National Dioxins Programme

Addendum to Technical Report No. 8

Dioxins in Agricultural Commodities in Australia - Summary of tuna dioxin & dioxin-like PCB testing

Prepared by the Australian Government Department of Agriculture, Fisheries and Forestry

Australian Government
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1. Dioxins emissions from Bushfires in Australia
2. Dioxins emissions from Motor Vehicles in Australia
3. Inventory of Dioxin emissions in Australia 2004
4. Dioxins in Ambient Air in Australia
5. Dioxins in Soils in Australia
6. Dioxins in Aquatic Environments in Australia
7. Dioxins in Fauna in Australia
8. **Dioxins in Agricultural Commodities in Australia**
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Phone: 1800 803 772
Fax: (02) 6274 1970
E-mail: dioxins@deh.gov.au
Mail
National Dioxins Programme
c/- Chemical Policy
Department of the Environment and Heritage
GPO Box 787
CANBERRA ACT 2601
AUSTRALIA
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Executive Summary

In August 2000, the then Standing Committee on Agriculture and Resource Management, SCARM, (now the Primary Industries Standing Committee [PISC]) agreed to a coordinated strategy for dioxin testing. The primary objective of the testing was to safeguard consumer health and provide baseline data to help maintain market access for agricultural products. The SCARM agreement was subsequent to the dioxin and polychlorinated biphenyls (PCB) crisis in Belgium in 1999. Australia did not have any monitoring data for dioxins in agricultural products, or a domestic health standard for dioxin intake.

In 2002-2003 the National Dioxins Programme co-funded a study that was tasked to quantify and assess the concentrations and relative chemical compositions of dioxin-like chemicals in Australian agricultural commodities. The commodity groups involved in the testing programme included cattle, sheep, pigs, poultry, aquaculture fish (salmonids and tuna) and milk. Results and findings of this study were released in a report (*National Dioxins Programme, Technical Report No. 8 Dioxins in Agricultural Commodities in Australia*), in conjunction with studies from the other components of the National Dioxins Programme.

A review by the Australian Government Department of Agriculture, Fisheries and Forestry (DAFF) of an initial set of 20 tuna samples taken in 2003, revealed some anomalies in respect of sample selection, which gave rise to possible concerns regarding the integrity of the results. As a result of consultations between DAFF, the tuna industry and the Australian Government Department of the Environment and Heritage (DEH), it was agreed that sampling and testing of 20 new samples would be undertaken with particular attention given to sampling methodology to allow for variability within and between fish. This report presents the results and findings of this dioxin testing for farmed Southern Bluefin Tuna (*Thunnus maccoyii*).

The levels of dioxins in Australian farmed Southern Bluefin Tuna in this study were all lower than the European Union (EU) standard for tuna. Results compared favourably with international data reported from other countries.

The framework for the Dioxins Testing Programme for Australian Agricultural Commodities was developed by the PISC Dioxins Working Group. The objective of the group was to:

> “safeguard consumer health and protect Australia’s export markets in regards to dioxin contamination of food and food ingredients through the collection of prevalence data of dioxins in Australia’s agricultural produce.”

DAFF obtained financing for the testing Programme through a joint arrangement between DEH and the participating industry bodies.

The National Residue Survey (NRS), managed by DAFF, arranged for the collection of aquaculture tuna samples during May and June 2004. Collection was organised by the South Australian Research and Development Institute (SARDI), Food Safety Research Programme. SARDI is part of the South Australian Government Department of

Primary Industries and Resources (PIRSA). AgriQuality UltraTrace™, an analytical laboratory with internationally recognised accreditation to ISO 17025 for the analysis of PCDD/F and PCBs in fish, was contracted to carry out the analysis of 20 samples.

In this report the terms "dioxin" or "dioxins" or "PCDD/F" are used in reference to each of the 2,3,7,8 chlorine substituted dibenzo-*p*-dioxins and dibenzofurans congeners and the term PCBs is used in reference to the PCBs with dioxin-like toxicity, unless otherwise specified.

Consistent with international reporting practice, results were reported in terms of both lowerbound and upperbound levels. Upperbound levels represent the sum of detected congeners multiplied by the relevant Toxic Equivalency Factor (TEF), plus the sum of the Limit of Detection (LOD) contributions for non-detected congeners also multiplied by the relevant TEF.

A Dioxins Technical Group (DTG) was established under PISC to assist with the interpretation of results and to provide recommendations for further action.

In the absence of an Australian commodity standard for dioxins and furans, Australian data were compared against the EU standard (Maximum Level (ML)) in EU Regulation (EC) No 2375/2001. A comparison of results for dioxins and furans follows:

Species	**EU Standard Maximum Level Pg TEQ/g***	**Mean** result from this study (%)**	**Number of samples**
Fish (Tuna)	4	0.20 (4.9%)	20

* expressed on a fresh weight basis (i.e. muscle meat of fish and fishery products and products thereof).

** mean results (dioxins and furans) are upperbound concentrations expressed as pg TEQ/g (to 2 significant figures). Values in parentheses are expressed as a percentage of the EU standard for that species.

It is important to note that the EU standard (ML) in EU Regulation (EC) No. 2375/2001 only referred to dioxins/furans, and that dioxin-like PCBs were not included. In February 2006, the EC released amended regulations for dioxins and dioxin-like PCBs in food. The EU Regulation (EC) No 199/2006 includes MLs for dioxins and combined MLs for dioxins and dioxin-like PCBs. The EU combined ML (dioxins and dioxin-like PCBs) for fish is 8 pg TEQ/g fresh weight.

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Definitions

Limit of Detection (LOD): the lowest concentration level that can be determined to be statistically different from background noise (99% confidence).

Lowerbound: the sum of detected congeners multiplied by the relevant toxic equivalency factor.

Toxic Equivalency Factor (TEF): the toxicity level of a congener expressed as a fraction of the most toxic congener (2,3,7,8-TCDD).

Toxic Equivalence (TEQ): Individual TEQs are calculated by multiplying the concentration of a congener by its assigned WHO-TEF. The total TEQ is the sum of all individual TEQs.

Upperbound: the maximum possible TEQ. Includes both detected and non-detected congeners. The non-detected congeners are assumed to be at the level of the reported detection limit.

Glossary/Abbreviations

DAFF	Department of Agriculture, Fisheries and Forestry
DEH	Department of the Environment and Heritage
DoHA	Department of Health and Ageing
DTG	Dioxins Technical Group
EC	Commission of the European Communities
EU	European Union
FSANZ	Food Standards Australia and New Zealand
JECFA	Joint Expert Committee on Food Additives
LOD	Limit of Detection
Lowerbound	Sum of detected congeners multiplied by the relevant toxic equivalency factor
MAFF	Japanese Ministry of Agriculture, Forestry and Fisheries
NBT	Northern Bluefin Tuna (*Thunnus thynnus*)
NHMRC	National Health and Medical Research Council
NRS	National Residue Survey
PCB	Polychlorinated biphenyls
PISC	Primary Industries Standing Committee
PIAPH	Product Integrity, Animal and Plant Health, DAFF
PIRSA	South Australian Government Department of Primary Industries and Resources
SARDI	South Australian Research and Development Institute
SBT	Southern Bluefin Tuna (*Thunnus maccoyii)*
SCARM	Standing Committee on Agriculture and Resource Management
TEF	Toxic Equivalency Factor
TEQ	Toxic Equivalence
TGA	Therapeutic Goods Administration
Upperbound	Maximum possible TEQ
WHO	World Health Organization

1. BACKGROUND

In August 2000, the Primary Industries Standing Committee (PISC), formerly the Standing Committee on Agriculture and Resource Management, SCARM, was informed of a dioxin and polychlorinated biphenyls (PCB) crisis in Belgium. The crisis had an adverse impact on consumer confidence and Belgian food exports. At that time, Australia did not have any monitoring data for dioxins in agricultural products, nor a domestic health standard for dioxin intake.

SCARM acknowledged the need for a coordinated strategy to maintain market access for agricultural products and agreed to the establishment of a Dioxins Working Group to conduct a strategic assessment of risk and recommend a risk management approach, including:

(a) dioxin testing of agricultural commodities to provide data on prevalence and levels

(b) development of a protocol for reporting dioxin results and the management of significant detections.

In this report the terms “dioxin”, “dioxins” or “PCDD/F” are used in reference to each of the 2,3,7,8 chlorine substituted dibenzo-*p*-dioxins and dibenzofurans congeners and the term PCBs is used in reference to the PCBs with dioxin-like toxicity, unless otherwise specified (Refer to Tables 2.1(A) and 2.1 (B)).

1.1 PISC Dioxins Working Group

At its first meeting on 4 December 2000, the Dioxins Working Group agreed to the following objective for the group:

> “To safeguard consumer health and protect Australia’s export markets in regards to dioxin contamination of food and food ingredients through the collection of prevalence data of dioxins in Australia’s agricultural produce.”

The Dioxins Working Group developed a framework for dioxin testing of agricultural commodities based on a risk management approach. The commodity groups proposed for the testing programme included cattle, sheep, pigs, poultry, aquaculture fish and milk.

The Standing Committee endorsed the Dioxins Testing Programme for Australian Agricultural Commodities in August 2001 and also endorsed:

> *“the establishment of a Dioxin Technical Group (DTG) to assist with interpretation of dioxin test results and determine whether detections warrant further actions based on relevant toxicological or scientific information. The Working Group considered the DTG necessary to interpret results because there are currently no legislated standards for maximum dioxin levels in food*

commodities and dioxins are generally found in nature as complex mixtures with greatly varying toxicological significance."

1.2 Members of the Dioxins Technical Group

The members of the DTG were chosen by PISC (then SCARM) on the basis of expertise rather than a representative role (Table 1.1).

Table 1.1: Members of the Dioxins Technical Group

Name	Organisation
Dr Angelo Valois (chair)	Australian Government Department of Agriculture, Fisheries and Forestry
Dr Les Davies	Therapeutic Goods Administration
Mr Denis Hamilton	Queensland Department of Primary Industries
Mr Graham Roberts	Chem Res Technical Services P/L, formerly Victorian Department of Primary Industries
Dr Bob Symons	National Measurement Institute

1.3 Terms of reference

Considering the intent of PISC in establishing the DTG, the DTG members agreed to the following terms of reference:

The DTG should:

A. Interpret results, as dioxins are generally found in nature as complex mixtures with individual components of greatly varying toxicological significance

B. Interpret results, as there are currently no legislated Australian standards for maximum dioxins levels in food commodities

C. Determine whether detections warrant further actions in respect of international trade (i.e. not a human health assessment) based on relevant toxicological or scientific information

D. Assist with the interpretation of dioxins test results.

1.4 Reporting

As detailed in the PISC paper establishing the dioxins testing programme, the DTG was established to report to the NRS, the expert opinion of DTG members as to whether the results warranted further actions. Should the DTG deem that the results warranted further action, the NRS would report results of concern to the state/territory Residue Coordinator in the state/territory of origin of the product and to the relevant industry body.

The exact format and content of the DTG's report to the NRS, was determined in the context of the terms of reference agreed to by the DTG.

Although it was the intention of PISC that the DTG report only to the NRS, the opinion of the DTG could also be provided to the PISC Dioxins Working Group and/or to the relevant industry bodies if it was considered necessary that some action was required.

1.5 Framework for the Australian Dioxins Testing Programme

The Australian Government Department of Agriculture, Fisheries and Forestry (DAFF) obtained financing for the testing programme through a joint arrangement between the Australian Government Department of the Environment and Heritage (DEH) and participating industry bodies.

The commodity groups involved in the testing programme include cattle, sheep, pigs, poultry, aquaculture fish (salmonids and tuna) and milk. This report presents the results and findings of dioxin testing for farmed Southern Bluefin Tuna (*Thunnus maccoyii*). Results and findings relating to the other commodity groups were released in an earlier report (National Dioxins Programme Technical Report No. 8 *Dioxins in Agricultural Commodities in Australia*), in conjunction with studies from the other components of the National Dioxins Programme. General recommendations and conclusions presented in that report are also relevant to the tuna study and in this report reference is made to Technical Report No. 8 in the relevant sections.

Review by DAFF of an initial set of 20 tuna samples taken in 2003, revealed some anomalies in respect of sample selection, which gave rise to possible concerns regarding the integrity of the results. As a result of consultations between DAFF, the tuna industry and DEH, it was agreed that sampling and testing of 20 new samples would be undertaken with particular attention given to sampling methodology to allow for within and between fish variability (refer to Section 3.1). Sample collection was organised by the South Australian Research and Development Institute (SARDI) in May and June 2004. SARDI is part of the South Australian Government Department of Primary Industries and Resources. AgriQuality UltraTrace™, an analytical laboratory with internationally recognised accreditation to ISO 17025 for the analysis of PCDD/F and PCBs in fish, was contracted to carry out the analysis of samples.

1.6 International developments

While there are currently no legislated standards for maximum dioxin levels in food commodities in Australia, dioxin levels continue to be an issue in export markets. Countries with dioxin testing programmes include New Zealand, Canada, the United States of America, the European Union, Japan, the Republic of Korea and Taiwan.

Dietary intake standards

The World Health Organization (WHO) established a tolerable daily intake (TDI) for dioxins in 1990. The WHO tightened the TDI range in 1998. Subsequently, the Joint Food and Agriculture Organization (FAO) and WHO Expert Committee on Food Additives (JECFA), established a provisional tolerable monthly intake. Japan set a TDI in 2003.

Australian Tolerable Monthly Intake

In January 2002, the Therapeutic Good Administration (TGA) and the National Health and Medical Research Council (NHMRC) within the Department of Health and Ageing

(DoHA) released a recommendation for a proposed Tolerable Monthly Intake of 70 pg TEQ/kg bodyweight. This value was reconfirmed in 2004 as part of the Australian human health risk assessment carried out on dioxins by the TGA's Office of Chemical Safety (refer to National Dioxins Programme Technical Report No. 12 *Human Health Risk Assessment of Dioxins in Australia*).

Overseas intake standards

WHO, EU, JECFA, Japan and the Australian NHMRC/TGA/DoHA intake standards are listed in the following table.

Table 1.2: Comparison of intake standards for dioxins/furans and dioxin-like PCBs

Agency/organisation	**Intake/exposure standard**	**Standards converted to the same units for comparison**
Japan (2003)	4 pg/kg bw/**day**	120 pg/kg bw/month
NHMRC/TGA/DoHA (2002)	70 pg/kg bw/**month**	70 pg/kg bw/month
JECFA (2001)	70 pg/kg bw/**month**	70 pg/kg bw/month
EU (2001)	14 pg/kg bw/**week**	60 pg/kg bw/month
WHO (1998)	1-4 pg kg bw/**day**	30-120 pg/kg bw/month

Commodity standards

The Commission of the European Communities (EC) has had in place maximum levels (ML) for dioxins in beef, sheep meat, fish meat, milk, pigs and poultry since 1 July 2002 (EC Regulation No 2375/2001). Refer to Section 4.1 for dioxin MLs in fish. The EC has also defined "action levels", nominally set at two-thirds the maximum levels (see EC 2002/201/EC), whereby Member States in cooperation with operators, are requested to:

- initiate investigations to identify the source of contamination
- check for the presence of dioxin-like PCBs
- take measures to reduce or eliminate the source of contamination.

The EC is expected to notify the WTO of a draft ML for the dioxin-like PCBs in the near future. It is believed that a separate ML will be set for dioxin-like PCBs which will be harmonised with the current dioxin (PCDD/F) ML by 2006 as a single combined ML.

The Commission Recommendation, EC 2002/201/EC, also covers animal feedstuffs.

2. SUMMARY OF RESULTS

The results presented in this paper use the WHO TEFs as outlined in Table 2.1(A) and Table 2.1(B). The use of the WHO TEFs, rather than the I-TEFs, is consistent with the NHMRC/TGA recommended intake standard for dioxins and dioxin-like PCBs.

Table 2.1(A): WHO TEFs for dioxins and furans

Analyte	TEFs*
2378 TCDF	0.1
2378 TCDD	1
12378 PeCDF	0.05
23478 PeCDF	0.5
12378 PeCDD	1
123478 HxCDF	0.1
123678 HxCDF	0.1
234678 HxCDF	0.1
123789 HxCDF	0.1
123478 HxCDD	0.1
123678 HxCDD	0.1
123789 HxCDD	0.1
1234678 HpCDF	0.01
1234789 HpCDF	0.01
1234678 HpCDD	0.01
OCDF	0.0001
OCDD	0.0001

* TEFs = Toxic equivalency factors

Table 2.1(B): WHO TEFs for Dioxin-like PCBs

Analyte	TEFs*
PCB#77	0.0001
PCB#81	0.0001
PCB#126	0.1
PCB#169	0.01
PCB#105	0.0001
PCB#114	0.0005
PCB#118	0.0001
PCB#123	0.0001
PCB#156	0.0005
PCB#157	0.0005
PCB#167	0.00001
PCB#189	0.0001

* TEFs = Toxic equivalency factors

Table 2.2: Dioxins and Dioxin-like PCBs in aquaculture tuna

Tuna	Mean	Standard Deviation	Minimum	Median	Maximum
Dioxins lowerbound (pg TEQ/g fw)	0.161	0.194	0.00986	0.117	0.790
Dioxins upperbound (pg TEQ/g fw)	0.197*	0.185	0.0603	0.152	0.798
PCBs lowerbound (pg TEQ/g fw)	0.872	0.811	0.148	0.494	3.52
PCBs upperbound (pg TEQ/g fw)	0.873	0.814	0.148	0.494	3.52
Total TEQ lowerbound (pg TEQ/g fw)	1.03	0.982	0.158	0.622	4.29**
Total TEQ upperbound (pg TEQ/g fw)	1.07	0.976	0.233	0.645	4.32**

n = 20
dioxins = dioxins and furans (see Table 2.1(A))
TEQ = WHO TEQ
Dioxin-like PCBs (see Table 2.1(B))
fw = fresh weight

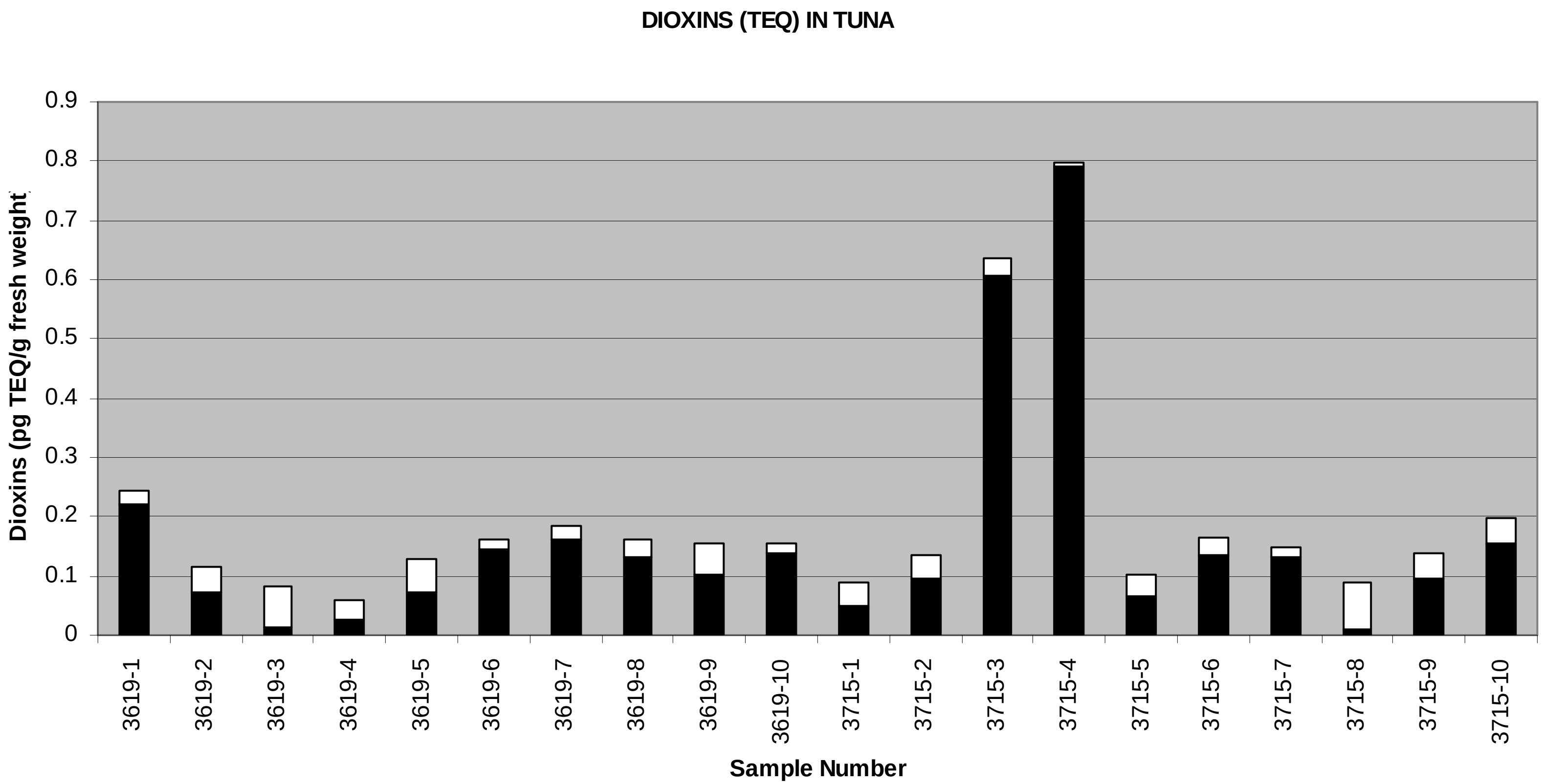
* The Australian data (mean dioxin upperbound result in pg TEQ/g fw) for tuna was 4.9% of the EC standard ((EC Regulation) No 2375/2001). The EU standard for dioxins does not include dioxin-like PCBs.

** Maximum 'Total TEQ' results represent the maximum value across all samples for the sum of dioxin and dioxin-like PCB results in an individual sample. For any sample, maximum 'Total TEQ' results are not the sum of maximum dioxin TEQ and maximum PCB TEQ values unless both maximums occur in the same sample. For example, the maximum upperbound dioxin TEQ in tuna occurs in sample 3715-4. The maximum upperbound PCB TEQ in tuna occurs in sample 3715-4. In this case, the highest total TEQ upperbound of any tuna sample also happens to occur in sample 3715-4 (see Figures 2.1(A) – (C)).

2.1 Individual results

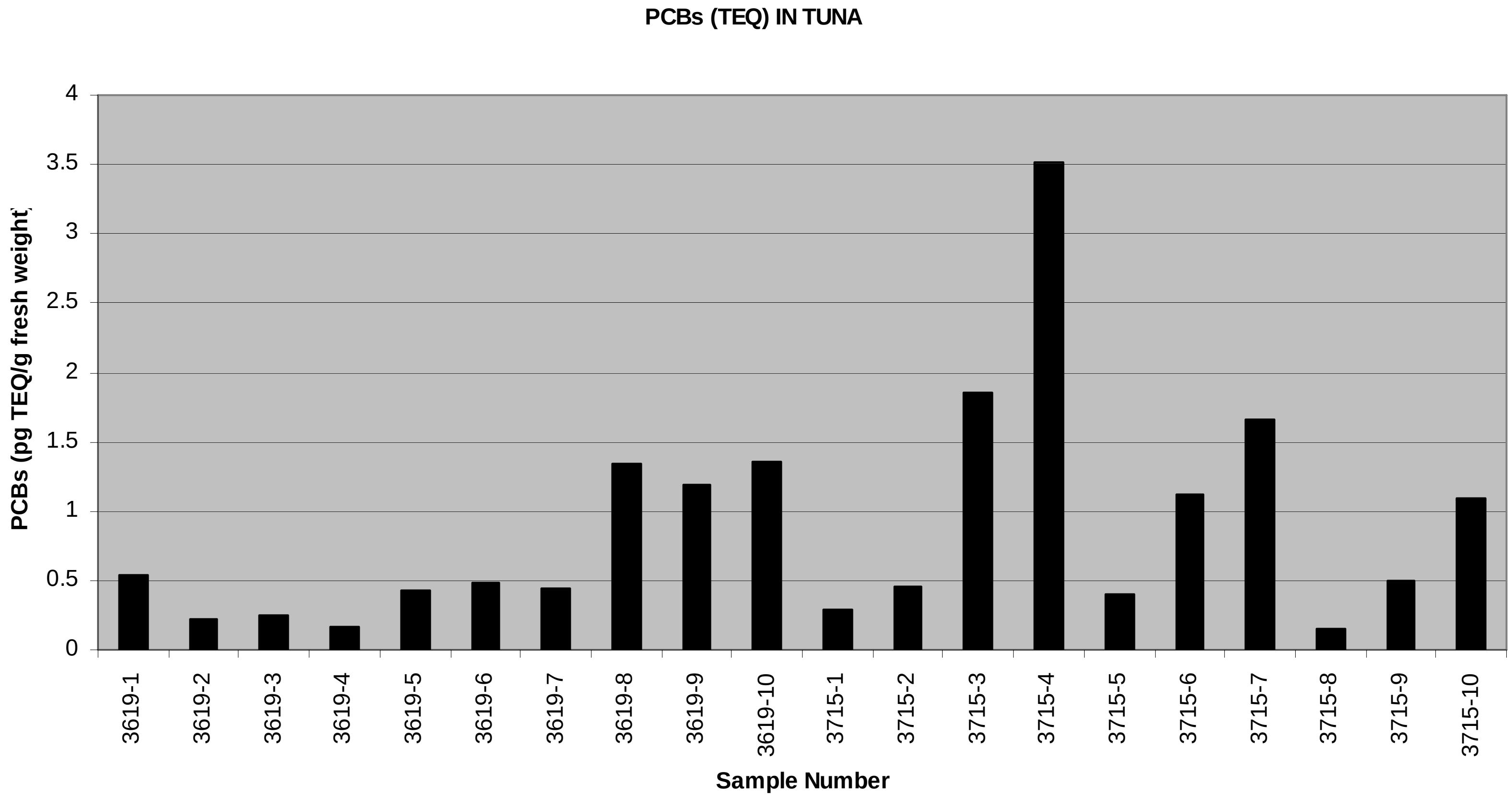
Graphical summaries of individual results are provided in Figures 2.1(A-C) to give a fuller explanation of the results.

Figure 2.1(A): Dioxins (TEQ) in aquaculture tuna



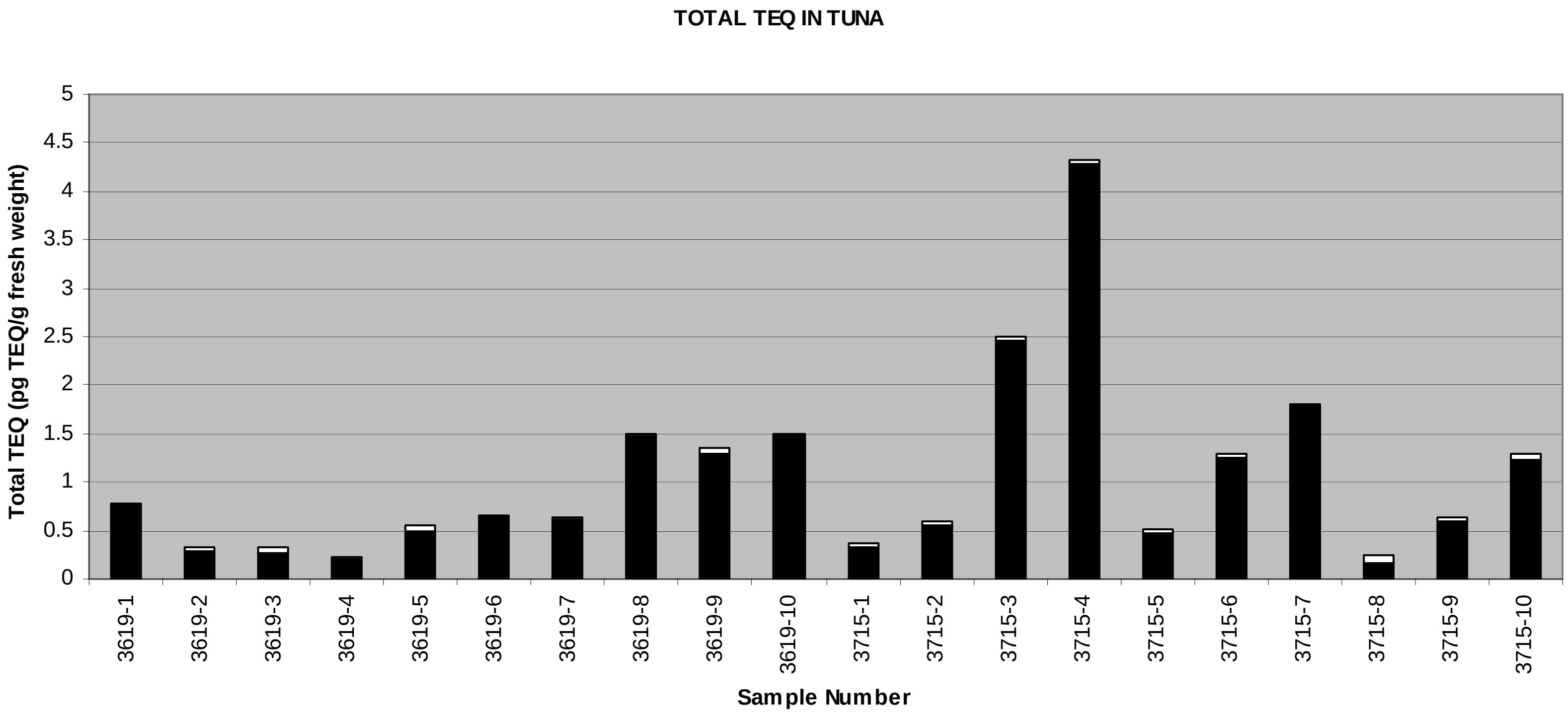
NOTE: Results of fish sample testing are expressed as per gram fresh weight. This is consistent with international practice for reporting this commodity.
Black bars represent lowerbound value (i.e. the sum of detected congeners multiplied by the relevant TEF).
White bars represent the sum of LOD contributions (i.e., the sum of the LOD for non-detected congeners multiplied by the relevant TEF).
The black and white bars together represent the upperbound value or maximum possible TEQ in that sample.

Figure 2.1(B): Dioxin-like PCBs (TEQ) in aquaculture tuna



NOTE: Results of fish sample testing are expressed as per gram fresh weight. This is consistent with international practice for reporting this commodity.
Black bars represent lowerbound value (i.e. the sum of detected congeners multiplied by the relevant TEF).
Non-detects did not make a significant contribution to the upperbound values. There was little difference between lowerbound and upperbound values.

Figure 2.1(C): Total (Dioxins (PCDD/F) + Dioxin-like PCBs) TEQ in aquaculture tuna



NOTE: Results of fish sample testing are expressed as per gram fresh weight. This is consistent with international practice for reporting this commodity.
Black bars represent lowerbound value (i.e. the sum of detected congeners multiplied by the relevant TEF).
White bars represent the sum of LOD contributions (i.e. the sum of the LOD for non-detected congeners multiplied by the relevant TEF).
The black and white bars together represent the upperbound value or maximum possible TEQ in that sample.

3. INFORMATION RELEVANT TO RESULTS

3.1 Sampling

Sampling for this study was undertaken in conjunction with the SARDI Food Safety Research Programme's review of residues in Australian commercially farmed and wild-caught Southern Bluefin Tuna in 2004. The sampling and sample preparation procedures were similar for both studies [see reference to SARDI report on page 29].

The collection of 20 Southern Bluefin Tuna samples was organised by officers from the SARDI Food Safety Research Programme, during May and June 2004. The fish were harvested from all 12 tuna companies in the Port Lincoln area of South Australia from 14 May 2004 to 16 June 2004. Sampling of the harvested fish began on 31 May 2004 with the last fish sampled on 24 June 2004. Sampling from the 12 companies related to production throughput. Tonnage of tuna into farms varied from 1000 tonnes for the largest farm to 200 tonnes for the smallest farm. Four fish were sampled from the largest farm, 3 fish from each of the next two largest farms (~730 tonnes input), 2 fish from the next largest farm (~420 tonnes input) and one fish each from the other eight farms (~250 tonnes average input).

The fish entered the farms during December to February. The period on feed ranged from 2-5 months. All fish sampled were part of normal commercial harvests. At each company farm, divers removed tuna from pens to meet marketing requirements at different times in the production season. The company set aside one fish from designated harvests for shipment to SARDI for sample processing. The selection of a particular fish for testing from a pen at a particular time was, therefore, opportunistically based on the constraints of commercial operations. However, the collection of the 20 tuna was designed to be representative of production across the 12 tuna farms over the production season.

The size of fish at the time of sampling ranged in weight from 10.6 kg to 30.9 kg (mean 20.3 kg; median 19.5 kg) and the length ranged from 76 cm to 116 cm (mean 98 cm; median 97 cm).

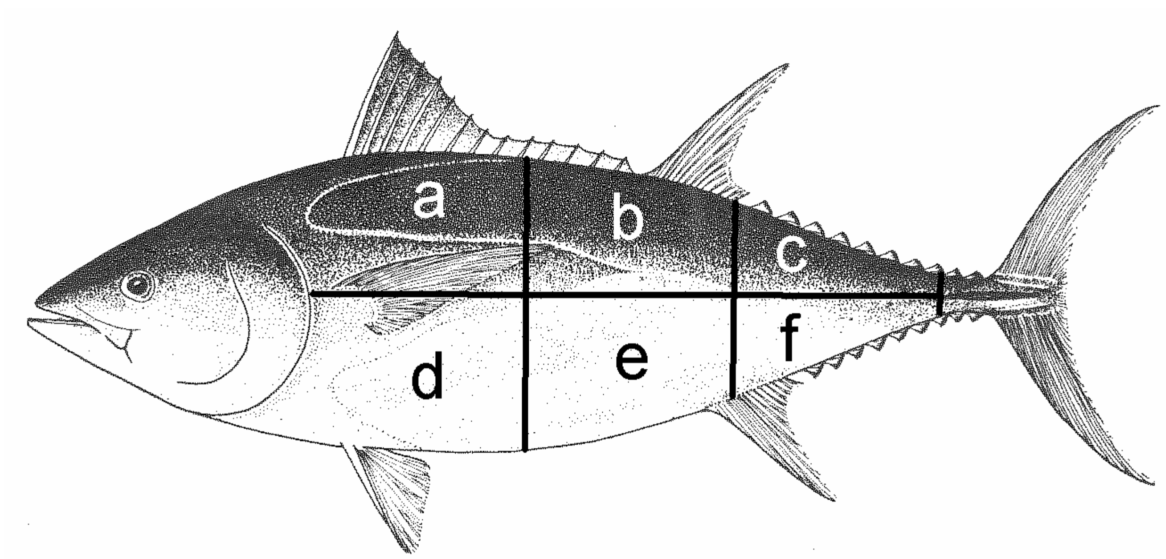
The diet of the fish can be assumed to have varied somewhat between tuna growers but specific feeding practice differences between ranches are not available. For the 2004 growing season across all 12 tuna companies the predominant feed was local South Australian pilchards (*Sardinops sagax neopilchardus*) (60%), American (Californian) Pilchards (*Sardinops sagax*) (20%), Australian redbait (*Emmelichthys nitidus nitidus*) (10%) and other fish (10%).

Each company provided whole fish to SARDI. Muscle tissue (200-250g) was collected from the individual whole fish by SARDI officers according to a procedure reflecting the sampling protocol of the Japanese Ministry of Agriculture, Forestry and Fisheries (MAFF) official cross carcase composite sampling method used for Bluefin Tuna residue testing in Japan. After skinning, the tuna carcase body for each fish was divided into 6 parts (see Figure 3.1). Equal muscle portions was carefully collected from each of the six carcase parts and homogenised in a stainless steel food processor to ensure thorough mixing of muscle tissue. The final sample was placed into solvent cleaned foil provided by the analytical laboratory, frozen and put in an NRS security satchel for consignment to the laboratory. Special attention was paid to minimise the risk of contamination of the sample from ambient sources or during processing and packaging of the samples.

The fat content (percentage fat) for the 20 homogenised tuna muscle tissue samples at the time of sample collection ranged from 1% to 17% (mean 9.5%; median 10.5%).

The samples were shipped directly by SARDI to the laboratory in New Zealand for analysis. Results were reported back to SARDI and to the NRS.

Figure 3.1: Diagrammatic representation of the 6 portions that are sampled in the official Japanese MAFF sample collection method for testing imported Bluefin Tuna



(Diagram courtesy of SARDI, adapted from the Japanese MAFF official cross carcase composite sampling method)

3.2 Dioxins / PCB analytical methodology

The methods used for the analysis of polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs) and polychlorinated biphenyls (PCBs) were based on USEPA Methods 1613 (PCDDs & PCDFs) and 1668A (PCBs). These methods utilise high-resolution gas chromatography and high resolution mass spectrometry (HRGC-HRMS) techniques for the identification and quantification of individual PCDD, PCDF and PCB congeners and enable their corresponding Toxic Equivalents (TEQs) to be calculated.

In the case of dioxins, the tetra- to octa- dibenzodioxins and dibenzofurans congeners substituted in the 2,3,7,8 positions are included in the analytical regime. In the case of

PCBs, the 12 coplanar congeners with dioxin-like toxicity as well as a number of other congeners are covered by the method.

Each toxic dioxin and PCB congener is assigned a WHO toxic equivalency factor (WHO-TEF), as detailed in Tables 2.1(A) and 2.1(B) under Section 2 of this report. Individual toxic equivalents (TEQs) are calculated for each individual toxic congener by multiplying the concentration of the congener with its assigned WHO-TEF. The individual TEQs are then summed to give a total TEQ.

The sum of congeners and total TEQ are reported at three levels – lowerbound, mediumbound (not included in this report) and upperbound. Lowerbound includes only the detected congener levels, thus giving a best-case scenario. Upperbound includes both detected and non-detected congeners, where the non-detected congeners are assumed to be at the level of the reported detection limit, thus giving a worse case scenario.

Consistent with USEPA methodology, responses observed in the samples or method blanks (all reagents and materials other than the sample) that meet the required signal to noise and identification criteria are reported as detected and their concentrations are calculated on the basis of the area of the peak observed.

A target compound can only be identified if it meets the following criteria:

1) the signals for both monitored ions must maximise within two seconds.
2) the signal to noise ratio must be greater than or equal to 2.5
3) the ratio of the areas for both monitored ions must be within 15% of theoretical value
4) the retention time of the peak must be within specific time limits, relative to internal standards.

However if all qualitative criteria are met with the exception of 3) above, US EPA methodology also allows the reporting of an EMPC (estimated maximum possible concentration). An EMPC value in the analytical report is treated as a detect value and are included in the lower bound summations.

4. EXISTING COMMODITY STANDARDS

In the absence of an Australian commodity standard for dioxins and furans the most relevant existing commodity standards for comparative assessment of Australian data are:

- the EU standard (ML) in EU Regulation (EC) No 2375/2001 and
- the EU action levels in EU Recommendation 2002/201/EC.

The salmonid data in this report represents data that was covered in National Dioxins Programme Technical Report No. 8 – *Dioxins in Agricultural Commodities in Australia*, released in May 2004. It has been included for comparative purposes both because it is an aquaculture species and much of the international data is shared by both reports.

4.1 European Union

Table 4.1(A): Comparison of the results from this study with the EU Standard for dioxins/furans

Species***	Maximum level pg TEQ /g *	Mean** result from this study (%)	Maximum** result from this study (%)
Fish (tuna)	4	0.197 (4.9%)	0.798 (20.0%)
Fish (salmonids)	4	0.228 (5.7%)	0.350 (8.75%)

* TEQ level is expressed on a muscle basis. Where a congener is not detected, the EU standard assumes the LOD for that congener.
** mean and maximum results are upperbound concentrations expressed as pg TEQ/g. Values in parentheses are expressed as a percentage of the EU standard for that species).
*** tuna were collected and analysed in 2004. Salmonids were collected and analysed in 2003. The results and findings of dioxin testing for salmonids are available from *National Dioxins Programme Technical Report No. 8 Dioxins in Agricultural Commodities in Australia*.

Table 4.1(B): Comparison of the results from this study with the EU Action levels for dioxins/furans

Species***	Maximum level pg TEQ /g *	Mean** result from this study (%)	Maximum** result from this study (%)
Fish (tuna)	3	0.197 (6.6%)	0.798 (26.6%)
Fish (salmonids)	3	0.228 (7.6%)	0.350 (11.7%)

* TEQ level is expressed on a muscle basis. Where a congener is not detected, the EU action level assumes the LOD.
** mean and maximum results are upperbound concentrations expressed as pg TEQ/g. Values in parentheses are expressed as a percentage of the EU action level for that species).
*** tuna were collected and analysed in 2004. Salmonids were collected and analysed in 2003. The results and findings of dioxin testing for salmonids are available from National Dioxins Programme Technical Report No. 8 *Dioxins in Agricultural Commodities in Australia*.

The definition of application of 'action level' in EU Recommendation 2002/201/EC is that Member States in cooperation with operators:

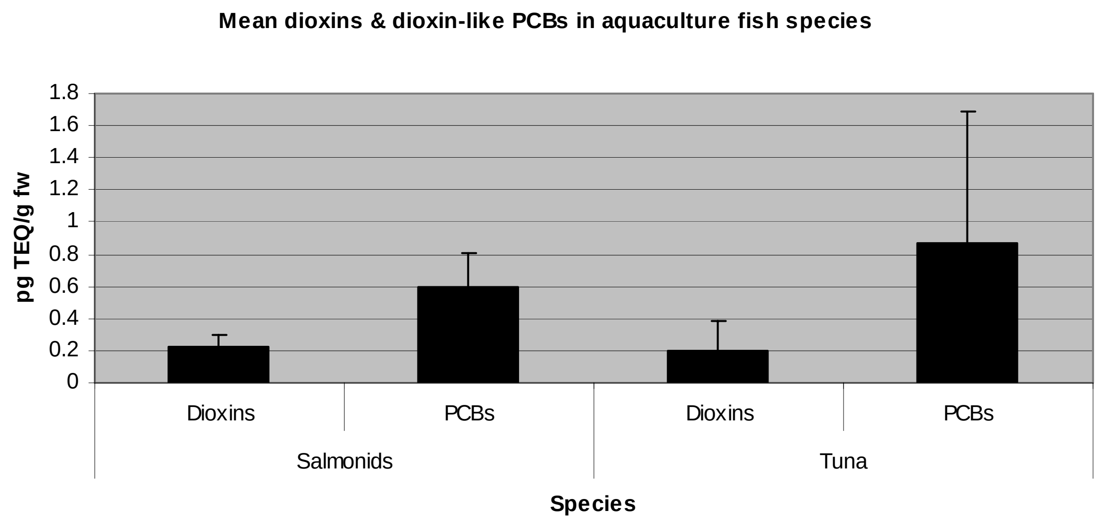
- initiate investigations to identify the source of contamination
- check for the presence of dioxin-like PCBs and
- take measures to reduce or eliminate the source of contamination.

5. COMMODITY COMPARISON

The figure presented in this section was prepared to provide a comparison between the Australian tuna and salmon samples tested in this study.

Figure 5.1 compares the mean upperbound level of dioxins (including furans) and dioxin-like PCBs in the aquaculture fish commodities (tuna and salmon) tested in this study. The international convention for testing fish is to report results on fresh weight, not per unit fat, basis.

Figure 5.1: Commodity comparison (fish)



Note: the error bars represent the standard deviation of upperbound concentrations

6. INTERNATIONAL COMPARISON

The figures presented in this section were prepared to provide a qualified comparison between the Australian aquaculture fish samples tested in this project with results reported in other studies from around the world. A high level of circumspection needs to apply to such comparisons because limited sample numbers and a number of confounding factors can influence results within any study (source of fish, time on feed, type and source of feed, size of fish at start of feeding, testing methodology).

Despite the inconsistency of methods and sampling between studies, there is some value in comparing the Australian dioxin data to reported international findings.

6.1 Comparison with CCFAC reported data

The data generated in this study were compared with the dioxin data for geographical regions in the Codex Committee on Food Additives and Contaminants (CCFAC) position paper (CX/FAC 03/32, January 2003). It is important to note that these results are not directly comparable and various methods are outlined or referenced in the CCFAC paper.

Note the testing conducted for the Australian study includes more compounds (i.e. dioxins, dioxin-like PCBs and Total TEQ) than data presented in the CCFAC paper. A comparison for dioxins and furans in fish using the data from the CCFAC paper is shown in Figure 6.1(A). A comparison from other studies reported internationally for dioxins and furans in fish is shown in Figure 6.1(B). Figure 6.1(C) shows a comparison for dioxin-like PCBs in fish using data from the CCFAC paper.

Figure 6.1(A): Range of dioxins in fish

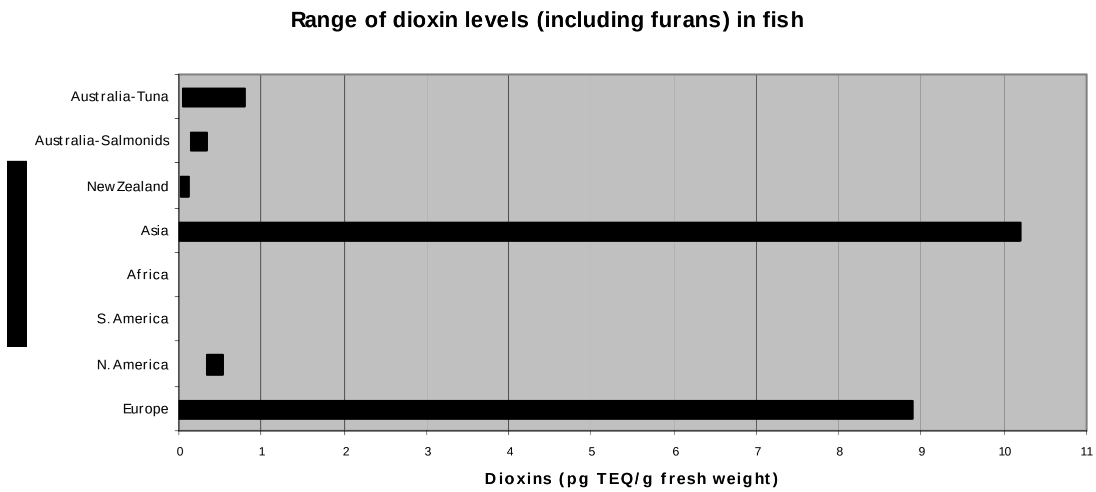


Figure 6.1(B): Range of dioxins in fish

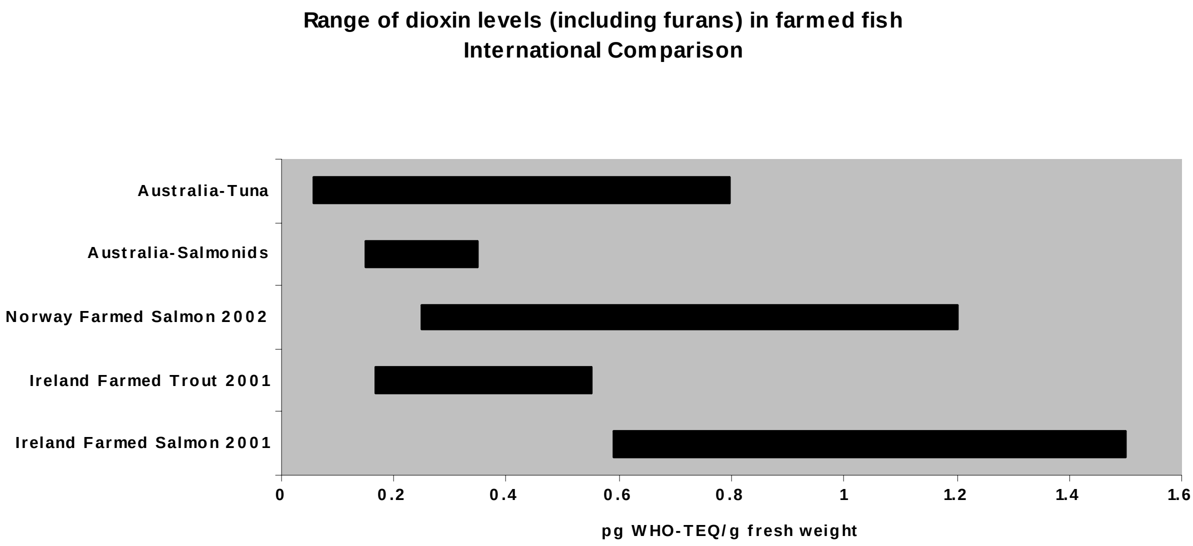
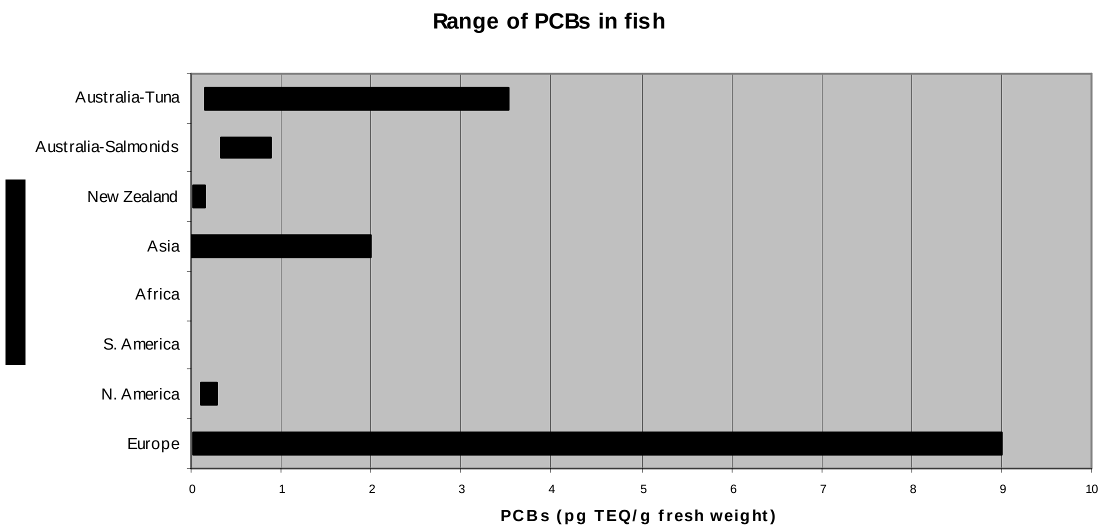


Figure 6.1(C): Range of dioxin-like PCBs in fish

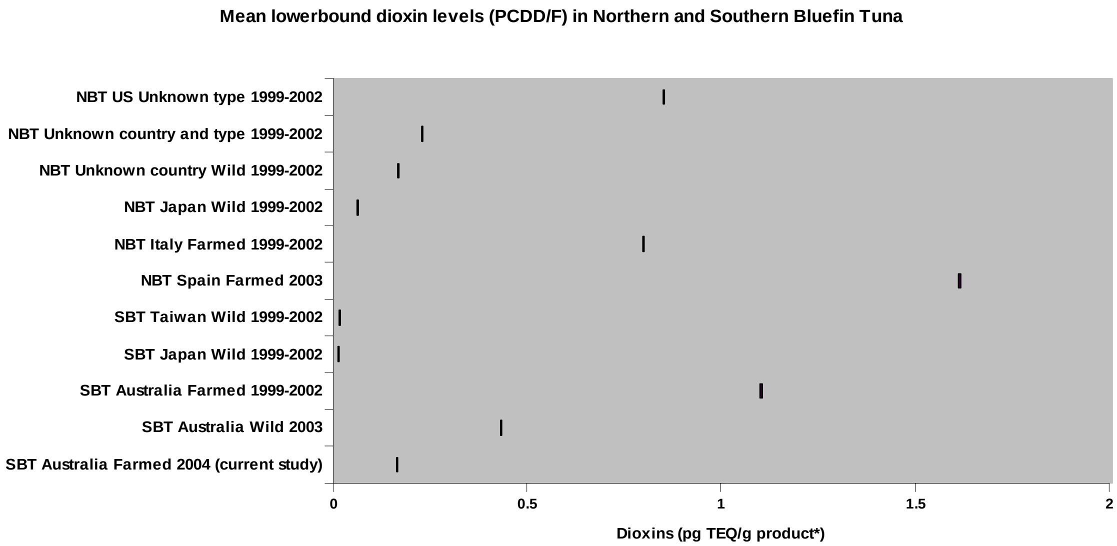


6.2 Comparison with tuna dioxin data from Japanese Ministry of Agriculture Forestry and Fisheries

The following two graphs (Figures 6.2(A) and 6.2(B)) summarise a comparison of tuna dioxin results published by the Japanese Ministry of Agriculture, Forestry and Fisheries (MAFF) (http://www.maff.go.jp/www/press/cont2/20040929press_6b1.pdf) with results obtained in this study. The comparisons are for lowerbound values of dioxins and dioxin-like PCB concentrations. The MAFF results are from imported and domestically harvested tuna (Southern and Northern Bluefin Tuna [*Thunnus thynnus*]) entering the Japanese market. The results include both wild caught and farmed tuna. Although the sampling approach in this study is based on the sampling protocol used by the Japanese MAFF, the MAFF results are obtained from composite samples blended from portions collected from 10 different fish sampled from different parts of each fish. However in this study (SBT Australia Farmed 2004), portions were collected from the same fish and blended for analysis, so each sample result was derived from an individual fish.

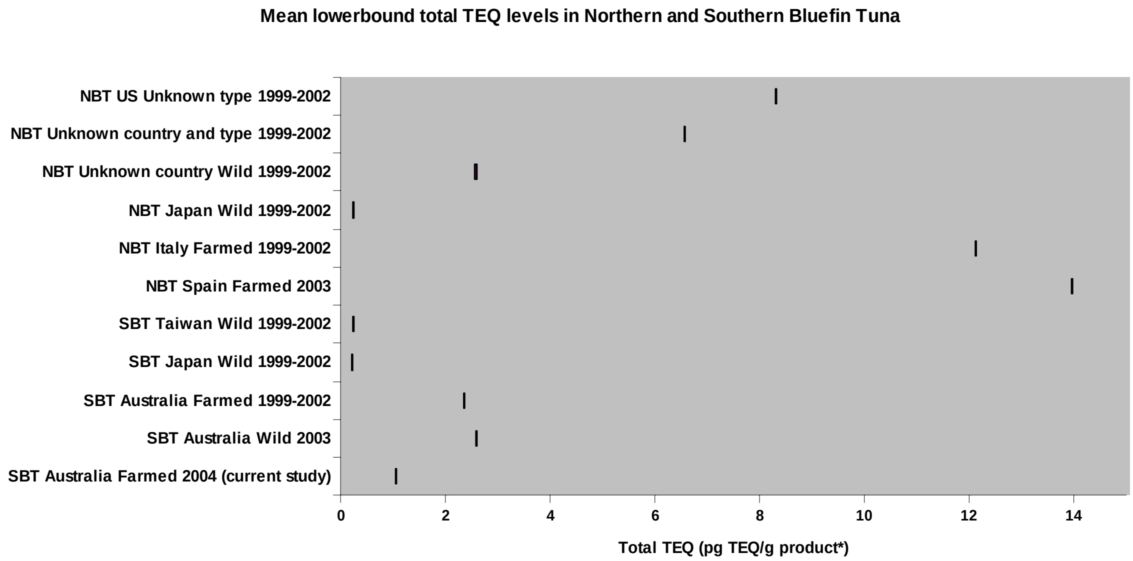
Although the sampling is not the same, the results suggest that dioxin levels in Australian farmed Southern Bluefin Tuna compare favourably with tuna harvested from other parts of the world. Figure 6.2(A) compares the mean dioxin levels, whereas Figure 6.2(B) compares total dioxin (dioxins + dioxin-like PCBs) levels.

Figure 6.2(A): Comparison of mean lowerbound dioxin levels (PCDD/F) from overseas Northern and Southern Bluefin Tuna (wild and farmed) reported by Japanese MAFF and Australian farmed Southern Bluefin Tuna from this study



* expressed on a fresh weight basis

Figure 6.2(B): Comparison of mean lowerbound total dioxin (dioxins + dioxin-like PCBs) levels from overseas Northern and Southern Bluefin Tuna (wild and farmed) reported by Japanese MAFF and Australian farmed Southern Bluefin Tuna from this study



* expressed on a fresh weight basis

7. FINDINGS AND RECOMMENDATIONS

This report is a supplement to National Dioxins Programme Technical Report No. 8 *Dioxins in Agricultural Commodities in Australia.* General recommendations contained in Technical Report No. 8 also apply to this study and should be read in conjunction with this report.

Recommendations 1 to 6 from Technical Report No. 8 addressed the following issues:

- interpretation of toxicological significance
- consumer exposure
- comparison to international data
- international trade (including the consideration of PCBs)
- methods of sampling
- limit of detections (LODs)
- national laboratory capability and
- measurement uncertainty.

7.1 Tuna (aquaculture) trade assessment

The conclusions of the DTG in the species specific trade assessment are derived from comparisons to existing or expected international trade standards and/or action levels. The DTG has not made any toxicological assessment of this data.

The DTG noted that no existing international fish commodity standards or action levels were exceeded in this study. The highest concentration of dioxins/furans recorded (upperbound result) was approximately 27% of the EU action level. Lowerbound dioxin and furan results were between 55-99% of upperbound results for 16 of the 20 samples tested. Lowerbound dioxin and furan concentrations were less than 50% of upperbound concentrations in the other four samples tested. All samples had detectable levels of dioxin-like PCBs with the highest lowerbound concentration for any sample estimated to be 0.79 pg WHO_{98}-TEQ/g fresh weight. In the opinion of the DTG, the observed low residue detections are most likely from exposure through fish feed. Although the detected levels for dioxins and dioxin-like PCBs were well below the known action levels set by overseas countries, the industry should be encouraged to continue to manage its feed sources as the best means of controlling exposure to fed tuna from these environmental contaminants.

As this study only tested a limited number of samples, further monitoring should be considered by the tuna industry.

RECOMMENDATIONS:
(a) That the Australian tuna industry carefully manage its feed sources with a view to reducing total dioxin (i.e. dioxin, furan and PCB) TEQ in fish.
(b) That further periodic testing of tuna takes place for dioxins and PCBs to verify the effectiveness of feed controls in the aquaculture tuna industry.

8. REFERENCES

Documents referred to in this report

Australian Government Department of Agriculture, Fisheries and Forestry (2004), *Dioxins in Agricultural Commodities in Australia*, National Dioxins Programme Technical Report No. 8, Australian Government Department of the Environment and Heritage, Canberra.

Office of Chemical Safety, Australian Government Department of Health and Ageing (2004), *Human Health Risk Assessment of Dioxins in Australia*, National Dioxins Programme Technical Report No. 12, Australian Government Department of the Environment and Heritage, Canberra.

European Commission (2001), 'Setting maximum levels for certain contaminants in foodstuffs, Official Journal of the European Communities', 29 November 2001.

European Commission (2002), Official Journal of the European Communities, 'Commission recommendation on the reduction of the presence of dioxins, furans and PCBs in feeding stuffs and foodstuffs', 4 March 2002, Brussels.

European Commission (2006), 'Setting maximum levels for certain contaminants in foodstuffs, Official Journal of the European Union', 3 February 2006.

JECFA (Joint FAO/WHO Food Standards Programme) March (2003), 'Codex Committee on Food Additives and Contaminants: Position Paper on Dioxin and Dioxin-like PCBs', Thirty-fifth session, Agenda Item 16 (g), 17-21 March 2003, United Republic of Tanzania.

South Australian Research and Development Institute, Food Safety Research Programme (2005), *A Review of Residues in Australian Commercially Farmed and Wild-Caught Southern Bluefin Tuna (Thunnus maccoyii) in 2004*, South Australian Research and Development Institute, Primary Industries and Resources, South Australia.

Sources of data for international comparison presented in Figures 6.1(B), 6.2(A) and 6.2(B)

Food Safety Authority of Ireland, (2003), 'Summary of Investigation of Dioxins, Furans and PCBs in Farmed Salmon, Wild Salmon, Farmed Trout and Fish Oil Capsules', http://193.120.54.7/surveillance/food/surveillance_food_summarydioxins.asp.

Japanese Ministry of Agriculture, Forestry and Fisheries (MAFF) dioxin & PCB imported Tuna data 1999-2003, http://www.maff.go.jp/www/press/cont2/20040929press_6b1.pdf.