25