Preliminary PFOS Risk Assessment for Seafood – Hunter River prawns

Executive summary

The NSW Government has undertaken further sampling of prawns collected within Fullerton Cove and other fishing areas in the Hunter River. This is in response to concerns regarding potential PFOA and PFOS contamination of prawns outside of the existing identified zone of concern in the upper Tilligerry Creek and Fullerton Cove areas which is closed to commercial fishers (see map).

Analysis of the samples taken showed presence of both PFOS and PFOA however assessment was only undertaken on the PFOS results as the presence of PFOA was less prevalent and where it was found it was just above the limit of detection and presented no food safety risk.

The levels of PFOS detected showed there was no significant food safety risk for the average consumer of prawns in the areas outside of the existing closure zone. There is the potential for higher exposure to PFOS for fishing communities, to consume prawns more frequently and in greater amounts than the average consumer, at two locations outside the closure area and this requires further investigation and evaluation in the form of a human health risk assessment.

Upon consideration of the findings commercial prawn fishers from the Hunter region have collectively agreed to extend their voluntary ban on trawling over the whole the Hunter River until further assessment is undertaken.

The industry has advised that the issues driving their concern and decision to continue the voluntary ban primarily relate to the Hunter River prawn brand, how to compress the fishery into a much reduced space and concern about expected low prices for any prawns caught from the Hunter system.

A human health risk assessment of the area is expected to commence in the first half of 2016.

All analysis and results took into account an estimate of dietary intake for all people and whether they were large consumers of prawns, and are based upon toxicology and dietary exposure advice from Food Standards Australian New Zealand (FSANZ).

Background

Perfluorooctane sulfonate (PFOS) and perfluorooctanic acid (PFOA) are perfluorinated compounds that are components in fire-fighting foams that were used at the Williamtown RAAF base prior to 2011. Since 2013 the Australian Defence Force (ADF) has been investigating the presence of these compounds in and near the base, with the compounds being detected in three samples of biota (fish and small shellfish) from a local drain and creek. Based on the levels detected, NSW Health advised that seafood caught or collected from the local area (upper Tilligerry Creek and Fullerton Cove) should not be consumed until more is known about the presence of these substances in seafood.

As a consequence, the NSW government has undertaken further sampling and analysis of seafood within upper Tilligerry Creek and Fullerton Cove, and also other areas adjacent to these waterways to assess the possible impact from these chemicals.

This report provides an assessment of some further sampling of prawns collected within Fullerton Cove and also in other fishing areas in the Hunter River.

Sampling and Processing

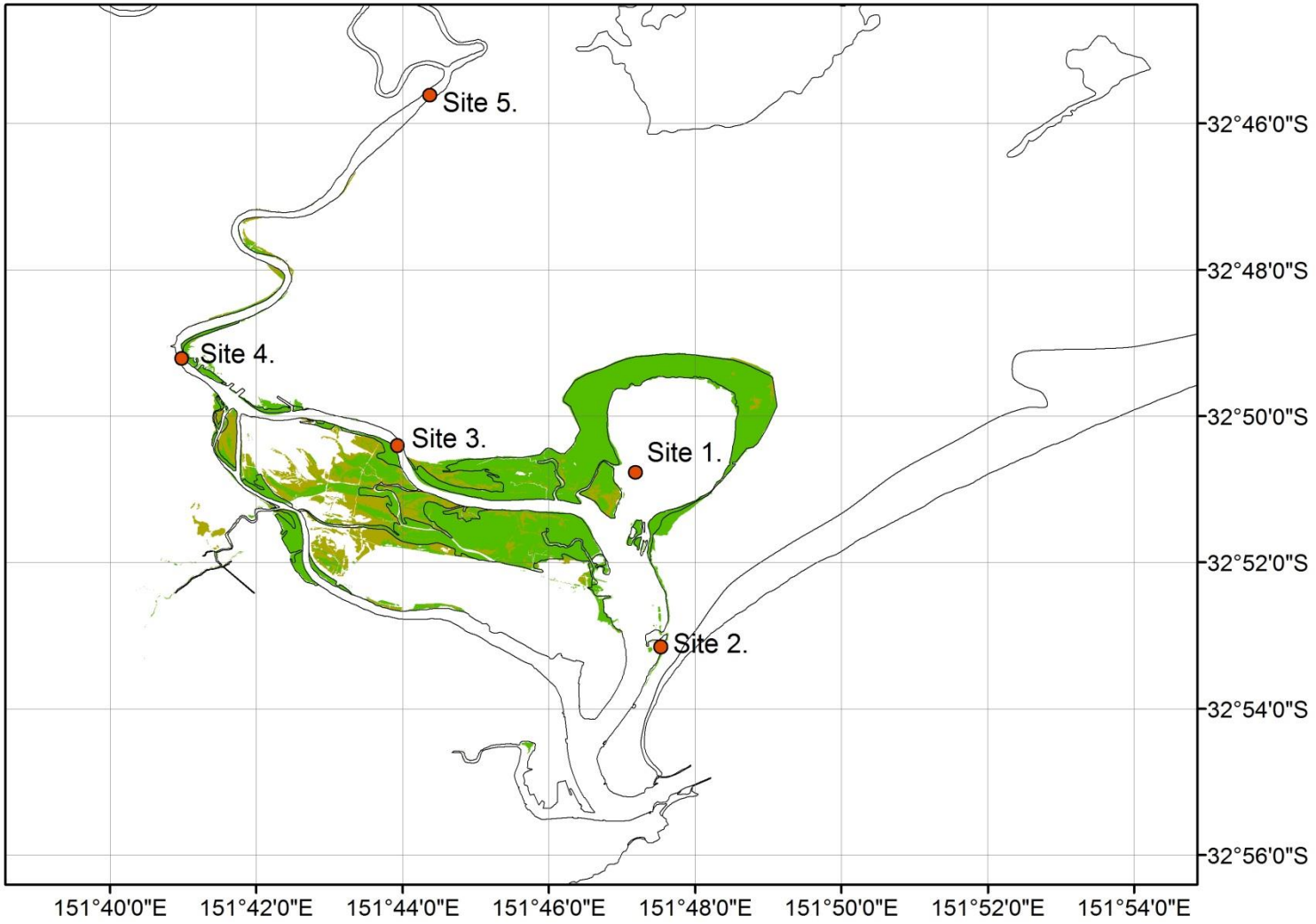
During October 2015 School Prawn were collected from Fullerton Cove and the Hunter River by DPI Fisheries with the assistance of commercial fishers. The locations where these samples were collected are presented in the following map.

Samples were placed on ice and shipped the following morning to National Measurement Institute (NMI) at North Ryde. At NMI, prawns were assigned to composites for analysis, shelled, and added to sample jars until the requisite mass of prawn meat was reached. Composite samples were then homogenised using a stick blender, and analysed as described below.

Analysis

Samples were sent to the NMI laboratory for analysis of perfluorinated compounds by Solid Phase Extraction and Liquid Chromatography/tandem Mass Spectrometry (LC/MS/MS) using reference method USEPA 537. While the laboratory does not currently have NATA accreditation for this method for food and seafood, the method is an international standard method which is used extensively in the US and Europe and has been used here in Australia over the past three years for environmental projects and a large food project. NMI will be submitting an application for NATA accreditation in 2015.

Sample locations for Hunter River Prawns



Results

The summary of the results is presented in Table 1. The main perfluorinated compound detected in the samples was PFOS. PFOA was only detected in two samples at site 1 (0.00052 and 0.00055 mg/kg). The limit of detection was 0.0005 mg/kg for both compounds.

Table 1: Prawn results from Fullerton Cove (location 1) and Hunter River (location 2 to 5)

PFOS					
Location	Count	Minimum (mg/kg)	Mean (mg/kg)	Median (mg/kg)	Maximum (mg/kg)
1	4	0.017	0.01825	0.0175	0.021
2	4	0.011	0.013	0.013	0.015
3	4	0.0028	0.004525	0.00345	0.0084
4	4	0.001	0.001225	0.0012	0.0015
5	4	0.0014	0.00165	0.0016	0.002
PFOA					
Location	Count	Minimum (mg/kg)	Mean (mg/kg)	Median (mg/kg)	Maximum (mg/kg)
1	4	0.0005	0.000518	0.00051	0.00055
2	4	0.0005	0.0005	0.0005	0.0005
3	4	0.0005	0.0005	0.0005	0.0005
4	4	0.0005	0.0005	0.0005	0.0005
5	4	0.0005	0.0005	0.0005	0.0005

Interpretation and Assessment of Results

In a risk assessment of chemical contaminants, estimated exposure is compared to a relevant health based guidance value. Exposure may arise from several sources, in this report only dietary exposure is assessed. In a dietary exposure assessment, estimated exposure, derived from combining food consumption data from national population surveys and food chemical concentration data, is compared to the appropriate health based guidance value.

An assessment was only undertaken on the PFOS results as PFOA was either not detected or present just above the limit of detection and present no food safety risk.

Health based guidance values

The European Food Safety Agency (EFSA) established a Tolerable Daily Intake (TDI) of 150 ng/kg bw[1]/day (0.00015 mg/kg bw/day) for PFOS based on a no observed adverse effect level (NOAEL) identified in sub-chronic, chronic and reproduction/developmental toxicity studies in laboratory animals (EFSA 2008). The TDI for PFOA established by EFSA at the same time was 1.5 µg/kg bw/day (0.0015 mg/kg bw/day).

[1] bw = human body weight

As adverse effects from PFOA and PFOS are thought to occur following long term exposure no acute health based guidance values need to be established.

Food consumption data

To evaluate the consumption of crustaceans in all people aged 2 years and over as well as children specifically in the 2-6 year old age group, food consumption data from the 2011-12 National Nutrition and Physical Activity Survey (NNPAS) component of the 2011-13 Australian Health Survey was used (Table 2). The figures in Table 2 are based on day 1 of the NNPAS, this is a conservative assumption as calculation of 'usual' or habitual intakes of fish and seafood would result in lower daily consumption amount estimates.

It is standard international practice in food chemical risk assessments to assess young children separately due to relatively higher food consumption amounts per kilogram bodyweight compared to older children and adults. In many cases this places them at higher risk of exceeding health based guidance values, however, in the case of crustacean, which are not commonly consumed by young children, they would tend to be of lower risk of exposure from consumption of these foods.

In this report, dietary exposure estimates were not undertaken for young children for crustacean (only 8 consumers/779 respondents) as the numbers would not be statistically valid due to small numbers of consumers.

Table 2: Fish, crustacean and mollusc consumption data for the general population (2+ years) and children (2-6 years)

NNPAS Food Code	Food Group Name	Age Group (years)	Number of consumers	Consumers as percentage of respondents* (%)	Consumption (g/day)					
					Mean all respondents	Mean consumers only	P50 (median) consumers only	P90 consumers only	P95 consumers only	P97.5 consumers only
15202	Crustacean	2+	117	<1	0.9	94	66	250	336	336
		2-6	8	1	0.3	26	17	**	**	**

** Total number of respondents: 2 years and above = 12 153; 2-6 years = 779.*

*** Too few consumers to derive reliable percentile.*

Notes: 2011-2012 NNPAS (National Nutrition and Physical Activity Survey), a 1 day 24-hour recall survey on all respondents with 64% of respondents undertaking a second 24-hour recall on a second non-consecutive day. Day 1 only survey results used for this analysis.

The data was filtered using specific survey food group classification codes: Finfish- fresh or frozen were included; however other types of finfish such as packed finfish (e.g. canned) and battered or crumbed finfish were excluded. Similarly, fresh or frozen crustacean and molluscs were included but packed or crumbed crustacean and molluscs were excluded.

PFOS concentration data used in the dietary exposure assessment

For this assessment, summary analytical results for PFOS in prawns were used. For contaminants, the international convention for chronic dietary exposure estimates is to use the median concentration value. For this report, dietary exposure estimates based on the median and the highest analytical value are reported to provide an understanding of the worse case scenario for consideration in the Human Health Risk Assessment.

Dietary Exposure

For chronic dietary exposure estimates, results are generally reported for the whole population, that is the mean dietary exposure is derived from data for all survey respondents (eaters and non-eaters of the foods of interest), assuming median contamination levels.

However, for sub-populations who may consume more than the average amount and consume on more occasions than the average consumer, for example families of recreational or commercial fishermen, dietary exposure estimates can be undertaken for consumers (eaters) only of the food of interest at the median consumption rate (i.e. P50 in Table 2). Foods such as crustaceans are not staples and are only available seasonally, so they are not likely to be consumed every day over many years even for the most exposed group. The risk assessment is, therefore, based on a worst case scenario where the median consumption of these foods (for people who eat them) is combined with the median concentration levels to estimate exposure. The use of the median concentration level reflects the fact that there will always be a distribution of the contaminant in the foods eaten over time or even in one meal, so it is considered unrealistic to expect each food item consumed to be contaminated at the highest reported level on every eating occasion. However, for this report the estimated dietary exposure for consumers assuming 90th percentile of food consumption is presented as well as median consumption, because the 90th centile provides information on those consuming seafood at the highest level and is the owrst case scenario.

Chronic dietary exposure estimates for PFOS for the whole population and for seafood consumers only are given in Table 3 (all ages) and 4 (children).

Table 3: Estimated dietary exposure assessment (DEA) for PFOS from Hunter River prawns – all age groups (2+ years)

Location	General		Median consumers		90th centile consumers	
	%TDI at median concentration	%TDI at maximum concentration	%TDI at median concentration	%TDI at maximum concentration	%TDI at median concentration	%TDI at maximum concentration
1	0.15	0.18	11.0	13.2	41.67	50.00
2	0.11	0.13	8.17	9.43	30.95	35.71
3	0.03	0.07	2.17	5.28	8.21	20.00
4	0.01	0.01	0.75	0.94	2.86	3.57
5	0.01	0.02	1.01	1.26	3.81	4.76

Table 4: Estimated dietary exposure assessment (DEA) for PFOS from fish, Hunter River prawns – children (2-6 years)

Location	General		Median consumers		90th centile consumers	
	%TDI at median concentration	%TDI at maximum concentration	%TDI at median concentration	%TDI at maximum concentration	%TDI at median concentration	%TDI at maximum concentration
1	0.18	0.22	10.44	12.53	nd	nd
2	0.14	0.16	7.75	8.95	nd	nd
3	0.04	0.09	2.06	5.01	nd	nd
4	0.01	0.02	0.72	0.89	nd	nd
5	0.02	0.02	0.95	1.19	nd	nd

nd = not determined

Risk characterisation

For the general population (aged 2+), estimated dietary exposure from consumption of prawns range from 0.01 to 0.15% of the TDI at the median PFOS concentration. For fishing communities who may consume higher amounts of prawns, estimated dietary exposure ranges from 2.86% to 41.67% at the median concentration.

For children (aged 2-6 years), estimated dietary exposure ranges from 0.02 to 0.18% of the TDI at the median concentration. Children consuming higher amounts of prawns, which may include children from fishing communities, estimated dietary exposure ranges from 0.72 to 10.44% at the median concentration.

These calculations do not take background dietary exposure from other foods or drinking water into account, however, fish and other seafood are reported to be the major contributors to the diet elsewhere (EFSA 2008). For all populations it is desirable to eat a balanced diet overall.

It is noted that in the general population an odd meal or day when a high amount of fish and/or seafood containing PFOS is consumed would not pose a concern because PFOS has such a long plasma half-life in humans (~5 years). This means it is the total PFOS dietary exposure over a long period of time (circa 20 years) that is of interest in terms of determining the risk to public health and safety.

Maximum amount of fish and crustacea able to be consumed at reported PFOS levels

The results were further assessed by conducting a back calculation to determine the maximum amount of prawns that could be consumed when the PFOS concentrations in the samples were at the median level reported. This involved calculating the kilograms of seafood the different age groups (male and female) would be required to consume before the TDI for PFOS was exceeded. Table 5 shows the estimated maximum consumption amounts for fish and crustacea respectively.

Consumption rates before exceeding the TDI ranged from 160 g (for children aged 2 to 6) per day to 9.75kg (for adults 18 years old plus).

Table 5: Maximum consumption amounts (kg) to exceed reference health values

Location	Age Group (years)									
	2 to 6		7 to 12		13 to 17		18 +		2+	
	Median concen.	Highest concen.	Median concen.	Highest concen.	Median concen.	Highest concen.	Median concen.	Highest concen.	Median concen.	Highest concen.
1	0.16	0.14	0.31	0.26	0.53	0.44	0.67	0.56	0.60	0.50
2	0.22	0.19	0.42	0.36	0.72	0.62	0.90	0.78	0.81	0.70
3	0.83	0.34	1.57	0.64	2.70	1.11	3.39	1.39	3.04	1.25
4	2.38	1.90	4.50	3.60	7.75	6.20	9.75	7.80	8.75	7.00
5	1.78	1.43	3.38	2.70	5.81	4.65	7.31	5.85	6.56	5.25

Discussion

This paper provides a preliminary analysis of the results from the sampling of prawns from Hunter River. The analysis has been undertaken to provide preliminary advice to local commercial fishers on the status of prawns within the Hunter River fishing area.

Of the five locations where samples were collected, one location is within the area currently closed by DPI Fisheries to both commercial and recreational fishing, with the remaining locations outside the DPI Fisheries closure area, however industry has put in place a voluntary closure in the Hunter River.

Results from the location within the current closure area are similar to the results obtained previously and were higher than those results for the other four sampling locations.

For the average consumer, the assessment of the results suggests that at average consumption rates, the presence of PFOS in the prawns does not present a food safety risk. For people consuming high amounts of prawns (e.g. fishing communities), prawns collected from inside the closure area (location 1) and outside the area (locations 2 and 3) appear to impact on the reference health standard, 41.67%, 30.95% and 8.21% of the TDI at the median concentration and 50%, 35.71% and 20% of the TDI at the maximum concentration respectively. A more accurate assessment of these results as part of a total diet study as proposed in the human health risk assessment work for Williamtown will provide a better indication as to risk to high consumers of prawns caught at these locations. For all other sample locations, consumption rates for the different age groups do not results in high exposure to PFOS.

The dietary exposure assessment undertaken in this report uses the EFSA TDI reference health value to align this report with previous assessments on other seafood from Tilligerry Creek and Fullerton Cove. The US Environmental Protection Authority (USEPA) in 2014 developed a draft reference health value which is lower than that established by EFSA. Using the USEPA draft value, the dietary exposure assessment would result in exposure rates closer to the reference health value and thereby could present a higher food safety risk when compare to the assessment based on the EFSA value, in particular for prawns collected at locations 1, 2 and 3. The issue of the most appropriate reference health value to use in dietary exposure assessments relating to PFOS and PFOA will be discussed at a national summit organised by enHealth in early December 2015.

Prawn trawl fishers from the Hunter River were provided an overview of the results at a meeting on 26 November. Their response was to recommend a voluntary closure of the entire Hunter River to prawn trawling. This was despite the results from the two locations upstream from Hexham being of very low concern. The issues driving the concern from industry included concern about the Hunter River prawn brand, how to compress the fishery into a much reduced space and concern about expected low prices for any prawns caught from the Hunter system.

Conclusion

Based on these results prawns taken from outside the current closure area do not pose a significant health risk to the general population. There is the potential for higher exposure to PFOS for fishing communities at two locations outside the closure area, and further assessment of these results will be undertaken as part of the human health risk assessment to be undertaken for the Williamtown area in the first half of 2016.

If necessary, this assessment will be reviewed following discussions on reference health values at the enHealth summit.