COMPARISON OF DARWIN FOOD SAMPLES WITH PFAS TRIGGER LEVELS

Prepared for Northern Territory Department of Health

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1. Background

The Northern Territory Department of Health requested that Food Standards Australia New Zealand (FSANZ) review per- and poly-fluoroalkylated substances (PFAS) analytical data for fish and seafood samples caught in Darwin waters (marine and river sites) and some other foods from the Darwin area and compare these data to the trigger levels proposed by FSANZ.

In April 2017 the Australian Department of Health published FSANZ's recommendations on appropriate tolerable daily intakes (TDIs) for perfluorooctane sulfohate (PFOS) and perfluorooctanoic acid (PFOA). Insufficient evidence was available to establish a TDI for perfluorohexane sulfonate (PFHxS), but FSANZ recommended that the TDI for PFOS should be used, meaning that PFOS and PFHxS concentrations should be summed for the purposes of risk assessment. In addition, FSANZ proposed 'trigger levels' for a range of food groups which indicate concentrations above which further consideration may be warranted by regulatory agencies. These reports were published on the Australian Department of Health website[1].

2. Analytical data

PFAS analytical data were provided to FSANZ for produce from the Darwin area, including fish and seafood, animal products, fruit and vegetables. Where duplicate and triplicate analyses were supplied for the same food sample, these values were averaged before further data analysis. A small number of fish samples were excluded from the database prepared for the dietary exposure assessment where the sample was for a small whole fish and not flesh only. For fish flesh, fish livers, crustaceans and other food samples, a small proportion of analytical results were for a composite sample. In these cases the analytical value was replicated in the database the same number of times as the number of contributing sub-samples. This was not done for molluscs as all analytical results were from composite samples. In addition, these foods are rarely consumed singly and the composite value was taken to represent the food as eaten.

For most of the data reported the level of reporting (LOR) was 0.3 µg/kg for PFOS and PFHxS and 0.5 µg/kg for PFOA. Non-detect results were assigned the LOR to enable upper bound mean and median values to be calculated; for non-detect results for PFOS+PFHxS combined a value of the sum of PFOS LOR and PFHxS LOR (usually 0.6 µg/kg) was assigned. Lower LORs were achieved by some laboratories for a few food matrices and occasionally the LOR was higher because the sample size was too small to achieve the standard LOR. These differences are noted in the text where relevant. For the purposes of this analysis, non-detect results were assigned the LOR as reported for that individual food sample, with no statistical adjustment made where different LORs were reported for the same food/chemical matrix.

2.1. Fish and seafood

PFAS analytical data were provided for 332 fish and other seafood samples caught in the Darwin waters from June 2016 to April 2018. Following data preparation 99 data points for fish flesh, 74 for fish liver, 165 for crustacean and 51 for molluscs were available in the database for further analysis following data clean up.

Fifteen species of fish were analysed including 3 diadromous fish (Barramundi, Salmon, Tarpon), 2 freshwater fish (Catfish, Spangled Perch) and 10 marine fish species (Branded Archerfish, Barred Javelin, Brown Sweetlips, Flathead, Giant Queenfish, Golden Snapper, Goldspotted Rockcod, Mangrove Jack, Mullet and shark). Fish flesh was analysed for all samples and fish liver for all species except Mullet.

Three crustacean species were analysed (crabs whole or flesh only, prawn, Redclaw Crayfish) and 6 molluscs species (Cockle, Long Bum, Oysters, Periwinkle, Terabralia, Whelk).

Data provided indicated that PFOS was detected at levels greater than the LOR of 0.3 µg/kg in 79 of the 99 fish flesh samples, in all the 74 fish liver samples, in 159 of the 165 crustacea samples and in 49 of the 51

[1] See Department of Health: Health Based Guidance Values for Per- and Poly Fluoroalkyl Substances http://www.health.gov.au/internet/main/publishing.nsf/Content/ohp-pfas-hbgv.htm

molluscs samples. Concentrations for the other two PFAS congeners considered in this report, PFOA and PFHxS, indicated a higher proportion of results less than the relevant LOR, compared to PFOS.

PFOA was detected at low levels (0.04 and 0.07 µg/kg in 8 replicate fish flesh samples and was not detected (<LOR of 0.5 µg/kg) in the remaining 91 fish flesh samples. PFOA was detected in 13 of the 74 fish liver samples, in 76 of the 165 crustacea samples and in 45 of the 51 molluscs samples (LOR of 0.5 µg/kg for all samples except for three mollusc samples with a LOR of 0.04 µg/kg).

PFHxS was detected at levels greater than the LOR of 0.3 µg/kg in 29 of the 99 fish flesh samples, in 49 of the 74 fish liver samples, in 140 of the 165 crustacea samples and in 34 of the 51 molluscs samples.

2.2. Animal products

Limited PFAS analytical data were available for four indigenous animal foods, Children's Python (1 sample), Keelback Snake (2 samples), Magpie Goose (3 samples) and Northern Brown Bandicoot (1 sample).

Data provided indicated that PFOS was detected at levels greater than the level of reporting (LOR) of 0.3 µg/kg in 4 of the 8 animal meat samples. PFAS concentrations in the animal meat samples were greater than the LOR of 0.3 µg/kg for PFHxS for 3 of 7 samples, and <LOR of 0.5 µg/kg for PFOA for all samples.

2.3. Fruit and vegetables

Limited PFAS analytical data were available for 5 fruit species (9 data points) and 10 vegetable species (15 data points).

Data provided indicated that PFAS (PFOS, PFHxS, PFOA) was not detected at levels greater than the relevant level of reporting for any of the fruit and vegetables analysed.

2.4. Summary of analytical data

Summary data for PFOS, PFOA, PFHxS and PFOS+PFHxS combined for fish and seafood are provided in Table 1. Table 2 provides summary data for PFOS, PFOA, PFHxS and PFOS+PFHxS for each individual fish and seafood species analysed with a sample size of ≥25. Detailed results for PFOS+PFHxS for all fish and seafood species sampled are at Attachment 1. As reported elsewhere in the world, PFAS levels were generally higher on average in freshwater fish species than in diadromous fish with marine fish having the lowest levels reported[2].

Summary data for PFOS, PFOA, PFHxS and PFOS+PFHxS combined for indigenous foods are provided in Table 3 and for fruit and vegetables in Table 4.

[2] Attachment 1 to Supporting Document 2 of Department of Health Consolidated Report on PFAS, titled Occurrence of and dietary exposure to PFOS, PFOA and PFHxS reported in the literature http://www.health.gov.au/internet/main/publishing.nsf/Content/ohp-pfas-hbgv.htm

Table 1 Summary PFAS concentration data (µg/kg) for Darwin fish and seafood

Matrix	Chemical	Count	Count of <LOR	Minimum	Maximum	Mean**	Median**
Fish Flesh*	PFHxS	99	70	<LOR	7.1	0.6	0.3
	PFOA	99	91	<LOR	0.07~	0.5	0.5
	PFOS	99	20	<LOR	450.0	19.0	2.0
	PFOS+PFHxS	99	20	<LOR	450.3	19.6	2.3
Fish liver*	PFHxS	74	25	<LOR	130.0	11.2	2.4
	PFOA	74	61	<LOR	2.8^	0.7	0.5
	PFOS	74	0	0.7	4000.0	320.5	54.5
	PFOS+PFHxS	74	0	0.7	4130.0	331.7	65.6
Crustacea*	PFHxS	165	25	<LOR	64.0	3.7	0.8
	PFOA	165	89	<LOR	9.2	0.8	0.5
	PFOS	165	6	<LOR	139.2	22.5	23.0
	PFOS+PFHxS	165	6	<LOR	180.1	26.2	29.5
Molluscs*	PFHxS	51	17	<LOR	56.0	3.2	0.3
	PFOA	51	6	<LOR	47.0	4.1	2.2
	PFOS	51	2	<LOR	100.0	10.3	3.1
	PFOS+PFHxS	51	2	<LOR	118.0	13.5	3.3

*All species combined
** Upper bound mean and median derived where not detected results are assigned a concentration equal to LOR (LOR of 0.3 µg/kg for PFOS, PFHxS, 0.5 µg/kg for PFOA unless otherwise reported).
~ Maximum quantified result: 8 replicate fish flesh samples had quantified results at limits of detection much lower than the standard PFOA LOR of 0.5 µg/kg, which was the LOR for the majority of fish flesh samples. The upper bound mean and median values reflect values assigned to LOR results for the majority of samples.
^ Maximum quantified result, two fish liver samples had a PFOA LOR of 5 µg/kg.

Table 2 Summary PFAS concentration data (µg/kg) by fish and seafood species with a sample size ≥25

Matrix	Chemical	Count	Count of <LOR	Minimum	Maximum	Mean*	Median*
Barramundi flesh	PFHxS	36	18	<LOR	1.5	0.6	0.4
	PFOA	36	28	<LOR	0.5	0.4	0.5
	PFOS	36	1	<LOR	47.0	12.5	2.9
	PFOS+PFHxS	36	1	<LOR	47.8	13.1	3.5
Barramundi liver	PFHxS	35	6	<LOR	26.6	8.7	7.0
	PFOA	35	27	<LOR	0.6	0.5	0.5
	PFOS	35	0	8.5	440.0	153.8	72.9
	PFOS+PFHxS	35	0	8.5	440.7	162.6	90.1
Crab flesh	PFHxS	49	16	<LOR	14.0	1.0	0.4
	PFOA	49	34	<LOR	0.5	0.4	0.5
	PFOS	49	5	<LOR	42.0	5.9	3.3
	PFOS+PFHxS	49	5	<LOR	44.1	6.9	3.6

* Upper bound mean and median derived where not detected results are assigned a concentration equal to LOR (LOR is 0.3 µg/kg for PFOS, PFHxS, 0.5 µg/kg for PFOA unless otherwise reported).

Table 3 Summary PFAS concentration data (µg/kg) for indigenous foods

Matrix	Chemical	Count	Count of <LOR	Minimum	Maximum	Mean*	Median*
Children's Python^	PFHxS	1	0	3.4	3.4	3.4	
	PFOA	1	1	<LOR	<LOR	0.5	
	PFOS	1	0	37	37	37	
	PFOS+PFHxS	1	0	40.4	40.4	40.4	
Keelback Snake	PFHxS	2	0	42	54	48	48
	PFOA	2	2	<LOR	<LOR	0.5	0.5
	PFOS	2	0	2500	2800	2650	2650
	PFOS+PFHxS	2	0	2542	2854	2698	2698
Magpie Goose	PFHxS	3	3	<LOR	<LOR	0.3	0.3
	PFOA	3	3	<LOR	<LOR	0.5	0.5
	PFOS	3	3	<LOR	<LOR	0.3	0.3
	PFOS+PFHxS	3	3	<LOR	<LOR	0.6	0.6
Northern Brown Bandicoot^	PFHxS	1	1	<LOR	<LOR	0.3	
	PFOA	1	1	<LOR	<LOR	0.5	
	PFOS	1	0	1.1	1.1	1.1	
	PFOS+PFHxS	1	0	1.1	1.1	1.4	

* Upper bound mean and median derived where not detected results are assigned a concentration equal to LOR (LOR of 0.3 µg/kg for PFOS, PFHxS, 0.5 µg/kg for PFOA)
^ Upper bound median value not calculated where only 1 sample, the upper bound mean was used as the upper bound concentration in estimates of number of serves that can be consumed (assigned the relevant LOR if not detected)

Table 4 Summary PFAS concentration data (µg/kg) for fruit and vegetables

Matrix	Chemical	Count	Count of <LOR	Minimum	Maximum	Mean**	Median**
Fruit*	PFHxS	9	9	<LOR	<LOR	0.3	0.3
	PFOA	9	9	<LOR	<LOR	0.5	0.5
	PFOS	9	9	<LOR	<LOR	0.3	0.3
	PFOS+PFHxS	9	9	<LOR	<LOR	0.6	0.6
Vegetables*	PFHxS	15	15	<LOR	<LOR	0.3	0.3
	PFOA	15	15	<LOR	<LOR	0.5	0.5
	PFOS	15	15	<LOR	<LOR	0.3	0.3
	PFOS+PFHxS	15	15	<LOR	<LOR	0.6	0.6

*All species combined, edible portion analysed
**Upper bound mean and median derived where not detected results are assigned a concentration equal to LOR (LOR of 0.3 µg/kg for PFOS, PFHxS, LOR of 0.5 µg/kg for PFOA)

3. Comparison with trigger levels proposed by FSANZ

3.1. Fish flesh

Trigger levels developed by FSANZ are provided at Attachment 2. Trigger levels of 5.2 µg/kg for PFOS+PFHxS combined and 41 µg/kg for PFOA were proposed for all finfish. These are conservative values based on high (90th percentile) consumption of all diadromous, freshwater and marine fish by children aged 2-6 years.

PFOA

Eight of the 99 fish flesh data points had detected concentrations of PFOA, with the remaining 91 samples <LOR of 0.5 µg/kg. Detections were reported for barramundi samples only where the LOR was lower than the standard value of 0.5 µg/kg, but these were well below the PFOA trigger level of 41 µg/kg, the maximum value being 0.5 µg/kg[3].

PFOS+PFHxS

79 of the 99 fish flesh data points had detected concentrations of PFOS+PFHxS combined, with the remaining 20 samples <LOR of 0.3 µg/kg for PFOS and all <LOR for PFHxS (0.3 µg/kg for all samples except 3 where LOR was 0.5 µg/kg).

The upper bound median level for the 36 Barramundi flesh data points for PFOS+PFHxS combined of 3.5 µg/kg was below the trigger level of 5.2 µg/kg. However, 16/36 (44%) data points exceeded the trigger level with the maximum value reported of 47.8 µg/kg well above the trigger level. This indicates that consumption of this fish species caught in the Darwin waters over time is unlikely to present a public health and safety concern as the median PFOS+PFHxS combined value is less than the trigger level[4]. However, Barramundi should continue to be monitored for PFAS.

For other fish species the number of data points was <25 so results need to be considered in light of these small sample numbers. Further investigation or risk management action may be required in relation to several fish species exceeding the finfish trigger level at median PFOS+PFHxS combined concentrations, as detailed below.

For the two diadromous fish analysed in addition to barramundi, the upper bound median levels of PFOS+PFHxS combined exceeded the finfish trigger level of 5.2 µg/kg for Tarpon (98.3 µg/kg, 5 samples) but not for Salmon (1.7 µg/kg, 3 samples).

For the two freshwater fish analysed, the upper bound median level of PFOS+PFHxS combined exceeded the finfish trigger level of 5.2 µg/kg for both species, Catfish (37 µg/kg, 2 samples) and Spangled Perch (450 µg/kg, 1 sample).

For the 10 marine fish analysed, the upper bound median levels of PFOS+PFHxS combined exceeded the finfish trigger level of 5.2 µg/kg for 5 species: Branded Archerfish (29.6 µg/kg, 3 samples), Brown Sweetlips (7.4 µg/kg, 3 samples), Goldspotted Rockcod (13.1 µg/kg, 4 samples), Mangrove Jack (20.3 µg/kg, 1 sample) and Mullet (74.6 µg/kg, 5 samples). The trigger level was not exceeded for the remaining five species: Barred Javelin, Flathead, Giant Queenfish, Golden Snapper and shark (refer to Attachment 1).

When all fish species analysed were considered together the upper bound median PFOS+PFHxS combined concentration was 2.3 µg/kg, less than the trigger level of 5.2 µg/kg. This indicates that, overall, consumption of a range of these fish species over time is unlikely to present a public health and safety concern[4].

3.2. Fish liver

Trigger levels of 280 µg/kg for PFOS+PFHxS combined and 2240 µg/kg for PFOA were proposed for all fish liver (Attachment 2). These are conservative values based on the consumption of one liver (5 g weight).

[3] LOR for PFOA for some barramundi samples from one laboratory was lower (0.04 and 0.07 µg/kg) than the standard LOR of 0.5 µg/kg.

[4] The use of the median concentration level reflects that there will always be a distribution of the contaminant in the foods eaten over time. It is unrealistic to expect each food item consumed to be contaminated at the highest reported concentration on every eating occasion.

PFOA

13 of the 74 fish liver data points had detected concentrations of PFOA, with the remaining 61 samples <LOR of 0.5 µg/kg[5]. Detections were reported for Barramundi liver, Catfish liver and Branded Archerfish liver samples but these were well below the PFOA trigger level of 2240 µg/kg, the maximum quantified value being 2.8 µg/kg for Branded Archerfish liver. Mullet liver was not analysed.

PFOS+PFHxS

For fish liver all 74 data points for PFOS+PFHxS combined had detected concentrations.

The upper bound median level for the 35 barramundi liver data points for PFOS+PFHxS combined of 90.1 µg/kg was below the trigger level of 280 µg/kg. However, 12/35 (34%) data points exceeded the trigger level with the maximum value reported of 440.7 µg/kg. This indicates that consumption of liver from barramundi caught in the Darwin waters over time is unlikely to present a public health and safety concern as the median PFOS+PFHxS combined value is less than the trigger level[1]. However, this supports the results for fish flesh that barramundi should continue to be monitored for PFAS.

For other fish species the number of data points was < 25 so results need to be considered in light of these small sample numbers. Further investigation or risk management action may be required in relation to several fish species exceeding the fish liver trigger level at median PFOS+PFHxS combined concentrations, as detailed below.

For the two diadromous fish livers analysed in addition to Barramundi, the upper bound median levels of PFOS+PFHxS combined exceeded the fish liver trigger level of 280 µg/kg for Tarpon (3008 µg/kg, 1 sample) but not for Salmon (22.9 µg/kg, 2 samples).

Only one freshwater fish liver was analysed, the upper bound median level of PFOS+PFHxS combined exceeded the fish liver trigger level of 280 µg/kg for Catfish (797 µg/kg, 2 samples).

For the 9 marine fish livers analysed, the upper bound median levels of PFOS+PFHxS combined exceeded the fish liver trigger level of 280 µg/kg for 1 species only: Branded Archerfish (4130 µg/kg, 3 samples). The trigger level was not exceeded for the remaining eight species: Barred Javelin, Brown Sweetlips, Flathead Giant Queenfish, Golden Snapper, Goldspotted Rockcod, Mangrove Jack and shark (refer to Attachment 1). Mullet liver was not analysed.

When the livers for all fish species analysed were considered together the upper bound median PFOS+PFHxS combined concentration was 65.6 µg/kg, less than the trigger level of 280 µg/kg. This indicates that, overall, consumption of livers from a range of these fish species over time is unlikely to present a public health and safety concern[4].

3.3. Crustacea

Trigger levels of 65 µg/kg for PFOS+PFHxS combined and 520 µg/kg for PFOA were proposed for crustacea and molluscs (Attachment 1). These are conservative values based on the median consumption of crustacea for children aged 2-6 years.

PFOA

76 of the 165 crustacea data points had detected concentrations of PFOA, with the remaining 89 samples <LOR of 0.5 µg/kg. Detections were reported for crabs, prawn and Redclaw Crayfish flesh, whole crab and whole Redclaw Crayfish, but these were well below the PFOA trigger level of 520 µg/kg, the maximum value being 9.2 µg/kg for whole crabs (including organs).

[5] The non-detect result for flathead was based on a LOR of 5.0 µg/kg for PFOA, a lower LOR was not achievable due to the small sample size available.

PFOS+PFHxS

For crustacea, 159 of the 165 data points had detected concentrations of PFOS+PFHxS combined, with the remaining 6 samples <LOR of 0.3 µg/kg for PFOS and PFHxS.

The upper bound median level for the 49 crab flesh data points for PFOS+PFHxS combined of 3.6 µg/kg was below the trigger level of 65 µg/kg, with no results exceeding the trigger level. The upper bound median level for the 93 whole crab data points for PFOS+PFHxS combined of 33.3 µg/kg was below the trigger level of 65 µg/kg, with 5/93 (5%) exceeding the trigger level, the maximum level being 180.1 µg/kg. This indicates that consumption of flesh from crabs caught in the Darwin waters over time is unlikely to present a public health and safety concern as the median and maximum PFOS+PFHxS combined values are less than the trigger level[4]. However, crabs should continue to be monitored for PFAS as some whole crab samples exceeded trigger levels.

For other crustacea the number of data points was < 25 so results need to be considered in light of these small sample numbers.

For other crustacea flesh samples, the upper bound median levels of PFOS+PFHxS combined were below the crustacea trigger level of 65 µg/kg for prawn flesh (41.1 µg/kg,14 samples) and Redclaw Crayfish flesh (25.2 µg/kg, 4 samples). None of these individual samples exceeded the trigger level.

For samples of whole crustacea including organs, the upper bound median levels of PFOS+PFHxS combined were below the crustacea trigger level of 65 µg/kg for whole prawns (2.2 µg/kg,1 sample) and whole Redclaw Crayfish (53 µg/kg, 4 samples). Two of 4 (50%) Redclaw Crayfish samples exceeded the trigger level, the maximum value being 142 µg/kg.

When all the crustacea species analysed were considered together the upper bound median PFOS+PFHxS combined concentration was 29.5 µg/kg, less than the trigger level of 65 µg/kg. This indicates that, overall, consumption of crustacea from a range of species over time is unlikely to present a public health and safety concern[4].

3.4. Molluscs

Trigger levels of 65 µg/kg for PFOS+PFHxS combined and 520 µg/kg for PFOA were proposed for crustacea and molluscs (Attachment 2). These are conservative values based on the median consumption of crustacea for children aged 2-6 years, noting the small number of consumers of molluscs meant separate trigger values could not be derived for molluscs.

PFOA

For Molluscs, 45 of the 51 data points had detected concentrations of PFOA, with the remaining 6 samples <LOR of 0.5 µg/kg. Detections were reported for four of the six species analysed (Long Bum, Periwinkle, Terebralia, Whelk), but these were well below the PFOA trigger level of 520 µg/kg, the maximum value being 47 µg/kg for Long Bum. Cockle (1 sample) and Oyster (2 samples) had no detected results (<LOR of 0.5 µg/kg).

PFOS+PFHxS

For molluscs, 49 of the 51 data points had detected concentrations of PFOS+PFHxS combined, with the remaining 2 samples <LOR of 0.3 µg/kg for PFOS and PFHxS.

For the 6 molluscs species analysed, the upper bound median levels of PFOS+PFHxS combined did not exceed the mollusc trigger level of 65 µg/kg: Cockle (0.4 µg/kg, 1 sample), Long bum (4.9 µg/kg, 21 samples), Oysters[6] (0.2 µg/kg, 2 samples), Periwinkle (1.3 µg/kg, 22 samples), Terebralia (13.5 µg/kg, 1 sample) and Whelk (54.6 µg/kg, 4 samples). Trigger levels were exceeded by 3/51 samples, the maximum value being 118 µg/kg for Whelk.

[6] LOR for PFOS, PFHxS for oyster samples from one laboratory was lower (0.04 µg/kg) than the standard LOR of 0.3 µg/kg.

The number of data points for individual species were < 25 so results need to be considered in light of these small sample numbers, When all the mollusc species analysed were considered together the median[7] PFOS+PFHxS combined concentration was 3.3 µg/kg, less than the trigger level of 65 µg/kg. This indicates that, overall, consumption of molluscs from a range of these species over time is unlikely to present a public health and safety concern[4].

3.5. Animal products

Trigger levels of 3.5 µg/kg for PFOS+PFHxS combined and 28 µg/kg for PFOA were proposed for mammalian meat (Attachment 2). These are conservative values based on the 90th percentile consumption of all meat for children aged 2-6 years. In the absence of other values for wild caught meat, these trigger levels were considered the most appropriate for the assessment of snake, magpie goose and bandicoot that were analysed for PFAS.

PFOA

None of the 7 samples had detected concentrations of PFOA (<LOR of 0.5 µg/kg). Snake (3 samples, 1 Children's Python and 2 Keelback Snakes), magpie goose (3 samples) and bandicoot (1 sample) were analysed.

PFOS+PFHxS

Some of the 7 samples had detected concentrations of PFOS+PFHxS (<LOR of 0.3 µg/kg for PFOS or PFHxS, <LOR 0.6 PFOS+PFHxS combined), the Magpie Geese analysed had no detected concentrations.

For the two species of snake analysed, the upper bound median levels of PFOS+PFHxS combined exceeded the mammalian meat trigger level of 3.5 µg/kg: Children's Python (40.4 µg/kg, 1 sample), Keelback Snakes (2650 µg/kg, 2 samples). Trigger levels were exceeded by all samples, the maximum value being 2854 µg/kg for Keelback Snakes.

For the single sample of Northern Brown Bandicoot, the upper bound level of PFOS+PFHxS combined of 1.1 µg/kg did not exceed the mammalian meat trigger level of 3.5 µg/kg.

The number of data points for individual species were < 25 so results need to be considered in light of these small sample numbers. The available results indicate that, overall, consumption of Magpie Goose and Northern Brown Bandicoot over time is unlikely to present a public health and safety concern[4,] However, results for the Children's Python and Keelback Snakes are of concern, particularly if these items were to be consumed on a regular basis.

3.6. Fruit

Trigger levels of 0.6 µg/kg or LOD if higher for PFOS+PFHxS combined and 5.1 µg/kg for PFOA were proposed for fruit (Attachment 2). These are conservative values based on the 90th percentile consumption of all fruit for children aged 2-6 years.

PFOA

None of the 9 fruit samples had detected concentrations of PFOA (<LOR of 0.5 µg/kg). Berries (raspberry, 1 sample), citrus (lemonade, 3 samples; lime 1 sample), tropical fruit edible peel (fig, 2 samples) and tropical fruit inedible peel (banana, 2 samples) were analysed.

PFOS+PFHxS

None of the 9 fruit samples had detected concentrations of PFOS+PFHxS (<LOR of 0.3 µg/kg for PFOS, PFHxS).

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The number of data points for individual species were < 25 so results need to be considered in light of these small sample numbers. The available results indicate that, overall, consumption of fruit from a range of these species over time is unlikely to present a public health and safety concern.

3.7. Vegetables

Trigger levels of 1.1 µg/kg or LOD if higher for PFOS+PFHxS combined and 8.8 µg/kg for PFOA were proposed for vegetables (Attachment 1). These are conservative values based on the 90th percentile consumption of all vegetables for children aged 2-6 years.

PFOA

None of the 15 vegetable samples had detected concentrations of PFOA (<LOR of 0.5 µg/kg). Three herbs (aloa vera, basil, lemongrass 1 sample each), three leafy vegetables (aibika, 2 samples; kankong 1 sample, spinach 4 samples), two root and tuber vegetables (cassava, 1 sample; sweet potato 2 samples) and two spices (ginger, 2 samples; turmeric 1 sample) were analysed.

PFOS+PFHxS

None of the 15 vegetable samples had detected concentrations of PFOS+PFHxS (<LOR of 0.3 µg/kg for PFOS and PFHxS).

The number of data points for individual species were < 25 so results need to be considered in light of these small sample numbers. The available results indicate that, overall, consumption of vegetables from a range of these species over time is unlikely to present a public health and safety concern.

4. Serves of food to reach the health based guidance value for PFOS

To provide additional context, Tables 5-7 below provide an indication of the approximate number of serves of fish flesh, fish liver, crustacea, molluscs, indigenous foods, fruit and vegetables with median PFOS+PFHxS combined concentrations that can be consumed by the whole population aged 2+ years before reaching the TDI for PFOS of 0.02 µg/kg bw/day on a food by food basis. Further details for serves of individual fish and seafood species is at Attachment 3.

Similar information is given in Tables 8-10 for children aged 2-6 years and in Attachment 3 for serves of individual fish and seafood species.

For all tables, the grams per day, number of serves per day, week or month have been rounded down, to be conservative. For foods where there were no detects in any of the samples, the grams per day and number of serves per day and week are based on an upper bound median where non-detect results for PFOS and PFHxS were both assigned the LOR of 0.3 µg/kg, resulting in an upper median value for PFOS+PFHxS of 0.6 µg/kg. This gives a conservative estimate of the amount of food that can be consumed, as actual levels of these PFAS chemicals are likely to be < LOR.

5. Conclusion

On the basis of the limited data provided, exposure to PFAS from consumption of a range of fish and seafood, from Darwin waters over time is unlikely to present a public health and safety concern. Given the exceedance of trigger levels for PFOS+PFHxS for some individual samples and low number of fish sampled, further monitoring may be required.

In particular, given the higher concentrations of PFOS in the fish flesh of Tarpon, Catfish, Spangled Perch, Branded Archerfish, Goldspotted Rockcod, Mangrove Jack and Mullet, and fish liver for all these species except Mullet (not sampled) further investigation of these species may be warranted. In the meantime, consumption of flesh of some of these species (Tarpon, Spangled Perch, Mullet) or fish liver of some of these species (Tarpon, Branded Archerfish) on a regular basis should be avoided, limiting to consumption on a monthly basis.

While this report details that many serves of a range of fish from Darwin waters can be consumed before reaching the TDI for PFOS, FSANZ nonetheless recommends that due to health concerns regarding naturally occurring mercury levels in fish, that people limit their consumption of fish in accordance with national fish consumption advice produced by FSANZ, which can be downloaded at: http://www.foodstandards.gov.au/consumer/chemicals/mercury/documents/mif%20brochure.pdf

On the basis of the limited data provided, exposure to PFAS from consumption of a range of fruit and vegetables from the Darwin region over time is unlikely to present a public health and safety concern. This is also true for consumption of Magpie Goose and Norther Brown Bandicoot. However, the limited data indicates that exposure to PFAS from regular consumption of Keelback Snake may be of public health and safety concern.

Table 5 Amount of fish and fish livers at median PFOS+PFHxS combined concentration that can be consumed every day over a lifetime before reaching the TDI* for the population aged 2+ years (expressed as grams/day, serves/day^ and frequency of consumption)

Matrix	Fish species	Amount of food that can be consumed before reaching PFOS+PFHxS TDI			Actual food consumption~ (grams/day)	
		Grams/day	Serves of foods /day	Approximate frequency of consumption	P90 (consumers only)	Mean (consumers only)
Fish flesh	All species	609	Approx 4 fillets (1 fillet/cutlet = 150 g)	About 28 serves of a range of fish per week	123	45
	Diadromous fish	400	Approx 2½ fillets (1 fillet/cutlet = 150 g)	About 18 serves of a range of fish per week		
	Barramundi	400	Approx 2½ fillets (1 fillet/cutlet = 150 g)	About 18 serves of Barramundi per week		
	Freshwater fish	28	Approx 1/8 fillet (1 fillet/cutlet = 150 g)	About 1 serve fish per week		
	Marine fish	1167	Approx 7½ fillets (1 fillet/cutlet = 150 g)	About 54 serves per week		
Fish liver	All species	21	Approx 4 livers (1 liver = 5 g)	About 28 serves fish liver from a range of species per week		5#
	Diadromous fish	15	Approx 3 livers (1 liver = 5 g)	About 21 fish livers per week		
	Barramundi	15	Approx 3 livers (1 liver = 5 g)	About 21 serves Barramundi liver per week		
	Freshwater fish	1	< 1 liver (1 liver = 5 g)	About 2 fish livers per week		
	Marine fish	52	Approx 10 livers (1 liver = 5 g)	About 74 fish livers per week		

^ Measures taken from AUSNUT 2011-12 Measures File AUSNUT Food Measures File

* Tolerable daily intake for PFOS and PFOS+PFHxS combined is 0.02 µg/kg body weight/day

~ Actual food consumption for all fish and seafood as reported in the 2011-12 Australian National Nutrition and Physical Activity Survey

no food consumption data available, Population 2+ years, median consumption assumed to be 5 g (weight of one liver). Source: FSANZ report on Edith River, Northern Territory 2013, https://dpir.nt.gov.au/__data/assets/pdf_file/0006/260187/TraceElementsNTFish.pdf

Table 6 Amount of crustacea and molluscs at median PFOS+PFHxS combined concentration that can be consumed every day over a lifetime before reaching the TDI* for the population aged 2+ years (expressed as grams/day, serves/day^ and frequency of consumption)

Matrix	Species	Amount of food that can be consumed before reaching PFOS+PFHxS TDI			Actual food consumption~ (grams/day)	
		Grams/day	Serves of foods /day	Approximate frequency of consumption	P90 (consumers only)	Mean (consumers only)
Crustacea flesh	All species	184	Approx 16 prawns or serves crab/ crayfish (1 prawn or serve crab/crayfish = 11 g)	About 117 serves of a range of crustacea per week	63	21
	Crabs	389	Approx 35 serves crab flesh (1 prawn or serve crab = 11 g)	About 247 serves of crab per week		
Crustacea whole or organs	All species	42	Approx 3 prawns or serves of crab/crayfish, whole or organs (1 prawn or serve crab/crayfish = 11 g)	About 26 serves of a range of crustacea (whole) per week		
Molluscs whole	All species	424	Approx 28 oysters or serves of other molluscs (1 oyster or serve other molluscs = 15 g)	About 197 serves of a range of molluscs per week	30	9

^ Measures taken from AUSNUT 2011-12 Measures File, measure for prawns applied to all crustacea, measure for oysters applied to all molluscs as low number of consumers of molluscs AUSNUT Food Measures File

* Tolerable daily intake for PFOS and PFOS+PFHxS combined is 0.02 µg/kg body weight/day

~ Actual food consumption for all fish and seafood as reported in the 2011-12 Australian National Nutrition and Physical Activity Survey

Table 7 Amount of animal products, fruit and vegetables at median PFOS+PFHxS combined concentration that can be consumed every day over a lifetime before reaching the TDI* for the population aged 2+ years (expressed as grams/day, serves/day^ and frequency of consumption)

Matrix	Species		Amount of food that can be consumed before reaching PFOS+PFHxS TDI			Actual food consumption~ (grams/day)	
			Grams/day	Serves of foods /day	Approximate frequency of consumption	P90 (consumers only)	Mean (consumers only)
Wild caught meat	Children's python#		34	Approx 1/3 fillet (1 fillet = 110 g)	About 2 serves of python per week	216	170
	Keelback Snake#		0.5	<<1/100 fillet (1 fillet = 110 g)	<1/8 fillet per month	216	170
	Magpie Goose#		2333	Approx 18 thighs (1 thigh = 125 g)	About 130 serves per week	222	194
	N Brown Bandicoot#		1000	Approx 10 serves (1 serve or ½ animal = 100 g)	About 70 serves per week	200	200
Fruit	*Berries and small fruit*	Raspberry#	2333	Approx 155 serves (1 serve of 8 raspberries = 15 g)	About 1088 serves per week	526	166
	Citrus	Lemonade	2333	Approx 31 lemonade (1 lemonade = 75 g)	About 217 serves per week	354	129
		Lime#	2333	Approx 46 limes (1 lime = 50 g)	About 326 serves per week		
	Tropical fruit edible peel	Fig#	2333	Approx 46 figs (1 fig = 50 g)	About 326 serves per week	10	5
	Tropical fruit inedible peel	Banana#	2333	Approx 23 bananas (1 banana, medium = 100 g)	About 163 serves per week	111	65
Vegetables	*Herbs*	Aloa vera# Basil# Lemongrass#	2333			4	2
	Leafy vegetables	Aibika# Kankong# Spinach	2333	Approx 155 serves (1 serve leaves = 15 g)	About 1088 serves per week	48	22
	Root & tuber vegetables	Cassava# Sweet potato#	2333	Approx 23 pieces (1 piece, roasted = 100g)	About 163 serves per week	273	123
	Spices	Ginger# Tumeric#	2333			5	2

^ Measures taken from AUSNUT 2011-12 Measures File, measure for kangaroo tail taken for snake, wild goose for magpie goose, possum for bandicoot, mandarin/lemon for lemonade AUSNUT Food Measures File

* Tolerable daily intake for PFOS and PFOS+PFHxS combined is 0.02 µg/kg body weight/day

~ Actual food consumption as reported in the 2011-12 Australian National Nutrition and Physical Activity Survey (NNPAS) , for indigenous foods from the Australian National Aboriginal and Torres Strait Islander Nutrition and Physical Activity Survey (NATSINPAS) 2012-13, noting kangaroo tail used as a proxy for snake consumption, possum as a proxy for bandicoot consumption

Limited data (<10 data points)

Table 8 Amount of fish and fish livers at median PFOS+PFHxS combined concentration that can be consumed every day over a lifetime before reaching the TDI* for children aged 2-6 years (expressed as grams/day, serves/day^ and frequency of consumption)

Matrix	Fish species	Amount of food that can be consumed before reaching PFOS+PFHxS TDI			Actual food consumption~ (grams/day)	
		Grams/day	Serves of foods /day	Approximate frequency of consumption	P90 (consumers only)	Mean (consumers only)
Fish flesh	All species	165	Approx 2 fillets (1 fillet/cutlet = 75 g)	About 15 serves of a range of fish per week	73	24
	Diadramous fish	109	Approx 1½ fillets (1 fillet/cutlet = 75 g)	About 10 serves of a range of fish per week		
	Barramundi	109	Approx 1½ fillets (1 fillet/cutlet = 75 g)	About 10 serves of Barramundi per week		
	Freshwater fish	7	Approx 1/10 fillet (1 fillet/cutlet = 75 g)	About 3 serves of a range of fish per month		
	Marine fish	317	Approx 4 fillets (1 fillet/cutlet = 75 g)	About 30 serves of a range of fish per week		
Fish liver	All species	5	Approx 1 liver (1 liver = 5g)	About 8 serves fish liver from a range of species per week		5[#]
	Diadramous fish	5	Approx 1 liver (1 liver = 5g)	About 8 serves fish liver per week		
	Barramundi	4	< 1 liver (1 liver = 5g)	About 6 serves Barramundi liver per week		
	Freshwater fish	0.4	< < 1 liver (1 liver = 5g)	About 2 serves fish liver per month		
	Marine fish	14	Approx 2 serves liver (1 liver = 5g)	About 20 serves fish liver per week		

^ Measures taken from AUSNUT 2011-12 Measures File AUSNUT Food Measures File

* Tolerable daily intake for PFOS and PFOS+PFHxS combined is 0.02 µg/kg body weight/day

~ Actual food consumption for all fish and seafood as reported in the 2011-12 Australian National Nutrition and Physical Activity Survey

[#] no food consumption data available, Population 2+ years, median consumption assumed to be 5 g (weight of one liver). Source: FSANZ report on Edith River, Northern Territory 2013, https://dpir.nt.gov.au/__data/assets/pdf_file/0006/260187/TraceElementsNTFish.pdf

Table 9 Amount of crustacea and molluscs at median PFOS+PFHxS combined concentration that can be consumed every day over a lifetime before reaching the TDI* for children aged 2-6 years (expressed as grams/day, serves/day^ and frequency of consumption)

Matrix	Species	Amount of food that can be consumed before reaching PFOS+PFHxS TDI			Actual food consumption~ (grams/day)	
		Grams/day	Serves of foods /day	Approximate frequency of consumption	P90 (consumers only)	Mean (consumers only)
Crustacea flesh	All species	50	Approx 4 prawns or serves crab/crayfish (1 prawn or serve of crab/crayfish = 11 g)	About 31 serves of a range of crustacea per week	21	8
	Crab	105	Approx 9 serves crab flesh (1 serve crab = 11 g)	About 67 serves of crab per week		
Crustacea whole or organs	All species	11	Approx 1 prawn or serve crab/crayfish (whole or organs)	About 7 serves of a range of crustacea (whole) per week		
Molluscs whole	All species	115	Approx 7 oysters or serves of other molluscs (1 oyster or serve of other molluscs = 15 g)	About 53 serves of a range of molluscs per week	4	2

^ Measures taken from AUSNUT 2011-12 Measures File, measure for prawns applied to all crustacea, measure for oysters applied to all molluscs as low number of consumers of molluscs AUSNUT Food Measures File

* Tolerable daily intake for PFOS and PFOS+PFHxS combined is 0.02 µg/kg body weight/day

~ Actual food consumption for all fish and seafood as reported in the 2011-12 Australian National Nutrition and Physical Activity Survey

Table 10 Amount of animal products, fruit and vegetables at median PFOS+PFHxS combined concentration that can be consumed every day over a lifetime before reaching the TDI* for children aged 2-6 years (expressed as grams/day, serves/day^ and frequency of consumption)

Matrix	Species		Amount of food that can be consumed before reaching PFOS+PFHxS TDI			Actual food consumption~ (grams/day)	
			Grams/day	Serves of foods /day	Approximate frequency of consumption	P90 (consumers only)	Mean (consumers only)
Wild caught meat	Children's python#		9	Approx 1/12 fillet (1 fillet = 110 g)	About 2 serves of python per month	150	150
	Keelback Snake#		0.1	<<1/100 fillet (1 fillet = 110 g)	<1/30 fillet per month	150	150
	Magpie Goose#		633	Approx 5 thighs (1 thigh = 125 g)	About 35 serves per week	150	150
	N Brown Bandicoot#		9	Approx 2½ serves (1 serve or ½ animal = 100 g)	About 19 serves per week	150	150
Fruit	*Berries and small fruit*	Raspberry#	633	Approx 42 serves (1 serve of 8 raspberries = 15 g)	About 295 serves per week	108	38
	Citrus	Lemonade#	633	Approx 8 lemonades (1 lemonade = 75 g)	About 59 serves per week	246	88
		Lime#	633	Approx 12 limes (1 lime = 50 g)	About 88 serves per week		
	Tropical fruit edible peel	Fig#	633	Approx 12 figs (1 fig = 50 g)	About 88 serves per week	10	5
	Tropical fruit inedible peel	Banana#	633	Approx 6 bananas (1 banana, medium = 100 g)	About 44 serves per week	111	61
Vegetables	*Herbs*	Aloa vera# Basil# Lemongrass#	633			2	1
	Leafy vegetables	Aibika# Kankong# Spinach#	633	Approx 42 serves (1 serve leaves = 15 g)	About 295 serves per week	48	22
	Root & tuber vegetables	Cassava# Sweet potato#	633	Approx 6 pieces (1 piece, roasted = 100g)	About 443 serves per week	164	66
	Spices	Ginger# Tumeric#	633			7	4

^ Measures taken from AUSNUT 2011-12 Measures File, measure for kangaroo tail taken for snake, wild goose for magpie goose, possum for bandicoot, mandarin/lemon for lemonade AUSNUT Food Measures File

* Tolerable daily intake for PFOS and PFOS+PFHxS combined is 0.02 µg/kg body weight/day

~ Actual food consumption as reported in the 2011-12 Australian National Nutrition and Physical Activity Survey (NNPAS), for indigenous foods from the Australian National Aboriginal and Torres Strait Islander Nutrition and Physical Activity Survey (NATSINPAS) 2012-13, noting kangaroo tail used as a proxy for snake, Actual food consumption as reported in the 2011-12

Australian National Nutrition and Physical Activity Survey (NNPAS) , for indigenous foods from the Australian National Aboriginal and Torres Strait Islander Nutrition and Physical Activity Survey (NATSINPAS) 2012-13, noting kangaroo tail used as a proxy for snake consumption as well as magpie goose and bandicoot consumption as no consumers were reorted for children aged 2-6 years

Limited data (<10 data points)

Attachment 1

Table 1. Summary concentration data (µg/kg) of PFOS+PFHxS combined by fish and seafood species analysed in Darwin

Commodity group	Species	Count	Count of <LOR	Minimum	Maximum	Mean	Median
Crustaceans	**Total***	**67**	**5**	**<LOR**	**49.1**	**14.2**	**7.6**
	Crabs	49	5	<LOR	44.1	6.9	3.6
	Prawn	14	0	7.4	49.1	37.6	41.1
	Redclaw crayfish#	4	0	6.0	28.0	21.1	25.2
Crustaceans whole or organs	**Total***	**98**	**1**	**<LOR**	**180.1**	**34.4**	**33.3**
	Crabs whole or organs	93	1	0	180.1	33.3	33.3
	Prawn whole or organs#^	1	0	1.9	2.2	2.2	
	Redclaw crayfish whole or organs#	4	0	25.0	142.0	68.3	53.0
Diadromous fish	**Total***	**44**	**1**	**<LOR**	**153.4**	**20.1**	**3.5**
	Barramundi	36	1	<LOR	47.8	13.1	3.5
	Salmon#	3	0	0.5	2.6	1.7	1.7
	Tarpon#	5	0	1.3	153.4	81.5	98.3
Diadromous fish liver	**Total***	**38**	**0**	**8.5**	**3008.3**	**230.1**	**90.1**
	Barramundi liver	35	0	8.5	440.7	162.6	90.1
	Salmon liver#	2	0	22.9	22.9	22.9	22.9
	Tarpon liver#^	1	0	3008.3	3008.3	3008.3	
Freshwater fish	**Total***	**3**	**0**	**25.3**	**450.3**	**174.8**	**48.7**
	Catfish#	2	0	25.3	48.7	37.0	37.0
	Spangled Perch#^	1	0	450.0	450.3	450.3	
Freshwater fish liver	**Total***	**2**	**0**	**797.0**	**797.0**	**797.0**	**797.0**
	Catfish liver#	2	0	797.0	797.0	797.0	797.0
Marine fish species	**Total***	**52**	**19**	**<LOR**	**74.6**	**10.2**	**1.2**
	Banded Archerfish#	3	0	19.3	42.1	30.3	29.6
	Barred Javelin#	7	6	<LOR	0.7	0.6	0.6
	Brown Sweetlips#	3	0	6.0	8.4	7.4	7.4
	Flathead#	2	0	2.6	4.8	3.9	3.9
	Giant Queenfish	10	0	0.7	6.5	2.3	1.7
	Golden Snapper	12	9	<LOR	1.2	0.7	0.6

Commodity group	Species	Count	Count of <LOR	Minimum	Maximum	Mean	Median
	Goldspotted Rockcod[#]	4	1	<LOR	21.3	12.0	13.1
	Mangrove Jack[#^]	1	0	20.0	20.3	20.3	
	Mullet[#]	5	1	<LOR	74.6	59.8	74.6
	Shark[#]	5	2	<LOR	1.4	0.9	0.9
Marine fish liver	**Total***	**34**	**0**	**0.7**	**4130.0**	**417.9**	**26.5**
	Banded Archerfish liver[#]	3	0	4130.0	4130.0	4130.0	4130.0
	Barred Javelin liver[#]	2	0	0.7	1.0	1.0	1.0
	Brown Sweetlips liver[#]	3	0	162.9	162.9	162.9	162.9
	Flathead liver[#^]	1	0	36.0	41.0	41.0	
	Giant Queenfish liver	10	0	26.0	91.4	53.2	30.2
	Golden Snapper liver[#]	9	0	1.4	15.0	3.2	1.7
	Goldspotted Rockcod liver[#]	3	0	153.0	153.0	153.0	153.0
	Mangrove Jack liver[#^]	1	0	263.2	263.2	263.2	
	Shark liver[#]	2	0	1.4	3.1	2.4	2.4
Molluscs	**Total***	**51**	**2**	**<LOR**	**118.0**	**13.5**	**3.3**
	Cockle[# ^]	1	0	0.3	0.4	0.4	
	Long Bum	21	0	0.7	20.0	7.2	4.9
	Oysters[#]	2	0	0.1	0.2	0.2	0.2
	Periwinkle	22	1	<LOR	115.0	13.5	1.3
	Terebralia[#^]	1	0	13.5	13.5	13.5	
	Whelk[#]	4	1	<LOR	118.0	56.9	54.6

*All species combined; ** Upper bound mean and median derived where not detected results are assigned a concentration equal to LOR; [#] Limited data (<10 data points)
^ Upper bound median value not calculated where only 1 sample, the upper bound mean was used as the upper bound concentration in estimates of number of serves that can be consumed (assigned the relevant LOR if not detected)

Table 2. Summary concentration data (µg/kg) of PFOA by fish and seafood species analysed in Darwin

Commodity group	Row Labels	Count	Count of <LOR	Minimum	Maximum	Mean**	Median**
Crustacea	**Total***	**67**	**34**	**<LOR**	**0.6**	**0.4**	**0.5**
	Crabs	49	34	<LOR	0.5	0.4	0.5
	Prawn	14	0	0.1	0.6	0.3	0.2
	Redclaw crayfish[#]	4	0	0.4	0.6	0.5	0.4
Crustaceans whole or organs	**Total***	**98**	**55**	**<LOR**	**9.2**	**1.0**	**0.5**
	Crabs whole or organs	93	54	<LOR	9.2	1.1	0.5
	Prawn whole or organs[#^]	1	1	<LOR	<LOR	0.5	
	Redclaw crayfish whole or organs[#]	4	0	0.6	1.3	0.9	0.9
Diadromous fish*	**Total***	**44**	**36**	**<LOR**	**0.5**	**0.4**	**0.5**
	Barramundi	36	28	<LOR	0.5	0.4	0.5
	Salmon[#]	3	3	<LOR	<LOR	0.5	0.5
	Tarpon[#]	5	5	<LOR	<LOR	0.5	0.5
Diadromous fish liver	**Total***	**38**	**30**	**<LOR**	**0.6**	**0.5**	**0.5**
	Barramundi liver	35	27	<LOR	0.6	0.5	0.5
	Salmon liver[#]	2	2	<LOR	<LOR	0.5	0.5
	Tarpon liver[#^]	1	1	<LOR	<LOR	0.5	
Freshwater fish	**Total***	**3**	**3**	**<LOR**	**<LOR**	**0.5**	**0.5**
	Catfish[#]	2	2	<LOR	<LOR	0.5	0.5
	Spangled Perch[#^]	1	1	<LOR	<LOR	0.5	
Freshwater fish liver	**Total***	**2**	**0**	**0.9**	**0.9**	**0.9**	**0.9**
	Catfish liver[#]	2	0	0.9	0.9	0.9	0.9
Marine fish	**Total***	**52**	**52**	**<LOR**	**<LOR**	**0.5**	**0.5**
	Banded Archerfish[#]	3	3	<LOR	<LOR	0.5	0.5
	Barred Javelin[#]	7	7	<LOR	<LOR	0.5	0.5
	Brown Sweetlips[#]	3	3	<LOR	<LOR	0.5	0.5
	Flathead[#]	2	2	<LOR	<LOR	0.5	0.5
	Giant Queenfish	10	10	<LOR	<LOR	0.5	0.5
	Golden Snapper	12	12	<LOR	<LOR	0.5	0.5
	Goldspotted Rockcod[#]	4	4	<LOR	<LOR	0.5	0.5

Commodity group	Row Labels	Count	Count of <LOR	Minimum	Maximum	Mean**	Median**
	Mangrove Jack#^	1	1	<LOR	<LOR	0.5	
	Mullet#	5	5	<LOR	<LOR	0.5	0.5
	Shark#	5	5	<LOR	<LOR	0.5	0.5
Marine fish liver	**Total***	**34**	**31**	**<LOR**	**5.0**	**1.0**	**0.5**
	Banded Archerfish liver#	3	0	2.8	2.8	2.8	2.8
	Barred Javelin liver#	2	2	<LOR	0.5	0.5	0.5
	Brown Sweetlips liver#	3	3	<LOR	<LOR	0.5	0.5
	Flathead liver#^	1	1	<LOR	<LOR	5.0	
	Giant Queenfish liver	10	10	<LOR	<LOR	0.5	0.5
	Golden Snapper liver#	9	9	<LOR	<LOR	1.0	0.5
	Goldspotted Rockcod liver#	3	3	<LOR	<LOR	0.5	0.5
	Mangrove Jack liver#^	1	1	<LOR	<LOR	0.5	
	Shark liver#	2	2	<LOR	<LOR	0.5	0.5
Molluscs	**Total***	**51**	**6**	**<LOR**	**47.0**	**4.1**	**2.2**
	Cockle#^	1	1	<LOR	<LOR	0.5	
	Long Bum	21	1	<LOR	47.0	7.3	5.4
	Oysters#	2	2	<LOR	<LOR	0.04	0.04
	Periwinkle	22	1	<LOR	4.3	1.5	0.9
	Terebralia#^	1	0	2.2	2.2	2.2	
	Whelk#	4	1	<LOR	9.8	4.7	4.2

* All species combined
** Upper bound mean and median derived where not detected results are assigned a concentration equal to LOR
# Limited data (<10 data points)
^ Upper bound median value not calculated where only 1 sample, the upper bound mean was used as the upper bound concentration in estimates of number of serves that can be consumed (assigned the relevant LOR if not detected)

Attachment 2

Table 1. Proposed trigger points for investigation

Food	Food classification	Proposed trigger points for investigation (µg/kg) PFOS, PFOS+ PFHxS combined	PFOA	Derivation
Fish and Seafood	Crustaceans and Molluscs[#]	65	520	Children 2-6 years, median consumption
	Finfish (all)	5.2	41	Children 2-6 years, P90 consumption
	Fish liver[#]	280	2240	Population 2+ years, median consumption assumed to be 5 g (weight of one liver)*
Animal Products	Meat mammalian	3.5	28	Children 2-6 years, P90 consumption
	Milk	0.4 or LOD if higher	2.8	Children 2-6 years, P90 consumption
	Honey	33	264	Children 2-6 years, P90 consumption
	Offal mammalian[#]	96	765	Population 2+ years, median consumption
	Poultry eggs	11	85	Children 2-6 years, P90 consumption
Fruits and vegetables	Fruit (all)	0.6 or LOD if higher	5.1	Children 2-6 years, P90 consumption
	Vegetables (all)	1.1 or LOD if higher	8.8	Children 2-6 years, P90 consumption

#occasionally consumed food, trigger points for investigation for crustaceans applied to molluscs due to small number of consumers of molluscs.
* no food consumption data available, source: FSANZ report on Edith River, Northern Territory 2013, https://dpir.nt.gov.au/__data/assets/pdf_file/0006/260187/TraceElementsNTFish.pdf

Attachment 3

Table 1 Amount of fish and seafood at median PFOS+PFHxS combined concentration that can be consumed every day over a lifetime before reaching the TDI* for the population aged 2+ years (expressed as grams/day, serves/day^ and frequency of consumption)

Matrix		Amount of food that can be consumed before reaching PFOS+PFHxS TDI			Actual food consumption~ (grams/day)	
		Grams/day	Serves of foods /day	Approximate frequency of consumption	P90 (consumers only)	Mean (consumers only)
Fish flesh	**Fish species**		**1 fillet/cutlet = 150 g**	**1 serve = 150 g**	143	56
	All species	609	Approx 4 fillets	About 28 serves of a range of fish per week		
	Barramundi	400	Approx 2½ fillets	About 18 serves of Barramundi per week		
	Salmon#	824	Approx 5½ fillets	About 38 serves of Salmon per week		
	Tarpon#	14	Approx 1/10 fillet	About 2 serves Tarpon **per month**		
	Catfish#	37	Approx 1/4 fillet	About 1 serve of Catfish per week		
	Spangled Perch#	3	Approx 1/50 fillet	About ½ serve of Spangled Perch **per month**		
	Branded Archerfish#	47	Approx 1/3 fillet	About 2 serves of Branded Archerfish per week		
	Barred Javelin#	2333	Approx 15½ fillets	About 108 serves Barred Javelin per week		
	Brown Sweetlips#	189	Approx 1 fillet	About 8 serves Brown Sweetlips per week		
	Flathead#	359	Approx 2 fillets	About 16 serves Flathead per week		
	Giant Queenfish	824	Approx 5½ fillets	About 38 serves Giant Queenfish per week		
	Golden Snapper	2333	Approx 15½ fillets	About 108 serves Golden Snapper per week		
	Goldspotted Rockcod#	107	Approx 2/3 fillet	About 5 serves Goldspotted Rockcod per week		
	Mangrove Jack#	69	Approx ½ fillet	About 3 serves Mangrove Jack per week		
	Mullet #	18	Approx 1/8 fillet	About 3 serves Mullet **per month**		
	Shark#	1566	Approx 10 fillets	About 72 serves shark per week		
Fish liver	**Fish species**		**1 liver = 5 g**	**I serve = 5 g**		5#
	All species	21	Approx 4 livers	About 28 serves fish liver from a range of species per week		
	Barramundi	15	Approx 3 livers	About 21 serves Barramundi liver per week		
	Salmon#	61	Approx 12 livers	About 85 serves Salmon liver per week		
	Tarpon#	0.5	< 1 liver	About 2 serves Tarpon liver **per month**		
	Catfish#	2	< 1 liver	About 2 serves Catfish liver per week		
	Branded Archerfish#	0.3	< 1 liver	About 2 serves Branded Archerfish liver **per month**		

Matrix		Amount of food that can be consumed before reaching PFOS+PFHxS TDI			Actual food consumption~ (grams/day)	
		Grams/day	Serves of foods /day	Approximate frequency of consumption	P90 (consumers only)	Mean (consumers only)
	Barred Javelin#	1400	Approx 280 livers	About 1960 serves Barred Javelin liver per week		
	Brown Sweetlips#	8	Approx 1 liver	About 12 serves Brown sweetlips liver per week		
	Flathead#	34	Approx 6 livers	About 47 serves Flathead livers per week		
	Giant Queenfish	46	Approx 9 livers	About 64 serves Giant Queenfish livers per week		
	Golden Snapper#	824	Approx 164 livers	About 1152 serves Golden Snapper livers per week		
	Goldspotted Rockcod#	9	Approx 1½ livers	About 12 serves Goldspotted Rockcod per week		
	Mangrove Jack#	5	Approx 1 liver	About 7 serves Mangrove Jack livers per week		
	Shark#	583	Approx 116 livers	About 816 serves Shark livers per week		
	Crustacea species		**1 prawn or serves crab/ crayfish = 11 g**	**1 serve = 11 g**	63	21
Crustacea flesh	All species	184	Approx 16 prawns or serves crab/crayfish	About 117 serves of a range of crustacea per week		
	Crabs	389	Approx 35 serves crab flesh	About 247 serves of crab per week		
	Prawns#	34	Approx 3 prawns	About 21 prawns per week		
	Redclaw Crayfish#	55	Approx 5 serves crayfish flesh	About 35 serves Redclaw Crayfish per week		
Crustacea whole or organs	All species	42	Approx 3 prawns or serves crab/crayfish (whole or organs)	About 26 serves of a range of crustacea (whole) per week		
	Crabs	42	Approx 3 serves crab whole or organs)	About 26 serves crab, whole per week		
	Prawns#	636	Approx 57 prawns whole or organs)	About 404 serves prawns, whole per week		
	Redclaw Crayfish#	26	Approx 2 serves crayfish, whole or organs)	About 16 serves Redclaw Crayfish, whole per week		
	Molluscs species		**1 oyster or serve other molluscs = 15 g**	**1 serve = 15 g**	30	9

Matrix		Amount of food that can be consumed before reaching PFOS+PFHxS TDI			Actual food consumption~ (grams/day)	
		Grams/day	Serves of foods /day	Approximate frequency of consumption	P90 (consumers only)	Mean (consumers only)
Molluscs whole	All species	424	Approx 28 oysters or serves other molluscs	About 197 serves of a range of molluscs per week		
	Cockle#	3500	Approx 233 serves Cockles	About 1633 serves cockles per week		
	Long Bum	286	Approx 19 serves Long Bums	About 133 serves Long Bums per week		
	Oysters#	7000	Approx 466 oysters	About 3266 serves oysters per week		
	Periwinkle	1077	Approx 71 serves Periwinkles	About 502 serves Periwinkles per week		
	Terebralia#	104	Approx 6 serves Terebralias	About 48 serves Terbralia per week		
	Whelk#	25	Approx 1½ serves Whelks	About 11 serves Whelk per week		

^ Measures taken from AUSNUT 2011-12 Measures File, measure for prawns applied to all crustacea, measure for oysters applied to all molluscs AUSNUT Food Measures File

* Tolerable daily intake for PFOS and PFOS+PFHxS combined is 0.02 µg/kg body weight/day

~ Actual food consumption for all fish and seafood as reported in the 2011-12 Australian National Nutrition and Physical Activity Survey

no food consumption data available, Population 2+ years, median consumption assumed to be 5 g (weight of one liver). Source: FSANZ report on Edith River, Northern Territory 2013, https://dpir.nt.gov.au/__data/assets/pdf_file/0006/260187/TraceElementsNTFish.pdf

Limited data (<10 data points)

Table 2 Amount of fish and seafood at median PFOS+PFHxS combined concentration that can be consumed every day over a lifetime before reaching the TDI* for children aged 2-6 years (expressed as grams/day, serves/day^ and frequency of consumption)

Matrix		Amount of food that can be consumed before reaching PFOS+PFHxS TDI			Actual food consumption~ (grams/day)	
		Grams/day	Serves of foods /day	Approximate frequency of consumption	P90 (consumers only)	Mean (consumers only)
Fish flesh	**Fish Species**		**1 fillet/cutlet = 75 g**	**1 serve = 75 g**	**73**	**24**
	All species	165	Approx 2 fillets	About 15 serves of a range of fish per week		
	Barramundi	109	Approx 1½ fillets	About 10 serves of Barramundi per week		
	Salmon#	224	Approx 3 fillets	About 20 serves of Salmon per week		
	Tarpon#	3	Approx 1/20 fillet	About 1 serve Tarpon **per month**		
	Catfish#	10.3	Approx 1/8 fillet	About 3 serves of Catfish per month		
	Spangled Perch#	0.84	Approx 1/100 fillet	< ½ serve of Spangled Perch **per month**		
	Branded Archerfish#	12.8	Approx 1/8 fillet	About 1 serve of Branded Archerfish per week		
	Barred Javelin#	633	Approx 8 fillets	About 59 serves Barred Javelin per week		
	Brown Sweetlips#	51.4	Approx ½ fillet	About 4 serves Brown Sweetlips per week		
	Flathead#	97.4	Approx 1 fillet	About 9 serves Flathead per week		
	Giant Queenfish	224	Approx 3 fillets	About 20 serves Giant Queenfish per week		
	Golden Snapper	633	Approx 8 fillets	About 59 serves Golden Snapper per week		
	Goldspotted Rockcod#	29	Approx 1/3 fillet	About 2 serves Goldspotted Rockcod per week		
	Mangrove Jack#	18.7	Approx 1/4 fillet	About 1 serves Mangrove Jack per week		
	Mullet#	5.09	Approx 1/20 fillet	About 2 serves Mullet **per month**		
	Shark#	422	Approx 5½ fillets	About 39 serves shark per week		
Fish liver	**Fish species**		**1 liver = 5 g**	**1 serve liver = 5 g**		**5#**
	All species	5	Approx 1 liver	About 8 serves fish liver from a range of species per week		
	Barramundi	4	< 1 liver	About 6 serves Barramundi liver per week		
	Salmon#	16.6	Approx 3 livers	About 23 serves Salmon liver per week		
	Tarpon#	0.13	<< 1 liver	< 1 serve Tarpon liver **per month**		
	Catfish#	0.48	<< 1 liver	About 2 serves Catfish liver **per month**		
	Branded Archerfish#	0.09	<< 1 liver	< 1 serve Branded Archerfish liver **per month**		
	Barred Javelin#	380	Approx 76 livers	About 532 serves Barred Javelin liver per week		
	Brown Sweetlips#	2.33	< 1 liver	About 3 serves Brown sweetlips liver per week		

Matrix		Amount of food that can be consumed before reaching PFOS+PFHxS TDI			Actual food consumption~ (grams/day)	
		Grams/day	Serves of foods /day	Approximate frequency of consumption	P90 (consumers only)	Mean (consumers only)
	Flathead#	9.27	Approx 1 liver	About 13 serves Flathead livers per week		
	Giant Queenfish	12.6	Approx 2 livers	About 17 serves Giant Queenfish livers per week		
	Golden Snapper#	224	Approx 44 livers	About 313 serves Golden Snapper livers per week		
	Goldspotted Rockcod#	2.48	< 1 liver	About 3 serves Goldspotted Rockcod per week		
	Mangrove Jack#	1.44	<1 liver	About 2 serves Mangrove Jack livers per week		
	Shark#	158	Approx 31 livers	About 221 serves Shark livers per week		
	Crustacea species		**1 prawn or serves crab/ crayfish = 11 g**	**1 serve = 11 g**	**21**	**8**
Crustacea flesh	**All species**	50	Approx 4 prawns or serves crab/crayfish	About 31 serves of a range of crustacea per week		
	Crabs	105	Approx 9 serves crab flesh	About 67 serves of crab per week		
	Prawns#	9	Approx ½ prawn	About 5 prawns per week		
	Redclaw Crayfish#	15	Approx 1 serve crayfish flesh	About 9 serves Redclaw Crayfish per week		
Crustacea whole or organs	All species	11	Approx 1 prawn or serve crab/crayfish (whole or organs)	About 7 serves of a range of crustacea (whole) per week		
	Crabs	11	Approx 1 serve crab whole (whole or organs)	About 7 serves crab, whole per week		
	Prawns#	172	Approx 15 prawns whole (whole or organs)	About 110 serves prawns, whole per week		
	Redclaw Crayfish#	7	½ serve crayfish, whole (whole or organs)	About 4 serves Redclaw Crayfish, whole per week		
Molluscs whole	**Molluscs species**		**1 oyster or serve other molluscs = 15 g**	**1 serve = 15 g**	**4**	**2**
	All species	115	Approx 7 oysters or serves other molluscs	About 53 serves of a range of molluscs per week		
	Cockle#	950	Approx 63 serves Cockles	About 443 serves cockles per week		
	Long Bum	77	Approx 5 serves Long Bums	About 36 serves Long Bums per week		

Matrix		Amount of food that can be consumed before reaching PFOS+PFHxS TDI			Actual food consumption~ (grams/day)	
		Grams/day	Serves of foods /day	Approximate frequency of consumption	P90 (consumers only)	Mean (consumers only)
	Oysters#	1900	Approx 126 oysters	About 886 serves oysters per week		
	Periwinkle	292	Approx 19 serves Periwinkles	About 136 serves Periwinkles per week		
	Terebralia#	28	Approx 1½ serves Terebralias	About 13 serves Terbralia per week		
	Whelk#	6	Approx ½ serve Whelks	About 3 serves Whelk per week		

^ Measures taken from AUSNUT 2011-12 Measures File, measure for prawns applied to all crustacea, measure for oysters applied to all molluscs AUSNUT Food Measures File

* Tolerable daily intake for PFOS and PFOS+PFHxS combined is 0.02 µg/kg body weight/day

~ Actual food consumption for all fish and seafood as reported in the 2011-12 Australian National Nutrition and Physical Activity Survey

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