ENVIRONMENT REPORT

LOWER YARRA RIVER FISH STUDY: INVESTIGATION OF CONTAMINANTS IN FISH

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ABBREVIATIONS

Composites	Sample consisting of tissue from 10 individual fish from a single species at a single site
DDT	dichlorodiphenyltrichloroethane
DDE	dichlorodiphenyldichloroethylene
DDD	dichlorodiphenyldichloroethane
ERL	Extraneous Residue Limits
FSANZ	Food Standards Australia New Zealand
ML	Maximum Levels or Limits
NMI	National Measurement Institute
OC	Organochlorine pesticides
OP	Organophosphate pesticides
PAH	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenyl
PCB congener	A single well defined chemical compound in the PCB category
PCDD	Polychlorinated dibenzo-p-dioxins
PCDF	Polychlorinated dibenzofuran
PBDE	Polybrominated diphenyl ethers
PPB	Port Philip Bay
TBT	Tributyltin
TCDD	2,3,7,8 tetrachloro-p-dibenzodioxin
TEF	Toxic equivalent factor – relative toxicity or potency of other chemicals compared to TCDD
TEQ	Abbreviation of WHO-TEQ
TPH	Total petroleum hydrocarbons
UCI	Upper Confidence Interval
USEPA SV	United States Environmental Protection Agency screening values
WHO-TEQ	World Health Organisation toxic equivalent

UNITS OF MEASUREMENT

kg – kilogram	10^{3} gram (1000 g)
mg – milligram	10^{-3} gram (0.001 g)
µg – microgram	10^{-6} gram (0.000 001 g)
ng – nanogram	10^{-9} gram (0.000 000 001 g)
pg – picogram	10^{-12} gram (0.000 000 000 001 g)

EXECUTIVE SUMMARY

The potential impacts from dredging in the lower Yarra River were assessed in 2007 as part of the Supplementary Environment Effects Statement (SEES) for the Channel Deepening Project. It concluded that dredging of contaminated material would not give rise to changes in contaminant concentrations in fish that would be of a concern to human health.

The Environmental Management Plan (EMP) sets out requirements for environmental monitoring. Amongst these requirements are nine Baywide Monitoring Programs that aim to detect changes to the Port Phillip Bay environment outside expected variability.

The 2009 Lower Yarra River Fish Study is one of these. The objective of this study is "*to identify if the concentration of contaminants in fish tissue in the lower Yarra River after the dredging of contaminated sediments requires review of the current health advisory*".

To address this objective eighty black bream (bream) were collected from the Lower Yarra River in January 2009, three months after the completion of dredging of contaminated silts by the Trailing Suction Hopper Dredge. Eight composite fillet samples of ten bream were analysed for a wide range of organic contaminants and heavy metals. These results were then compared with the analysis of bream sampled from the same area in April/May 2006.

The results from the eight composite bream fillet samples show that:

- the median concentration of total polychlorinated biphenyls (PCBs), total dichlorodiphenyltrichloroethane (DDT), total arsenic, copper and zinc were less ($p<0.05$) than reported in 2006
- the median concentration of polybrominated diphenyl ethers (PBDE), total dioxins and dioxin-like PCBs, tributyltin (TBT), lead, total mercury and selenium are statistically similar ($p>0.05$) to those reported in 2006
- organophosphate pesticides (OPs), polycyclic aromatic hydrocarbons (PAHs), inorganic arsenic, cadmium, and chromium were not recorded at levels above the limit of reporting, as was also reported in 2006
- contaminant concentrations were below guideline levels for Australian food standards
- lipid content in fish samples was lower than that reported in 2006. This variation has no significance for the lipophilic compound concentrations reported above on a fresh weight basis.

In conclusion the contaminant levels are essentially unchanged when compared to those levels found in the 2006 samples which formed the basis for the existing health advisory.

2009 LOWER YARRA RIVER FISH STUDY

Report from an Expert Panel
May 2009

BACKGROUND

The Office of the Environmental Monitor (the Office) has sought an independent expert review of the 2009 Lower Yarra River Fish Study (EPA, 2009). EPA Victoria prepared a report on contaminants in fish sampled in the Lower Yarra River in January/February 2009. Its objective was "*to identify if the concentration of contaminants in fish tissue in the lower Yarra River after the dredging of contaminated sediments requires review of the current health advisory*" via analysis of a range of trace metals and organic compounds in two fish species – black bream (bream) *Acanthopagrus butcheri* and yellow-eye mullet (mullet) *Aldrichetta forsteri*.

This study was part of an ongoing investigation of the concentrations of chemical contaminants in fish caught in the Lower Yarra River and was conducted by EPA Victoria with the support of the Department of Sustainability and Environment and the Port of Melbourne Corporation. The study is also one of a number of baywide monitoring programs being conducted as part of the Channel Deepening Project (the Project) Environmental Management Plan.

The 2009 report collated results on a range of chemicals in fish caught in the Lower Yarra River and included data on potentially bioaccumulative chemicals including polychlorinated biphenyls (PCBs), dioxins, persistent organochlorine pesticides, trace metals (metals and metalloids) and non-bioaccumulative organophosphate pesticides and polycyclic aromatic hydrocarbons (PAHs). In the case of the dioxins and dioxin-like PCBs, the concentrations of individual congeners have been converted using 2,3,7,8-TCDD Toxic Equivalency Factors (TEFs) to determine the sum contribution of the measured congeners to a toxic outcome, with the data expressed in terms of Toxic Equivalents (TEQs). The report compared results with a similar study conducted by EPA Victoria in 2006 (EPA, 2007).

To assist with the interpretation of the data, the Office established an Independent Expert Review Panel (the Panel), conducted under the auspices of the Independent Expert Group established by the Department of Sustainability and Environment for the Project. It is intended that this Panel report be read in conjunction with the 2009 EPA report.

The composition of the Expert Panel and its review tasks are listed in Appendix 1.

IEG PANEL ADVICE

Panel members initially met via teleconference on 17 December 2008 to discuss expectations and process for the review. The Panel subsequently met three times during April/May 2009 to discuss the data and results in the 2009 report.

1. Sampling program

The species of fish and the range of contaminants tested were selected to be comparable to the 2006 study (EPA, 2007), although eels were not included in this study. Similarly fish were sampled and processed based on the methods used previously. Bream were sampled at three locations but nearly all fish were caught at the Docklands area and these fish were used to form the eight composite samples (containing ten fish each). Skinless fish fillets were prepared as composites for analysis at the National Measurement Institute (NMI), the laboratory contracted by EPA Victoria, noting that the same laboratory also conducted analyses for the 2006 study. The Panel noted that too few mullet were caught to enable analyses to be obtained for this species, even though the sampling time had been extended and alternate sampling methods used. While it would have been preferable for both species to be analysed, the Panel noted that mullet could not be caught due to environmental conditions. The Panel concluded that the sampling method used for this study was suitable.

2. Analytical processing

The fish composites were analysed for a range of potential contaminants. The emphasis was on commonly found PCB congeners, as well as the seventeen 2,3,7,8-Cl-substituted dioxins and 12 dioxin-like PCBs, selected polybrominated diphenyl ethers (PBDEs), selected organochlorine and organophosphate pesticides, organotins (mono-, di- and tri-butyltins), selected trace elements (metals and metalloids), PAHs, and total petroleum hydrocarbons. This range of compounds was the same as those analysed previously and was sufficiently comprehensive to determine contaminants likely to be of health concern.

The analytical methods used by NMI were suitable and the Panel notes that three separate laboratories were involved in interlaboratory QA/QC testing covering all analytes in 30% of samples.

The Panel noted that there was some variation in results between the testing laboratory, NMI, and the QA/QC laboratories and, indeed, between QA/QC laboratories for several analytes. The results for inorganic arsenic are an example and this is discussed in Appendix 3 of the 2009 report. It is the view of the Panel that such variation is not surprising, particularly when so many results were near or below the Limit of Reporting (LOR). In its analysis of the results, the Panel considered that these variations did not compromise the conclusions which could be drawn from the study.

3. Assessment of analytical results

The Panel notes that, for many of the analytes tested, concentrations were below the LOR of the laboratory. In these instances, while it makes quantitative risk assessment somewhat more difficult, the LOR was generally sufficiently below listed guideline trigger values (in Appendix 6 of the 2009 report) to indicate that these chemicals were at concentrations unlikely to be of health concern.

PCBs and dioxins

The concentrations of PCBs, dioxins and dioxin-like PCBs in composites reported in the 2009 study on a fresh weight basis were similar to or less than results found in 2006. The Panel notes that total dioxins and dioxin-like PCBs were expressed in terms of World Health Organisation TEQs in the 2009 report. This method is supported but it is noted that the method was based on that of Van den Berg et al. (1998) rather than the updated version by the same authors (Van den Berg et al., 2006). The Panel accepts that, while it would have been preferable to use the more recent work, it noted that the 1998 method varied the TEFs for only some of the congeners and left most unchanged. The Panel accepted that use of the 1998 TEFs provides for consistency with previous studies and allows more direct comparison between the 2009 and 2006 studies.

The Panel noted that the lipid contents of fish samples in 2009 were significantly less than 2006. This could affect the concentrations of lipophilic compounds such as PCBs and dioxins in the samples. The Panel requested results for the congeners of these compounds that were detected in 2009, together with results from those similar congeners detected in 2006, to be provided on a lipid weight basis. This would allow the Panel to see how concentrations of individual congeners changed in 2009, compared to the WHO-TEQ calculated values. Analysis of these data indicated that while most congeners had concentrations on a lipid weight basis that were similar to or less than 2006 samples, some congeners had increased concentrations, although this was not confirmed statistically. These included PCB #180 and 187, and dioxin-like PCBs #105, 118, 156, 157, 167, and 189. It was also noted that only six PCB congeners were detected above the LOR in 2009, a reduction from the nine detected in 2006. Similarly, the number of dioxin-like PCB congeners detected reduced from 12 in 2006 to six in 2009.

The reason for the differences in concentrations on a fresh weight basis compared to lipid weight for these compounds from 2006 to 2009 was not clear. The reduction in lipid content in the samples was likely due to the bream spawning prior to when sampling was undertaken. When fish spawn a proportion of their lipid is passed to the gametes (i.e. sperm and ova) and is therefore removed. A similar proportion of lipophilic compounds in the lipid may also be removed. However, it was also noted that the fish sampled in 2009 were consistently leaner, in that their weight was consistently less for the same length, than in 2006. This could also explain the lower lipid content. Under this scenario, lipophilic compounds could be concentrated in the remaining lipid, as triglycerides are used by the fish for energy production. A combination of these two options could also be a valid explanation. There may be other possible explanations, including that the fish in 2009 have been exposed to a change in contaminant concentrations.

Regardless of the possible explanations for the change in lipid content, the Panel considered the results from a worst-case scenario - that the fish, in spawning lost on average 70% of their lipids and consequently a similar proportion of the lipophilic compounds. Increasing the median concentrations of PCBs and dioxin-like PCBs for 2009, on a fresh weight basis as presented in Figures 3.1 and 3.2 of the 2009 report, by a factor of 3.3 still resulted in concentrations similar to those in 2006 and well below guideline values.

The Panel noted the report's discussion that lipid-weighted data should be treated with caution and that, from a human health perspective, it is more appropriate to base conclusions on concentrations expressed on a fresh weight basis.

Other chemicals

The Panel has noted that the concentrations of organochlorine and organophosphate pesticides, TBT, trace metals, PAHs and PBDEs were less than or similar to levels recorded in 2006. Many of the samples were at or below the reporting limits for the various analytes and (as for the 2006 study), where detected, concentrations were generally below respective ERL, MRL, ML or US EPA screening values relating to fish compounds.

The 2009 report advised that, for TPHs, the testing and QA/QC laboratories all had difficulty in providing reliable results. Results obtained were low but failed to meet quality standards and were therefore considered invalid and not included in the results. The Panel accepts the rationale that, given the relative change of other contaminants, there would not be a statistically significant increase in the levels of TPHs from 2006 to 2009, noting also that TPHs were not recorded at concentrations above the limit of detection in the 2006 study.

4. Report conclusions

The Panel notes that the conclusions drawn in the report are scientifically valid and reasonable.

5. Advice on management options

The current health advisory was informed by expert advice that considered the contaminant concentrations found in the 2006 samples. This advice was based on conservative assumptions and consideration of national and international guideline values for the chemical compounds analysed. Based on consideration of the results in the fish fillets from the 2009 report compared to those reported in 2006, noting that eels were not included in this study, and reflecting the potential chemical intake from the edible portions of the sample rather than the lipid-standardised data, the Panel was of the opinion that nothing observed in the 2009 data indicated the need to review this health advisory.

6. IEG Panel findings

The Panel has concluded that:

- For the contaminants examined on a fresh weight basis, the concentrations recorded in 2009 were generally lower than those recorded in the 2006 samples.
- It was observed that the lipid concentrations of the 2009 fillet samples were lower compared with the 2006 samples, which may explain the observed variation in lipophilic contaminants. The change may be due to the 2009 and 2006 samples being at different life-cycle stages.
- The EPA report is technically sound and robust and takes account of the more limited range of fish able to be resampled in 2009, and the variations in fish lipid content, in reaching its conclusions
- The current health advisory was informed by expert advice that considered the contaminant concentrations found in the 2006 samples. The health advice was based on conservative assumptions and consideration of national and international guidelines, and nothing observed in the 2009 data indicates the need to review this advice.

REFERENCES

EPA, (2007). Yarra and Maribyrnong Estuaries: Investigation of contamination in fish. Publication 1094, January 2007.

EPA, (2009). Lower Yarra River Fish Study:Investigation of contaminants in fish. Publication 1283, May 2009.

Van den Berg M, Birnbaum L, Bosveld ATC, Brunström B, Cook P, Feeley M, Giesy JP, Hanberg A, Hasegawa R, Kennedy SW, Kubiak T, Larsen JC, van Leeuwen FXR, Liem AKD, Nolt C, Peterson, RE, Poellinger L, Safe S, Schrenk D, Tillitt D, Tysklind M, Younes M, Waern F, and Zacharewski T, (1998). Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. *Environmental Health Perspectives* 106: 775-792.

Van den Berg M, Birnbaum LS, Denison M, De Vito M, Farland W, Feeley M, Fiedler H, Hakansson H, Hanberg A, Haws L, Rose M, Safe S, Schrenk D, Tohyama C, Tritscher A, Tuomisto J, Tysklind M, Walker N, and Peterson RE, (2006). The 2005 World Health Organization reevaluation of human and mammalian toxic equivalency factors for dioxins and dioxin-like compounds. *Toxicological Sciences* 93:223-241.

APPENDIX 1

2009 Lower Yarra River Fish Study

Expert Panel Members:

Chair

Dr Graham Mitchell (Chair)

RDA, BVSc, FACVSc, PhD, FAA, FTSE, AO. Chief Scientist DSE and DPI, Victorian Government. Principal, Foursight Associates Pty Ltd, Melbourne.

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Dr Graeme Batley

BSc (Hons1), MSc, PhD, DSc (UNSW); Chief Research Scientist, Centre for Environmental Contaminants Research, CSIRO Land and Water (Lucas Heights, NSW)

Observers: representatives from the Department of Sustainability and Environment, EPA Victoria, Port of Melbourne Corporation, Office of the Environmental Monitor.

Task of Expert Review

The Panel will be required to:

Familiarise themselves with the Contaminants in Fish Monitoring Program Detailed Design, EPA's Project Delivery Plan and the previous report on contaminants in fish and its Independent Panel report.

Participate in a teleconference to discuss expectations in detail in mid-December 2008 - Review EPA report on the data and results from the Contaminants in Fish Program and provide expert advice as required.

Participate in a teleconference to discuss the data and report from the program in April 2009

Prepare a report on the findings of the Contaminants in Fish program

If the contaminants are significantly higher than historic records (2006 study) provide advice on management options, e.g. amend advisory on human health, further monitoring, etc.

More meetings may be scheduled if the level of contaminants differ and are significantly higher than previous studies.

TABLE OF CONTENTS

1. INTRODUCTION

A preliminary investigation of contaminant levels in recreational fish species was undertaken in 2005 by EPA Victoria and Melbourne Water (Coleman and Tiller 2005). This was followed by a more comprehensive study by EPA in 2006 (EPA 2007). The aim of these studies was to provide the community with better information about contaminant concentrations in recreationally caught fish and their safety for human consumption.

The results from the 2006 study showed that for most contaminants, levels were low when compared to Foods Standards Australia New Zealand Maximum Levels or Limits (FSANZ MLs). For some fish, particularly eels, polychlorinated biphenyls (PCBs) levels were above the United States Environmental Protection Agency screening values (USEPA SVs).

The Department of Human Services (DHS) issued health advice in 2007 for people who catch fish in the lower Yarra and Maribyrnong Rivers. This advice states that while it is safe to eat fish from the Lower Yarra and Maribyrnong Rivers, it is recommended that people limit themselves to four serves of fish a month and one serve of eel a month, and children and women of child bearing age should limit themselves to one serve of fish per month and should eat no eels from these rivers.

The Port of Melbourne Corporation's (PoMC) Channel Deepening Project (CDP) Supplementary Environment Effects Statement (SEES) concluded that dredging of contaminated material would not give rise to changes in contaminant concentrations in fish that would be of concern to human health.

Under the CDP Environmental Management Plan (EMP) a suite of Baywide Monitoring Programs (BMPs) were developed to monitor the status of Port Phillip Bay and detect changes outside expected variability. Using the 2006 study conducted by EPA as a guide, PoMC developed a BMP *'to identify if the concentration of contaminants in fish tissue in the lower Yarra River after the dredging of contaminated sediments requires review of the current health advisory'.*

2. METHODS

2.1 Program design

This study was based on the USEPA guidelines for the assessment of the risk to human health from eating contaminated fish (USEPA 2000) and those methods used in the 2006 study. The Contaminants in Fish Detailed Design CDP_ENV_MD_13 Rev 1 (PoMC 2008) outlines the requirements for the program and was supported by an independent peer review (Mueller 2007).

2.2 Species selection

The study targeted the following species, as the primary species for comparison given their relevance to recreational fishing and the availability of data from the 2006 study:

- Black bream (bream) *Acanthopagrus butcheri*
- Yellow-eye mullet (mullet) *Aldrichetta forsteri*.

Bream are a popular recreational species found in the area all year round and therefore present during dredging of the lower Yarra River. Mullet, while a popular angling species are more seasonal, moving between the marine and estuarine environments.

2.3 Sampling areas

As shown in Figure A1.1, the sampling area was bound by and included the lower reaches of the Yarra and Maribyrnong estuary, specifically:

- the lower Yarra estuary (near the 'Warmies')
- the urban section of the Yarra River (near South Wharf No. 6-10, Docklands)
- the urban reach of the lower Maribyrnong River (near the Whitehall St, Yarraville region).

This sampling area is consistent with the 2006 study, areas of contaminated sediment dredging, and inclusive of a number of popular recreational fishing sites.

2.4 Fish sampling

The sampling for this study aimed to collect 60 bream and 60 mullet to form six composites of 10 (60 fish) for each species using methods consistent with the 2006 study.

Sampling commenced on the evening of 13 January 2009, approximately three months following the completion of dredging of the bulk contaminated sediments in the Yarra River/Williamstown Channel. The three month duration was nominated as a point in time where any accumulation of contaminants, as a result of the dredging program, through the food chain could be measured in fish.

The Department of Sustainability and Environment (DSE) Arthur Rylah Institute (ARI), with the support of EPA field staff, undertook the field sampling (in accordance with a research fishing permit issued by the Department of Primary Industries). Bottom-set gill nets were deployed with mesh panels targeting fish that exceeded the recreational size limit. Mesh nets ranging from 3.5–4.0" were used to target bream greater than the legal limit of 26 cm. As there is no recreational size limit specified for mullet, it was estimated that mullet in the size range 20–25 cm would provide sufficient fillet for analysis. Nets ranging in size from 2.0–3.0" were used to target mullet. Nets were set prior to dusk to allow for effective overnight fishing, with retrieval at dawn. By 27 January 2009, 84 bream had been caught, predominantly from the Docklands area, achieving the target numbers for that species. Difficulties were encountered in catching mullet, subsequently the sampling times and methods (e.g., line fishing) were altered in an attempt to increase and diversify the opportunities of capturing mullet and securing the requisite numbers for the program (as detailed in exception report ER090201).

Concluding on 23 February 2009, at the end of the defined six week sampling period, seven mullet had been caught within the sampling area. This was less than the target number for the species and insufficient for a single composite sample so these were not analysed as part of this study (as detailed in exception report ER090202).

The results from this study are derived from the analysis of eighty bream.

2.5 Fish processing

All fish were assigned an identification code (reach, fish species, fish number and fillet number) and anatomical details were recorded on sample sheets. Fish were weighed to the nearest gram (with an error margin of ±2 g) and their total length (TL) and caudal fork length (CFL) measured (see Appendix 8 for details).

Samples were dissected to obtain skinless fish fillets and randomly allocated into groups of 10 in preparation for processing and compositing at the National Measurement Institute (NMI) (Appendix 8 provides details of composites). Samples were stored on ice or below minus 20°C, until delivered to the laboratories for processing.

2.6 Target contaminants

The contaminants of interest for the program are principally based on those used in the 2006 study and include:

- metals and metalloids (cadmium, copper, chromium, zinc, lead, selenium, nickel, total and inorganic arsenic and total mercury)
- organochlorine pesticides (OCs), organophosphate pesticides (OPs), polycyclic aromatic hydrocarbons (PAHs), tributyltin (TBT), and total petroleum hydrocarbons (TPHs)
- total polychlorinated biphenyls (PCB)
- polychlorinated dibenzodioxins (PCDD), dibenzofurans (PCDF), dioxin-like PCBs and polybrominated diphenyl ethers (PBDEs).

2.7 Laboratories

As in the 2006 study, NMI conducted all processing and compositing of samples and completed all general analysis and relevant laboratory QA/QC analyses including spikes, recoveries, duplicates and blanks, and analysis of some Standard Reference Materials.

Processing of the samples involved weighing the skinless fish fillets to ensure that all fillets were approximately of the same weight (within 1 gram). Fillets were then individually freeze-dried, ground and homogenised. Equal amounts of the homogenised fillet material were then taken to make up the appropriate composites.

Inter-laboratory QA/QC testing on 30 per cent of the samples was undertaken by the following laboratories:

- Agrifood Technology – QA/QC testing for metals and metalloids including inorganic arsenic
- AsureQuality New Zealand – QA/QC testing for lipid content, OCs, OPs, PAH, TBT and ultratrace organics including PCDDs, PBDEs, PCDFs and dioxin-like PCBs and TPH
- Advanced Analytical – QA/QC testing for PCBs and TPH.

See Appendix 3 for further discussion on the application of QA/QC results.

2.8 Data assessment

For comparison against the eight bream composite samples collected as part of this program, data from the 2006 study was used as a baseline. Specifically, the median concentrations of contaminants in six bream composites taken from the lower Yarra estuary (near the 'Warmies') and the Docklands areas in April and May 2006 were selected, as these were comparable to the 2009 program for both species and sampling area.

A change in the concentration of each contaminant was determined by statistical analysis. Kruskal-Wallis tests were performed to determine whether or not the 2009 median data was within a similar range or was indicative of a change from the median data from the 2006 results. The existence of a difference in the medians of samples between the two studies where the statistical p-value was determined to be less than 0.05.

Median and the 95 per cent upper confidence intervals of the 2009 data were calculated in order to compare the results against the 2006 study, together with the following guideline values (refer to Appendix 7):

- FSANZ MLs, which are based on typical consumption levels by the general population; and
- USEPA SVs, which are based on risks associated with high levels of fish consumption.

Other guideline references were used as deemed appropriate from international studies to provide contextual reference. Results presented are from fresh weight samples unless specified.

For further detail regarding data analysis, refer to Appendix 2.

3. RESULTS AND DISCUSSION

3.1 Fish sampled in 2009 and 2006

The objective of this study is *'to identify if the concentration of contaminants in fish tissue in the lower Yarra River after the dredging of contaminated sediments requires review of the current health advisory'*. The advisory was informed by expert review that included detailed consideration of contaminants levels in fish sampled in April and May 2006.

In order to address the study objective contaminant levels in fish from the Lower Yarra River in January 2009 were therefore compared against contaminant levels in the same fish species sampled in 2006 from the same area. This difference in sample timing between 2006 and 2009 means that the bream were sampled at different stages in their lifecycle.

Comparisons of length and weight data show that the condition of bream captured in 2009 were different than fish caught in 2006 (Figure 3.1). Fish at different stages of their life cycle commonly have different lipid levels. A Mann-Whitney test of the comparison of median lipid contents showed that the bream caught in 2009 had significantly less ($p<0.05$) lipid in their tissues than fish caught in 2006 (Figure 3.2). As the lipid content of fish samples in 2009 was significantly less than 2006 this could possibly influence or affect the level of lipophilic compounds such as PCBs and dioxins in the samples.

The reduction in lipid content could be a potential consequence of spawning. When fish spawn a proportion of their lipid is passed to the gametes (i.e. sperm and ova) and is therefore removed from the fish. Conservatively, this process could lead to the depuration of lipophilic contaminants. Alternatively, a range of other factors including difference in sampling, condition of the fish, food availability, natural variability in growth rate of bream, environmental conditions or a combination of these could also explain a difference in lipid content.

It is only absolute contaminant content that is relevant to the study objective. However, as outlined in USEPA (2000) when comparing the accumulation of lipophilic contaminants that the analysis should consider variations in lipid content. Appendix 6 provides data on a lipid weight basis for lipophilic contaminants for those composites where at least half of the observations in 2006 and 2009 were above their respective reporting limits. Analysis of this data indicates that some lipophilic contaminants in the 2009 study appear to have increased on a lipid weight basis when compared to 2006.

Lipid-weighted data should be treated with caution. Dividing the fresh (or wet) weight concentrations with the lipid concentrations may 'overcompensate' for the lipid content, especially when the lipid content is below one per cent (pers com Professor Anders Bignert, 15/05/2009), as is the case with the 2009 samples. The determination of the lipid content itself can be a source of analytical uncertainty. Also the results of the statistical analysis on these compounds showed that the concentrations of most contaminants not significantly related to lipid content. Consideration of these issues increases the level of uncertainty regarding reporting lipophilic compounds on a lipid-weighted basis, therefore it is more appropriate to report concentrations on a fresh weight basis (pers com Professor Anders Bignert, 15/05/2009). It should be noted that the Australian food standards are based on concentrations on a wet weight basis, and forms the basis of the conclusions drawn in this report.

Whilst for most lipophilic compounds there was no significant relationship to lipid content, the lower lipid levels of the 2009 samples compared to 2006 may account for the lower concentrations observed for lipophilic contaminants on a fresh weight basis.

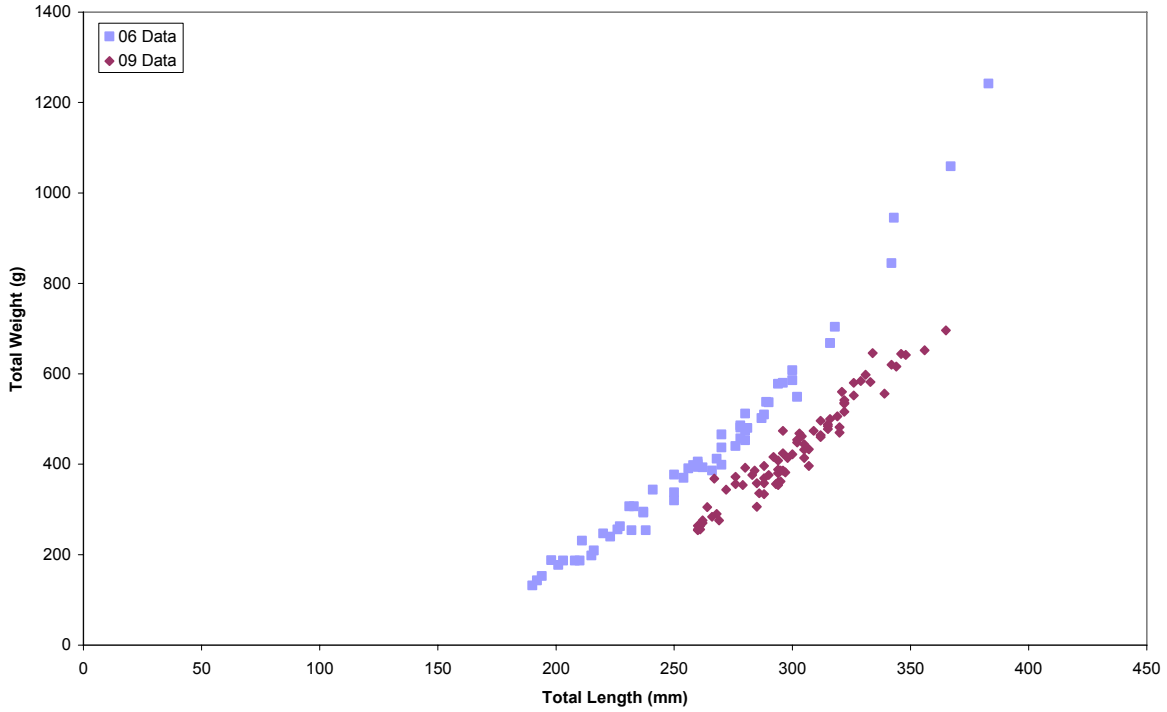

Figure 3.1: Total length and weight of bream sampled in 2006 and 2009

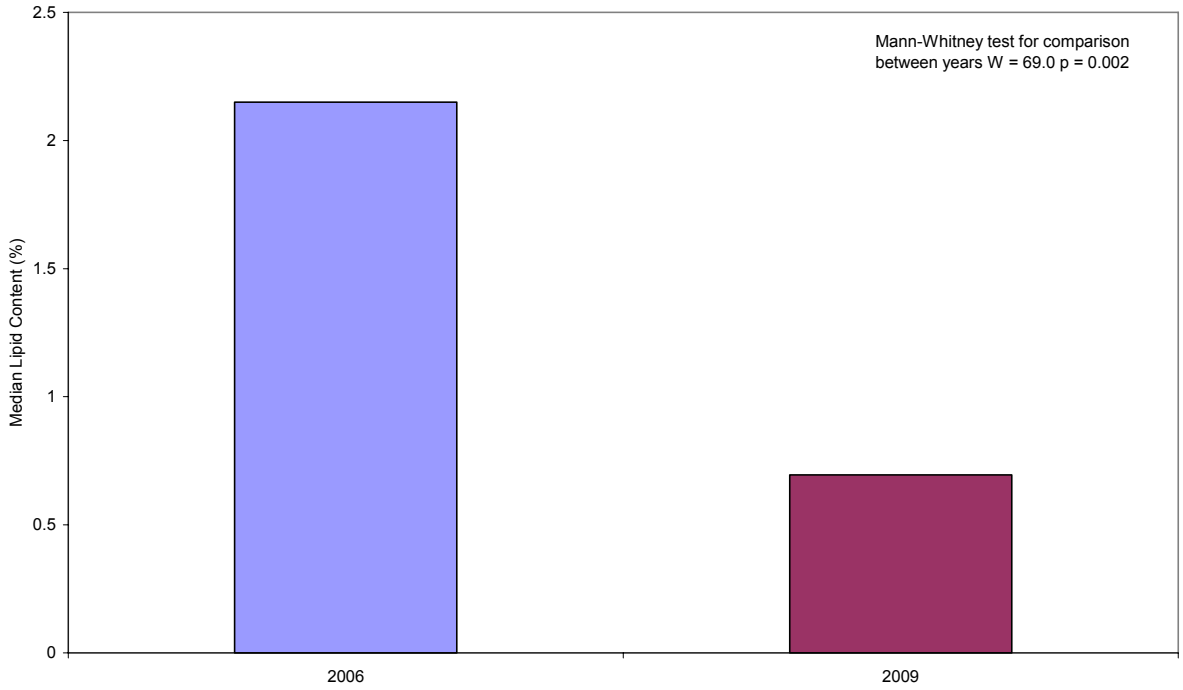

Figure 3.2: Lipid Content of bream sampled in 2006 and 2009

3.2 Results and discussion

Polychlorinated biphenyls

In 2009, PCBs were recorded in seven of the eight composite fish samples (refer to Table A4.1). Of the 21 PCB congeners analysed, only six were found, a reduction from nine in the previous study (refer to Table A5.1). A comparison of the median total PCB concentrations from samples collected in 2006 and 2009 show a reduction ($p<0.05$) in concentration of 0.032 mg/kg to 0.026 mg/kg (middle bound) (Figure 3.3). Where congeners below the LOR were excluded from the calculation of total PCBs (lower bound), the median concentration was 0.008 mg/kg. The difference in the middle and lower bound median concentration is due the large proportion of congeners being below the LOR (refer to Table A4.1).

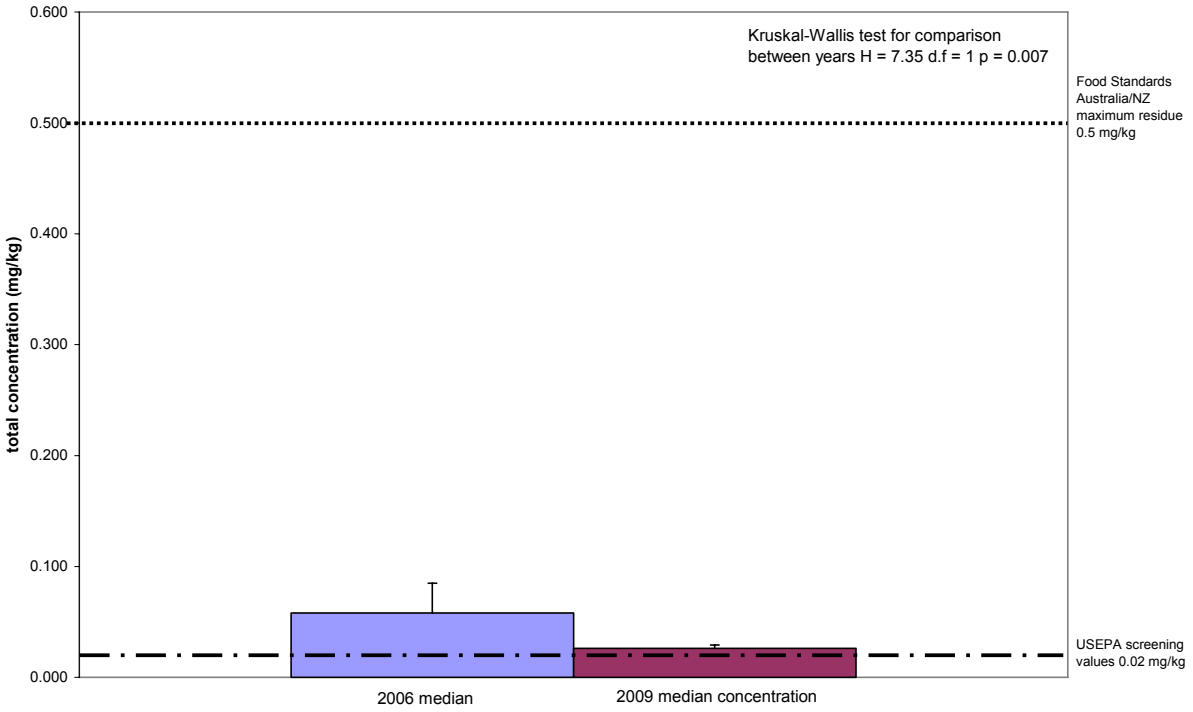

Figure 3.3: Median and 95% UCI Total PCB concentrations

Note: Total PCBs calculated with all congener values reported below the LOR as half the LOR

Dioxins and dioxin-like PCBs

Total dioxins and dioxin-like PCBs are expressed in terms of World Health Organisation Toxic Equivalents (WHO-TEQs). WHO-TEQs are the international standard to determine the toxicity of dioxins. The method described by Van den Berg *et al* (1998) was used in the calculation of WHO-TEQs for consistency with the 2006 study. WHO-TEQs calculated for results from 2009 and 2006 studies can be found in Tables A4.4 and A5.4

In 2009, all composites recorded levels of both dioxins and dioxin-like PCBs (refer to Tables A4.2 and A4.3). A reduction in the number of detected dioxin congeners was seen. Six congeners were reported at levels above the LOR present in samples compared to twelve congeners reported at levels above the LOR in the 2006 study (Table A5.2). The median of total dioxins and dioxin-like PCBs in samples collected in 2009 was 0.78 pg TEQ/g (middle bound) (Figure 3.4). Where congeners below the LOR were excluded from calculations, the median for 2009 samples was 0.77 pg TEQ/g (lower bound).

A comparison of the median of total dioxins and dioxin-like PCBs from samples collected in 2009 and 2006 showed that they were statistically similar, with the small sample size (n=3) for 2006 limiting statistical analysis.

The Expert Panel reporting to the NSW Food Authority for the 2006 study *Dioxins in Seafood in Port Jackson and its Tributaries*[1] has endorsed the use of 6 pg TEQ/g fresh weight as a 'temporary action level for dioxin in seafood'

1 NSW Food Authority 2006, *Dioxins in seafood in Port Jackson and its tributaries*, Report of the Expert Panel.

pending further information. This value is consistent with the FSANZ risk assessment and is similar to the European Union amended Maximum Level for fish and fish products of 4 pg TEQ/g fresh weight for PCDDs/Fs or 8 pg TEQ/g fresh weight for the combined amount of PCDDs/Fs and dioxin-like PCBs.[2]

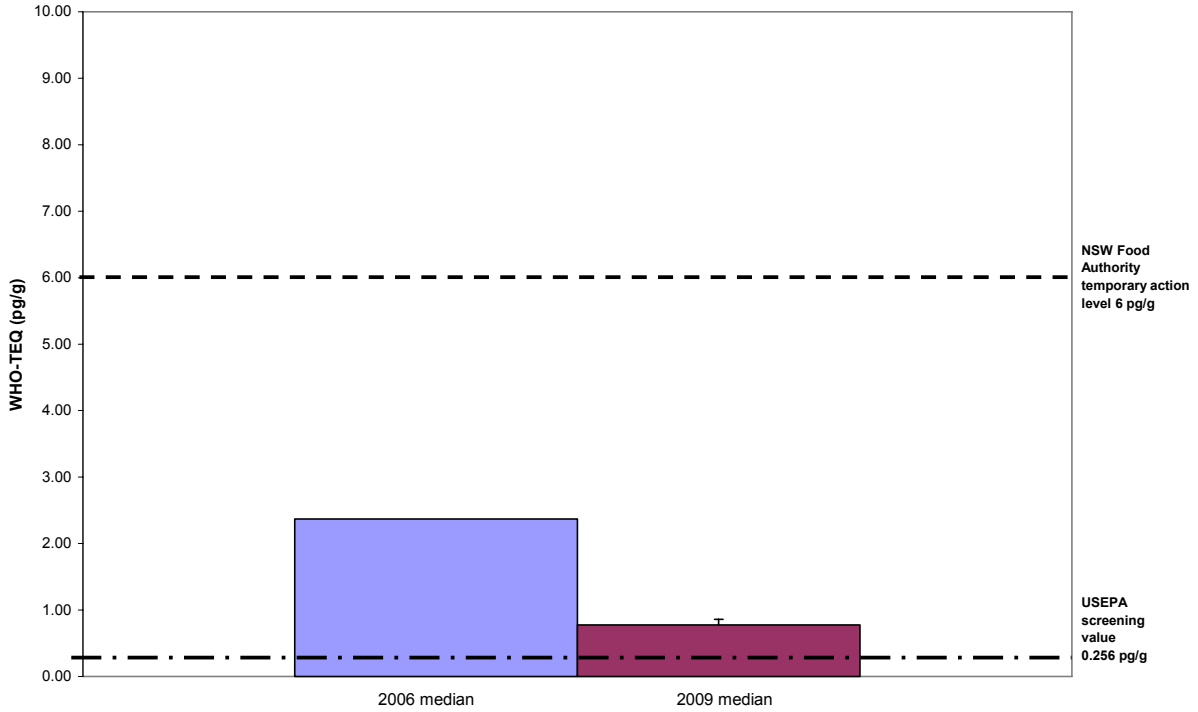

Figure 3.4: Median and 95% UCI dioxins and dioxin-like PCB concentrations

Note: Total dioxins and dioxin-like PCBs calculated with all congener values reported below the LOR as half the LOR

Organochlorine pesticides

A range of organochlorine pesticides were tested during this program and include:

- total DDT (pp'-DDE, pp'-DDD and pp'-DDT)
- dieldrin and endrin
- heptachlor and heptachlorepoxide
- amma-BHC (lindane)
- lpha-BHC, beta-BHC and delta-BHC
- rans-cchlordane and cis-chlordane
- lpha-endosulfan and beta-endosulfan

In 2009, pp'DDD was the only organochlorine pesticide reported at levels above the LOR, with the concentration being 0.01 mg/kg (Table A4.5). The median concentration of sum DDTs in samples collected in 2009 was 0.02 mg/kg (middle bound), and are lower than in those collected in 2006 ($p<0.05$) (Figure 3.5). The median lower bound concentration of sum DDTs was zero, due to only one composite displaying a concentration of pp'DDD above the LOR. This was lower than the median lower bound concentration of 0.03 mg/kg found in 2006 samples.

2 EUSC 2001. EC Health and Consumer Protection Directorate-General 2001. *Opinion of the Scientific Committee on Food on the risk Assessment of Dioxins and Dioxin-like PCBs in Food*. (Update Based on New Scientific Information Available Since the Adoption of the SCF Opinion of 22 Nov 2000). Document CS/CNTM/DIOXIN/20 Final, 30 May 2001. European Commission, Brussels, Belgium.

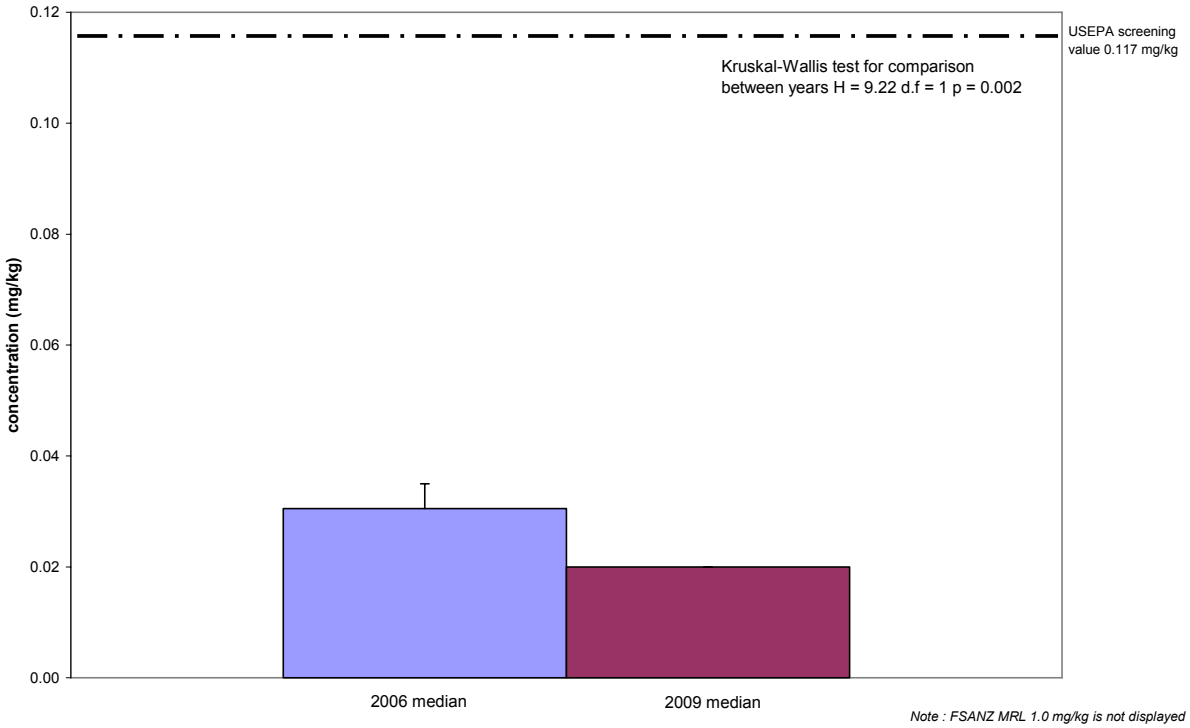

Figure 3.5: Median and 95% UCI Total DDT

Note: Total DDT calculated with all congener values reported below the LOR as half the LOR.

The 95% CI for 2009 is equal to the median value.

Metals and metalloids

All composites were analysed for total and inorganic arsenic, cadmium, chromium, copper, lead, total mercury, nickel, selenium and zinc (Table A4.8).

Lower ($p<0.05$) median concentrations of copper and zinc (refer to Figures 3.6 and 3.7 respectively) were found in samples collected in 2009 compared to those collected in 2006. Lower ($P<0.05$) median concentrations of total arsenic were also found (Figure 3.8), with the considerably more toxic inorganic fraction below the limit of reporting, consistent with results from the 2006 study (Table A5.8).

Concentrations of cadmium and chromium were all below the limit of reporting as in the 2006 study and lead, total mercury and selenium statistically similar to 2006 results. All results for metals and metalloids in 2009 remain below the applicable guideline levels.

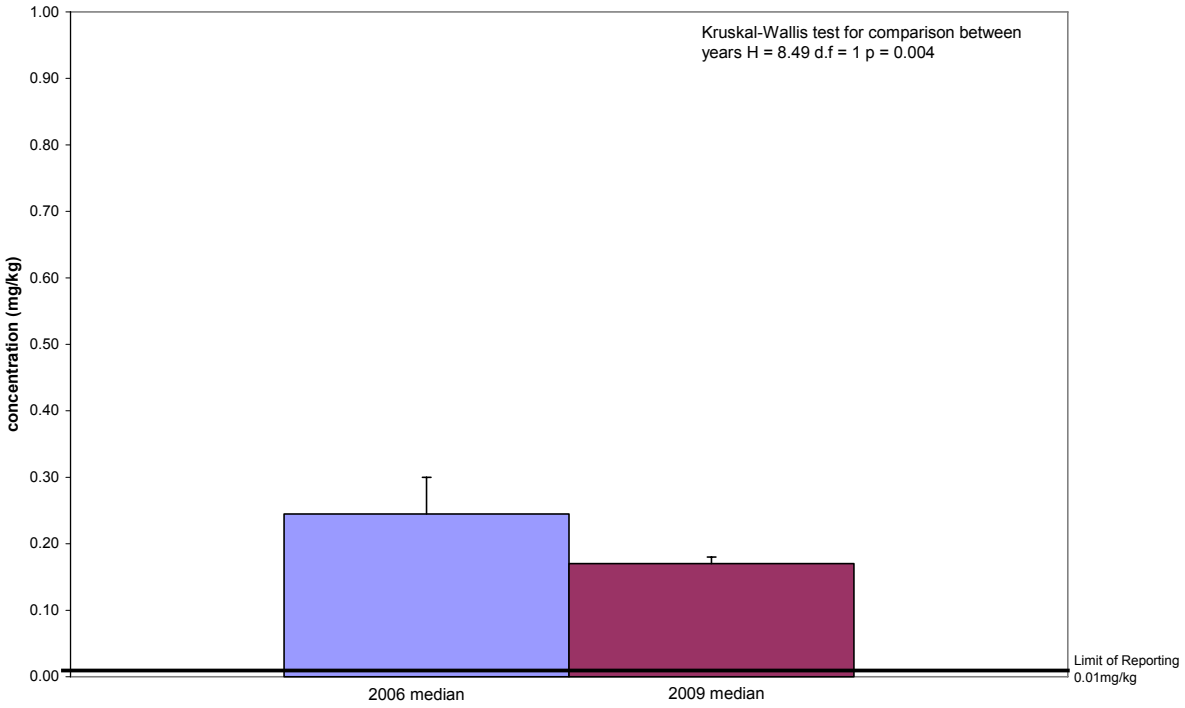

Figure 3.6: Median and 95% UCI Copper

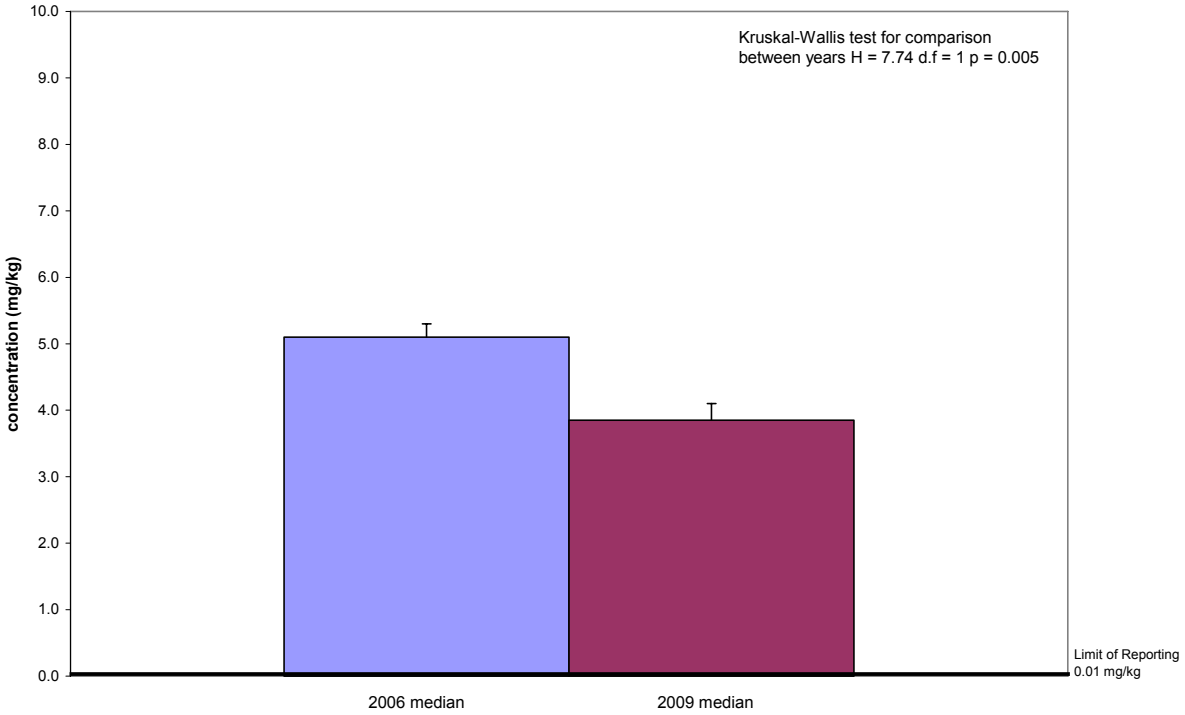

Figure 3.7: Median and 95% UCI Zinc

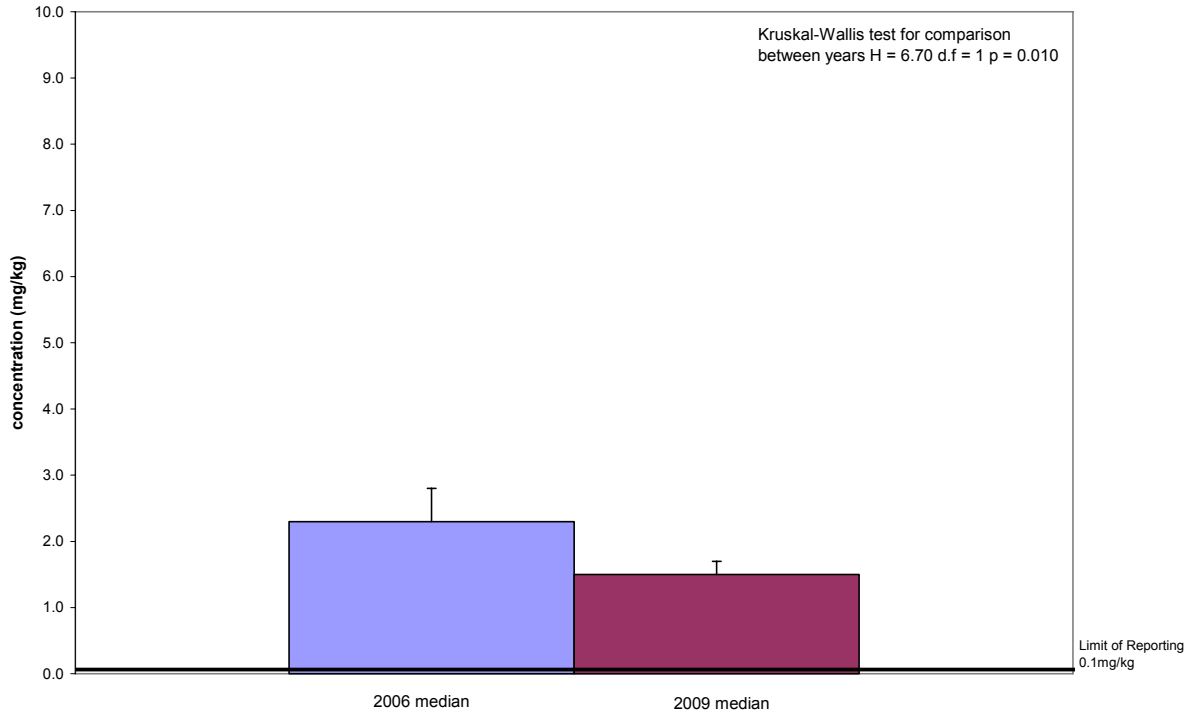

Figure 3.8: Median and 95% UCI Total Arsenic

Tributyltin

In 2009, the TBT as Sn median concentration of 0.0027 mg/kg (Table A4.9) is statistically similar to 2006 levels (Table A5.9). The European Food Safety Authority (ESFA) estimates that a person can safely consume an average of 0.00025 mg of organotins per kilogram of body weight every day.[3] For a 60 kg person this equals 0.015 mg of TBT. For the fish collected in this study, based on the average fillet size of 70 g collected, a person would consume 0.000189 mg of TBT for every fillet eaten. To reach the amount of TBT referred to by ESFA, a person of 60 kg would need to eat 79 fillets (or approximately 5.5 kg of fish) per day.

Organophosphate pesticides

In 2009, there were no recorded levels of organophosphate pesticides above the limit or reporting (Table A4.6), as also found in 2006 (Table A5.6).

Polycyclic aromatic hydrocarbons

In 2009, there were no recorded levels of PAHs above the limit of reporting (Table A4.7), as also found in 2006 (Table A5.7).

Polybrominated diphenyl ethers

In 2009, a total of twenty-four PBDE congeners were analysed (Table A4.10) with a median total PBDE concentration of 666.8 pg/g. A comparison of the median total PBDE concentration from samples collected in 2009 and 2006 shows they are statistically similar. There are currently no published USEPA SVs or FSANZ MRL for PBDE although Health Canada considers levels of PBDE of 5500 pg/g in seafood not to be of health concern.[4]

Petroleum hydrocarbons

There are no USEPA SVs for TPHs as the large number of petroleum-derived hydrocarbons and their wide ranges of toxicities make it difficult to derive meaningful guidelines.[5]

3 European Food Safety Authority www.efsa.europa.eu/EFSA/efsa_locale-1178620753812_1178620762916.htm

4 Health Canada www.hc-sc.gc.ca/fn-an/securit/chem-chim/environ/pbde-edpb/pbde_fish-edpb_poisson-eng.php

5 ANZECC/ARMCANZ 2000. *Australian and New Zealand .Guidelines for Fresh and Marine Waters Quality*.

There are known issues with the effective analysis of TPH concentrations in fish tissue. The known issues associated with analysis of TPHs include interference by other compounds resulting in reported results potentially higher than the actual TPH concentration. The results obtained from the 2009 program were low but failed to meet the necessary quality standards and were considered invalid. This is not considered detrimental to the program as concentrations of TPHs were not recorded at levels above the limit of reporting in the 2006 study. It is also considered unlikely that there would be a statistically significant increase in the levels of TPHs given the relative change of other contaminants analysed. Further detail on this issue can be found in Appendix 3.

4. CONCLUSION

In 2009, eighty bream were collected from the lower Yarra River and tested for a wide range of organic contaminants and trace metals. The results of the study are summarised as follows:

- The median concentration of total PCBs, total DDT, total arsenic, copper and zinc were less ($p<0.05$) than reported in 2006.
- PBDEs, total dioxins and dioxin-like PCBs, TBT, lead, total mercury and selenium are statistically similar ($P>0.05$) to those reported in 2006.
- OPs, PAHs, inorganic arsenic, cadmium, and chromium were the same as the 2006 study and not recorded at levels above the limit of reporting.
- Contaminant concentrations were below guideline levels for Australian food standards.
- Lipid content in fish samples was lower than that reported in 2006.

The level of uncertainty around the low level of lipid in the 2009 fish samples means that it is more sensible to focus on a comparison of lipophilic concentrations on a fresh weight basis rather than on a lipid weight basis.

In conclusion the contaminant levels are essentially unchanged when compared to those levels found in the 2006 samples which formed the basis for the existing health advisory.

5. REFERENCES

ANZECC/ARMCANZ, 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Australian and New Zealand Environment and Conservation Council/Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

Coleman R and Tiller D, 2005. Preliminary Investigation of Contaminants within Fish, Yarra and Maribyrnong Rivers. *EPA and Melbourne Water Pilot Study*.

EPA, 2007. *Yarra and Maribyrnong Estuaries: Investigation of contamination in fish*. Publication 1094.

European Food Safety Authority (7/11/2007) Opinion of the Scientific Panel on contaminants in the food chain [CONTAM] to assess the health risks to consumers associated with exposure to organotins in foodstuffs. Viewed 07/05/2009
www.efsa.europa.eu/EFSA/efsa_locale-1178620753812_1178620762916.htm

Health Canada (5/5/2004) Fact Sheet: Polybrominated Diphenyl Ethers (PBDEs) in Fish. Viewed 07/05/2009.
http://www.hc-sc.gc.ca/fn-an/securit/chem-chim/environ/pbde-edpb/pbde_fish-edpb_poisson-eng.php

Mueller J, 2007. *Final Peer Review of the Port of Melbourne Corporation – CDP Monitoring Program – Contaminants in Fish Detailed Design Document*, University of Queensland.

PoMC, 2008. *Contaminants in Fish – Detailed Design* CDP_ENV_MD_013 Rev 1.

USEPA, 2000. *Guidance for Assessing Chemical Contaminant Data for Use In Fish Advisories. Volume 1: Fish Sampling and Analysis* – Third Edition. Web: http://www.epa.gov/ost/fishadvice/volume1/

Van den Berg M, Birnbaum L, Bosveld ATC, Brunström B, Cook P, Feeley M, Giesy JP, Hanberg A, Hasegawa R, Kennedy SW, Kubiak T, Larsen JC, van Leeuwen FXR, Liem AKD, Nolt C, Peterson, RE, Poellinger L, Safe S, Schrenk D, Tillitt D, Tysklind M, Younes M, Waern F, and Zacharewski T, 1998. 'Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife'. *Environmental Health Perspectives* 106: 775-792.

APPENDIX 1: SAMPLING SITES

Figure A1.1 Location Map: Sampling area within the Maribyrnong/Yarra Estuary

APPENDIX 2: DATA ANALYSIS

To determine a change in the median values of contaminants in the tissues of fish sampled in 2009 against those collected during the 2006 study, Kruskal-Wallis tests were performed. The Kruskal-Wallis test, also known as 'analysis of variance by ranks', is the non-parametric equivalent of the one-way ANOVA and is used where the assumption of an underlying normal distribution is not valid.

Analysis was undertaken on all contaminants from 2006 and 2009, except those where all data were below the limits of reporting. A difference in the medians of samples from 2009 and 2006 was concluded where the p-value was <0.05.

Nonparametric estimates of medians and their approximate 95% upper confidence limits were calculated[6] (Table A4.11). The probability associated with the confidence limit is approximate due to the discrete nature of the data when sample sizes are small. Using the eight composites, the upper confidence limit is given by the 6th ordered observation[7].

The actual confidence level is not less than 95%.If a median or its 95% upper confidence limit was found to be below LOR, then the result was expressed as <LOR.

The median and 95 per cent upper confidence limits were used to assess the results against relevant:

- FSANZ MRLs, which are based on typical consumption levels by the general population.
- USEPA SVs[8], which are based on risks associated with high levels of fish consumption. These SVs reflect a higher dietary intake of fish by recreational fishers compared to the general population, and are generally lower than the FSANZ MRL values. Therefore, SVs are particularly relevant as a screening tool when considering the consumption of fish by recreational fishers in the Yarra River (Appendix 7).

For PCBs, DDT and dioxins (dioxins and dioxin-like PCBs), all congener values reported below the LOR were considered to be equal to half the LOR in the determination of total values and assessment against the guideline values. These values are known as 'middle bound' and the use of this method is consistent with the 2006 study and was based on USEPA guidelines that recommend "a datum reported below the method detection limit, including a datum reported as not detected (i.e., ND, no observed response) should be assigned a value of one-half the MDL or zero." [9] Lower bound values, where below the LOR were considered to be equal to zero, were also calculated. These values were used to determine the contribution of below LOR data to the totals for PCBs, dioxins and DDT.

WHO-TEQ (World Health Organisation Toxic Equivalent) values were calculated to assess total dioxins (dioxins and dioxin-like PCBs) against guideline values. The WHO-TEQs are the international standard to determine the toxicity of dioxins and expresses the total toxicity of the sum of congeners relative to that of TCDD. The method described by Van den Berg et al (1998) was used in the calculation of WHO-TEQs for consistency with the 2006 study.

6 Mosteller, F and Rourke, REK (1973). *Sturdy Statistics. Nonparametrics and order statistics*. Addison-Wesley Educational.

7 Goudey, R (2007). 'Do statistical inferences allowing three alternative decisions give better feedback for environmentally precautionary decision-making?'. *Journal of Environmental Management* 85, 338-344.

8 The USEPA SVs are risk-based, and application of the SVs is linked in USEPA guidance (USEPA, 2000) to a specified sampling approach using composites of four to 10 individual fish blended to form each sample for analysis.

9 USEPA 2000. *Guidance for Assessing Chemical Contaminant Data for Use In Fish Advisories. Volume 1: Fish Sampling and Analysis* - Third Edition. Web: www.epa.gov/ost/fishadvice/volume1

APPENDIX 3: QUALITY ASSURANCE AND QUALITY CONTROL (QA/QC)

The primary laboratory, NMI, conducted all processing and compositing of samples and completed all general analysis and relevant laboratory QA/QC analyses. In addition to internal laboratory QA/QC, a number of samples were sent to secondary laboratories to confirm the results. Each QA/QC laboratory completed the required analysis and relevant laboratory QA/QC analyses on at least two composite samples.

In order to determine whether results obtained from primary and QA/QC laboratories were consistent, the Measurement of Uncertainty (MU) was applied to each result. MUs are provided by the laboratory and quantify the uncertainty of the analytical method. MUs were applied to each result to determine the spread of the data and results were considered acceptable if the primary and QA/QC results overlapped.

All QA/QC results, with the exception of TPH, inorganic arsenic and some dioxin congeners, were found to be consistent with the primary results. Investigation into differences between the results for these contaminants is outlined below.

Petroleum hydrocarbons

Total petroleum hydrocarbons (TPHs) are a mixture of chemical compounds that originate from crude oil.

There is no USEPA SVs for petroleum hydrocarbons as the large number of petroleum-derived hydrocarbons and their wide ranges of toxicities make it difficult to derive meaningful guidelines.[10]

From previous studies, there are known issues with the analysis of TPH in fish tissue. In the current program, the study showed levels above the limit of detection in two of the four bands (as determined by the carbon bonds) and its validity was investigated. All laboratories reported issues for TPH analysis results. The primary laboratory noted that natural fatty acids and other organics would have contributed to the TPH values for the C15 and C36 bands. One QA/QC laboratory could not report on surrogate and matrix spike recoveries for TPH analyses due to matrix interferences, while another could not produce results. This was due to significant matrix interferences that were unable to be resolved during the allocated analysis period. As a result, the TPH data is considered invalid and not included in this report.

Inorganic arsenic

The primary laboratory reported inorganic arsenic to be <0.05 mg/kg for all composites. This varied considerably from the results provided by the QA/QC laboratories. Of the five samples tested by the QA/QC laboratories, four of the results were above the LOR of 0.05 mg/kg with values ranging from 0.056 – 0.24mg/kg (Figure A3.1). Inorganic arsenic was not tested as part of the QA/QC program in 2006 so no comparisons can be made.

Composites 3 and 5, designated as the QA/QC samples, were tested and showed differences when compared with the primary results. As a result of this discrepancy, analysis of composites 1, 2 and 8 by the QA/QC labs was undertaken. The results for these composites were similar to the primary results. Therefore the differences seen in the results for composites 3 and 5 are most likely attributed to laboratory variations.

10 ANZECC/ARMCANZ 2000. Australian and New Zealand Water Quality Guidelines for Fresh and Marine Waters.

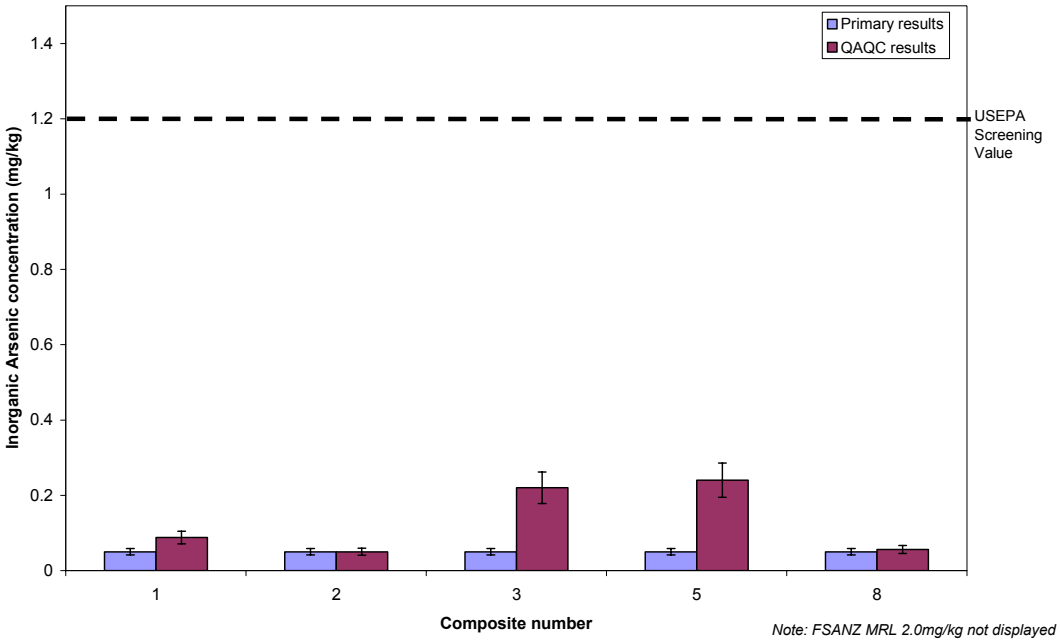

Figure A3.1 Comparison of primary and QA/QC data – Inorganic arsenic

Dioxins

Inconsistencies in the results from the primary and QA/QC laboratories were noted for dioxin congeners 1 to 8, 12, 15 and 17. The variation in individual congeners does not impact the primary results as the major output for Dioxins is the evaluation against the WHO-TEQ. The calculation methodology for WHO-TEQs takes into account the toxicity of each congener in comparison to 2,3,7,8 TCDD (the most toxic congener). The WHO-TEQ for both the primary and QA/QC data is within an acceptable range of variation. Data supplied by both laboratories have passed QA/QC standards set by NATA and investigation into variation in the data shows no obvious cause.

APPENDIX 4: TABLES OF ANALYTICAL 2009 RESULTS

Colour index for the following tables:

NMI (primary laboratory)
AsureQuality (QAQC lab)
Advanced Analytical (QAQC lab)
Agrifood Technology (QAQC lab)

A4.1 Polychlorinated biphenyls (PCBs)

Table A4.1: 2009 analytical results for PCBs (congeners)

PCB Congeners	PCB # 8	PCB # 18	PCB # 28	PCB # 44	PCB # 52	PCB # 66	PCB # 77	PCB # 101	PCB # 105	PCB # 118	PCB # 126	PCB # 128
Composite	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
2	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
3	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
3 QAQC	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
3 QAQC	NT	NT	<0.002	<0.002	<0.002	NT	<0.002	<0.002	<0.002	<0.002	<0.002	NT
4	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.003	<0.002	0.003	<0.002	<0.002
5	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.002	<0.002	<0.002
5 QAQC	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
5 QAQC	NT	NT	<0.002	<0.002	<0.002	NT	<0.002	<0.002	<0.002	<0.002	<0.002	NT
6	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.003	<0.002	0.003	<0.002	<0.002
7	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.002	<0.002	<0.002
8	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

Footnotes:
NT - Not tested. This PCB congener was not available in the standard suite of PCB congener screening.
All results reported in ug/g and required conversion

Table A4.1: 2009 analytical results for PCBs (congeners) continued

PCB Congeners	PCB # 138	PCB # 153	PCB # 169	PCB # 170	PCB # 180	PCB # 187	PCB # 195	PCB # 206	PCB # 209	Total PCB*
Composite	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.021
2	<0.002	0.003	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.023
3	0.003	0.004	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.026
3 QAQC	<0.05	NT	<0.05	<0.05	<0.05	<0.05	<0.05	NT	<0.05	
3 QAQC	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	NT	<0.002	<0.002	
4	0.004	0.006	<0.002	<0.002	0.002	0.002	<0.002	<0.002	<0.002	0.036
5	0.003	0.005	<0.002	<0.002	0.002	<0.002	<0.002	<0.002	<0.002	0.029
5 QAQC	<0.05	NT	<0.05	<0.05	<0.05	<0.05	<0.05	NT	<0.05	
5 QAQC	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	NT	<0.002	<0.002	
6	0.004	0.008	<0.002	<0.002	0.004	0.002	<0.002	<0.002	<0.002	0.039
7	0.002	0.004	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.026
8	<0.002	0.003	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.023

Footnotes:
* denotes total determined using half of the limit of reporting (LOR) for those values below reporting limit.
NT – Not tested. This PCB congener was not available in the standard suite of PCB congener screening.
All results reported in ug/g and required conversion

A4.2 Dioxins and dioxin-like PCBs

Table A4.2: 2009 analytical results for dioxins

PCDD/F Congeners	Congener #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Lipid[1]	WHO TEQ (middle bound)*
Composite		pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	%	pg/g
1	Level lipid	7.90	4.00	1.40	1.50	<4.00	<1.00	<1.00	<0.70	<0.6	<2.00	<2.00	<2.00	<2.00	<1.00	<4.00	<2.00	<20.00	0.83	8.10
	Level fresh weight	0.07	0.03	0.01	0.01	<0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.03	<0.02	<0.20		0.07
2	Level lipid	11.00	5.70	1.90	5.70	<4.00	<2.00	<2.00	<1.00	<1.00	<3.00	<2.00	<2.00	<2.00	<2.00	<3.00	<3.00	<20.00	0.58	12.00
	Level fresh weight	0.06	0.03	0.01	0.03	<0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.02	<0.09		0.07
3	Level lipid	6.60	3.40	<1.00	<2.00	2.90	<0.80	<0.80	<0.70	<1.00	<1.00	<1.00	<1.00	<2.00	<0.80	<3.00	<1.00	<10.00	0.94	7.80
	Level fresh weight	0.06	0.03	<0.01	<0.02	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.03	<0.01	<0.10		0.08
3 QAQC	Level fresh weight	<0.13	<0.05	0.09	0.13	0.08	0.07	0.05	0.05	<0.07	<0.06	<0.07	0.08	<0.07	<0.12	0.17	<0.22	0.55	0.71	0.22
4	Level lipid	9.50	5.90	<3.00	5.70	<7.00	<2.00	<2.00	<2.00	<3.00	<4.00	<4.00	<3.00	<4.00	<4.00	<4.00	<3.00	<20.00	0.51	14.00
	Level fresh weight	0.05	0.03	<0.02	0.03	<0.04	<0.01	<0.01	<0.01	<0.01	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.10		0.08
5	Level lipid	12.00	5.00	<3.00	5.50	5.20	<1.00	<1.00	<1.00	<1.00	<3.00	<3.00	<2.00	<3.00	<3.00	<4.00	<3.00	<20.00	0.51	15.00
	Level fresh weight	0.06	0.03	<0.02	0.03	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.09		0.08
5 QAQC	Level fresh weight	<0.18	<0.06	<0.05	0.09	<0.05	<0.05	<0.05	<0.05	<0.07	<0.08	<0.08	<0.08	<0.09	<0.15	0.18	<0.29	0.49	0.66	0.14
6	Level lipid	5.50	4.70	<2.00	6.70	<3.00	<1.00	<1.00	<1.00	<1.00	<2.00	<2.00	<1.00	<2.00	<1.00	<2.00	<0.6	<20.00	0.81	11.00
	Level fresh weight	0.05	0.04	<0.01	0.06	<0.02	<0.01	<0.01	<0.01	<0.01	<0.02	<0.02	<0.01	<0.02	<0.01	<0.01	<0.01	<0.10		0.08
7	Level lipid	7.80	4.80	<1.00	5.00	<4.00	<0.90	<1.00	<0.90	<2.00	<2.00	<2.00	<1.00	<1.00	<0.80	<3.00	<1.00	10.00	0.69	11.00
	Level fresh weight	0.05	0.03	<0.01	0.03	<0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	0.07		0.07
8	Level lipid	13.00	<4.00	<2.00	6.60	4.20	<1.00	<1.00	<1.00	<1.00	<3.00	<3.00	<3.00	<3.00	<2.00	<8.00	<2.00	25.00	0.58	12.00
	Level fresh weight	0.07	<0.02	<0.01	0.04	0.02	<0.01	<0.01	<0.01	<0.01	<0.02	<0.02	<0.02	<0.02	<0.01	<0.05	<0.01	0.14		0.07

Footnotes:
*defines all congener values reported below the limit of reporting as equal to half the LOR.
1. QAQC laboratory was not required to analyse the contaminants in lipids The lipid content in the sample was provided for information purposes.

Congener #	Congeners	Congener #	Congeners	Congener #	Congeners
1	2,3,7,8-Tetrachlorodibenzofuran	7	1,2,3,6,7,8-Hexachlorodibenzofuran	13	1,2,3,4,6,7,8-Heptachlorodibenzofuran
2	2,3,7,8-Tetrachlorodibenzo-p-dioxin	8	2,3,4,6,7,8-Hexachlorodibenzofuran	14	1,2,3,4,7,8,9-Heptachlorodibenzofuran
3	1,2,3,7,8-Pentachlorodibenzofuran	9	1,2,3,7,8,9-Hexachlorodibenzofuran	15	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin
4	2,3,4,7,8-Pentachlorodibenzofuran	10	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	16	Octachlorodibenzofuran
5	1,2,3,7,8-Pentachlorodibenzo-p-dioxin	11	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	17	Octachlorodibenzo-p-dioxin
6	1,2,3,4,7,8-Hexachlorodibenzofuran	12	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin		

Table A4.3: 2009 analytical results for dioxin-like PCBs

		Non-ortho PCBs				Mono-ortho PCBs									
Dioxin-like PCBs	**PCB Congener #**	**77**	**81**	**126**	**169**	**105**	**114**	**118**	**123**	**156**	**157**	**167**	**189**	**Lipid[1]**	**WHO TEQ (middle bound)***
Composite		pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	%	pg/g
1.00	Level lipid	1860.00	180.00	580.00	12.00	73500.00	3270.00	219000.00	3480.00	27400.00	5880.00	14600.00	1740.00	0.83	110.00
	Level fresh weight	15.00	1.50	4.90	0.10	610.00	27.00	1820.00	29.00	230.00	49.00	120.00	14.00		0.89
2.00	Level lipid	1400.00	140.00	640.00	<5.00	66100.00	2660.00	203000.00	3310.00	25500.00	5850.00	13200.00	2220.00	0.58	110.00
	Level fresh weight	8.10	0.80	3.70	<0.03	380.00	15.00	1170.00	19.00	150.00	34.00	77.00	13.00		0.63
3.00	Level lipid	1410.00	150.00	490.00	5.70	64300.00	2570.00	205000.00	4480.00	28800.00	4700.00	12900.00	2160.00	0.94	95.00
	Level fresh weight	13.00	1.40	4.60	0.05	600.00	24.00	1930.00	42.00	270.00	44.00	120.00	20.00		0.89
3 QAQC	Level fresh weight	11.00	<6.12	7.02	<5.65	691.00	41.40	2080.00	21.30	282.00	53.40	150.00	23.50	0.71	1.20
4.00	Level lipid	1840.00	180.00	710.00	<9	65900.00	3140.00	200000.00	3800.00	24500.00	4990.00	11900.00	1880.00	0.51	110.00
	Level fresh weight	9.30	0.91	3.60	<0.05	340.00	16.00	1010.00	19.00	120.00	25.00	61.00	9.50		0.58
5.00	Level lipid	1960.00	170.00	880.00	<10	70500.00	3230.00	211000.00	3250.00	25000.00	5170.00	11200.00	2020.00	0.51	130.00
	Level fresh weight	9.90	0.85	4.50	<0.06	360.00	16.00	1070.00	16.00	130.00	26.00	57.00	10.00		0.68
5 QAQC	Level fresh weight	7.92	<5.70	5.46	<4.45	413.00	18.00	1180.00	10.70	145.00	32.30	75.90	11.80	0.66	0.83
6.00	Level lipid	950.00	99.00	540.00	9.90	58300.00	2490.00	180000.00	3220.00	27800.00	4880.00	13000.00	2170.00	0.81	96.00
	Level fresh weight	7.80	0.81	4.40	0.08	470.00	20.00	1470.00	26.00	230.00	40.00	110.00	18.00		0.78
7.00	Level lipid	1440.00	120.00	520.00	<3.00	56500.00	3070.00	178000.00	3140.00	27400.00	4750.00	12300.00	1970.00	0.69	94.00
	Level fresh weight	10.00	0.85	3.60	<0.02	390.00	21.00	1240.00	22.00	190.00	33.00	85.00	14.00		0.65
8.00	Level lipid	1690.00	140.00	740.00	<10.00	72700.00	3400.00	233000.00	4780.00	28400.00	5720.00	15000.00	2010.00	0.58	120.00
	Level fresh weight	9.80	0.79	4.30	<0.08	420.00	20.00	1350.00	28.00	160.00	33.00	87.00	12.00		0.73

Footnotes:
*defines all congener values reported below the reporting limit as equal to half the LOR.
1. QAQC laboratory was not required to analyse the contaminants in lipids The lipid content in the sample was provided for information purposes.
NT – Not tested. This PCB congener was not available in the standard suite of PCB congener screening.
QA/QC laboratory results reported in ng/g and required conversion

Table A4.4: 2009 analytical results for dioxins and dioxin-like PCBs

Middle bound TEQ*		Dioxin WHO-TEQ	Dioxin-like PCBs WHO-TEQ	Dioxin plus Dioxin-like PCBs WHO-TEQ	Dioxin plus Dioxin-like PCBs WHO-TEQ	Lipid[1]
Composite		mg/kg	mg/kg	mg/kg	pg/g	% w/w
1	Level lipid	8.10E-06	1.10E-04	1.18E-04	118.10	0.83
	Level fresh weight	6.50E-08	8.90E-07	9.55E-07	0.96	
2	Level lipid	1.20E-05	1.10E-04	1.22E-04	122.00	0.58
	Level fresh weight	6.90E-08	6.30E-07	6.99E-07	0.70	
3	Level lipid	7.80E-06	9.50E-05	1.03E-04	102.80	0.94
	Level fresh weight	7.50E-08	8.90E-07	9.65E-07	0.97	
3 QAQC	Level fresh weight	2.20E-07	1.20E-06	1.42E-06	1.42	0.71
4	Level lipid	1.40E-05	1.10E-04	1.24E-04	124.00	0.51
	Level fresh weight	7.50E-08	5.80E-07	6.55E-07	0.66	
5	Level lipid	1.50E-05	1.30E-04	1.45E-04	145.00	0.51
	Level fresh weight	7.50E-08	6.80E-07	7.55E-07	0.76	
5 QAQC	Level fresh weight	1.40E-07	8.30E-07	9.65E-07	0.97	0.66
6	Level lipid	1.10E-05	9.60E-05	1.07E-04	107.00	0.81
	Level fresh weight	8.40E-08	7.80E-07	8.64E-07	0.86	
7	Level lipid	1.10E-05	9.40E-05	1.05E-04	105.00	0.69
	Level fresh weight	7.40E-08	6.50E-07	7.24E-07	0.72	
8	Level lipid	1.20E-05	1.20E-04	1.32E-04	132.00	0.58
	Level fresh weight	6.60E-08	7.30E-07	7.96E-07	0.80	

Footnotes:
*defines all congener values reported below the reporting limit as equal to half the LOR.
1. QAQC laboratory was not required to analyse the contaminants in lipids The lipid content in the sample was provided for information purposes.

A4.3 Organochlorine pesticides

Table A4.5: 2009 analytical results for organochlorine pesticides

Organochlorine pesticides	HCB	Heptachlor	Heptachlor epoxide	Aldrin	gamma-BHC (Lindane)	alpha-BHC	beta-BHC	delta-BHC	trans-chlordane	cis-chlordane	Oxychlordane	Dieldrin	pp-DDE	pp-DDD	pp-DDT	Endrin	Endrin aldehyde	Endrin ketone	alpha-endosulfan	beta-endosulfan	Endosulfan sulfate	Methoxychlor
Composite	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
3	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.012	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
3 QAQC	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NQ	NQ	NT	NT	NT	<0.01	0.01	0.01	<0.01	<0.01	NQ	<0.01	<0.01	<0.01	NQ	<0.01
4	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
5 QAQC	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NQ	NQ	NT	NT	NT	<0.01	<0.01	<0.01	<0.01	<0.01	NQ	<0.01	<0.01	<0.01	NQ	<0.01
6	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
7	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
8	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Footnotes:
NT – Not tested. This Organochlorine pesticide was not available in the standard suite of screening.
NQ – Not quantified. Some analytes were not recovered during the analysis of this batch of samples. This has been attributed to losses occurring during chromatographic clean up procedures. QA/QC laboratory results reported in ng/g and required conversion

A4.4 Organophosphate pesticides

Table A4.6: 2009 analytical results for organophosphate pesticides

Organophosphate pesticides	Dichlorvos	Demeton-S-methyl	Diazinon	Dimethoate	Chlorpyrifos	Chlorpyrifos methyl	Malathion (Maldison)	Fenthion	Ethion	Fenitrothion	Chlorfenvinphos (E)	Chlorfenvinphos (Z)	Parathion (ethyl)	Parathion methyl	Pirimiphos methyl	Pirimiphos ethyl	Azinphos methyl	Azinphos ethyl
Composite	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
3 QAQC	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NT	<0.01	<0.01	NT	<0.01	NT
4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
5 QAQC	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NT	<0.01	<0.01	NT	<0.01	NT
6	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
8	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Footnote:
NT – Not tested. This Organophosphate pesticide was not available in the standard suite of screening.

A4.5 Polycyclic aromatic hydrocarbons

Table A4.7: 2009 analytical results for PAHs

Poly aromatic hydrocarbons	Naphthalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benz(a)anthracene	Chrysene	Benzo(b)&(k) fluoranthene	Benzo(a)pyrene	Indeno(1,2,3-cd)pyrene	Dibenz(ah)anthracene	Benzo(ghi)perylene
Composite	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01
2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01
3	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01
QAQC	<0.01	<0.00	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01
4	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01
5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01
QAQC	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01
6	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01
7	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01
8	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01

Footnote:
QA/QC laboratory results reported in mg/g and required conversion

A4.6 Metals and metalloids

Table A4.8: 2009 analytical results for metals and metalloids

Metals	Total Arsenic	Arsenic (inorganic)	Cadmium	Chromium	Copper	Lead	Total Mercury	Nickel	Selenium	Zinc	Moisture
Composite	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%
1	1.6	<0.05	<0.01	<0.05	0.16	0.01	0.09	0.01	0.39	4.2	80%
1 QAQC	1.5	0.09	<0.01	<0.05	0.12	<0.02	0.07	<0.02	0.36	3.6	
2	1.8	<0.05	<0.01	<0.05	0.17	<0.01	0.11	<0.01	0.46	3.8	80%
2 QAQC	1.6	<0.05	<0.01	<0.05	0.11	<0.02	0.09	<0.02	0.40	3.0	
3	1.4	<0.05	<0.01	<0.05	0.17	0.01	0.10	0.02	0.38	4.3	79%
3 QAQC	1.2	0.22	<0.01	<0.05	0.11	0.01	0.08	<0.02	0.42	3.2	
4	2.4	<0.05	<0.01	<0.05	0.20	<0.01	0.09	<0.01	0.42	4.6	79%
5	1.3	<0.05	<0.01	<0.05	0.13	<0.01	0.10	<0.01	0.33	3.6	80%
5 QAQC	1.3	0.24	<0.01	<0.05	0.09	0.01	0.08	<0.02	0.36	3.0	
6	1.3	<0.05	<0.01	<0.05	0.16	<0.01	0.09	<0.01	0.36	3.8	80%
7	1.7	<0.05	<0.01	<0.05	0.18	0.01	0.08	<0.01	0.44	3.9	80%
8	1.1	<0.05	<0.01	<0.05	0.19	<0.01	0.07	<0.01	0.40	3.5	80%
8 QAQC	1.0	0.06	<0.01	<0.05	0.10	<0.02	0.06	<0.02	0.40	3.0	

A4.7 Tributyltin

Table A4.9: 2009 analytical results for tributyltins

Organotins	Monobutyltin as Sn	Dibutyltin as Sn	Tributyltin as Sn
Composite	mg/kg	mg/kg	mg/kg
1	<0.0010	<0.0010	0.0015
2	<0.0010	<0.0010	0.0029
3	<0.0010	<0.0010	0.0025
3 QAQC	<0.0090	<0.0070	0.0045
4	<0.0010	<0.0010	0.0041
5	<0.0010	<0.0010	0.0028
5 QAQC	<0.0090	<0.0070	0.0043
6	<0.0010	0.0012	0.0075
7	<0.0010	<0.0010	0.0022
8	<0.0010	<0.0010	0.0014

Footnotes:

Primary laboratory results reported in ug/g and required conversion

A4.8 Polybrominated Diphenyl Ethers

Table A4.10: 2009 analytical results for PBDE

PBDE	Congener #	17	28 & 33	47	49	66	71	77	85	99	100	119	126	138 & 166	153	154	156 & 169	183	184	191
Composite	Sum of congeners	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g
1	Level lipid	60.0	2600.0	44000.0	1800.0	1300.0	<40.0	<40.0	<80.0	4500.0	14000.0	400.0	<30.0	200.0	1900.0	6300.0	300.0	130.0	<70.0	90.0
	Level fresh weight	0.5	22.0	370.0	15.0	11.0	<0.3	<0.4	<0.7	38.0	120.0	3.3	<0.3	<2.0	16.0	52.0	<2.0	1.1	<0.6	<0.8
2	Level lipid	150.0	3300.0	58000.0	3700.0	1700.0	<60.0	90.0	140.0	6300.0	22000.0	400.0	40.0	200.0	3700.0	11000.0	300.0	66.0	100.0	<40.0
	Level fresh weight	0.9	19.0	330.0	22.0	10.0	<0.3	0.5	0.8	36.0	130.0	2.3	0.2	<1.0	21.0	61.0	<2.0	0.4	<0.6	<0.2
3	Level lipid	93.0	2700.0	43000.0	1100.0	960.0	<6.0	<50.0	<60.0	2900.0	15000.0	460.0	<70	<100.0	<2300.0	7000.0	<300.0	90.0	<80.0	<40.0
	Level fresh weight	0.9	26.0	400.0	10.0	9.0	<0.1	<0.5	<0.6	27.0	140.0	4.4	<0.7	<9	21.0	65.0	<3.0	<0.9	<0.7	<0.3
3 QAQC	Level fresh weight	NQ	17.6	377.0	8.0	19.8[1]	<5.11	<1.42	<2.14	15.4	165.0	3.8[1]	1.5	<4.64	17.9	66.9	<3.0	<1.10	<0.96	<2.59
4	Level lipid	120.0	3900.0	57000.0	1900.0	1400.0	<500.0	66.0	210.0	7200.0	17000.0	430.0	<30	300.0	2300.0	7400.0	<700	<40.0	25.0	<70
	Level fresh weight	0.6	20.0	290.0	9.5	7.4	<3.0	0.3	1.0	37.0	88.0	2.2	<0.1	<2.0	12.0	37.0	<4.0	<0.2	0.1	<0.4
5	Level lipid	280.0	4200.0	99000.0	3600.0	3800.0	<200.0	72.0	180.0	5300.0	29000.0	760.0	100.0	<700	4400.0	13000.0	<600	<60	<3000	<60
	Level fresh weight	1.4	21.0	500.0	18.0	19.0	<0.8	0.4	0.9	27.0	150.0	3.9	<0.6	<4.0	22.0	65.0	<3.0	<0.3	<10	<0.3
5 QAQC	Level fresh weight	NQ	16.4	500.0	11.3	26.4[1]	<5.17	<1.43	<4.16	15.7	206.0	5.3[1]	0.1	<7.25	22.3	62.9	<3.94	<1.26	<10	<2.96
6	Level lipid	72.0	1100.0	40000.0	740.0	750.0	<7.0	40.0	<80.0	2400.0	17000.0	240.0	<30	100.0	2300.0	7700.0	<900	<30	<50	<20
	Level fresh weight	0.6	9.1	330.0	6.1	6.1	<0.1	0.3	<0.6	20.0	140.0	1.9	<0.2	<0.8	19.0	63.0	<7.0	<0.3	<0.4	<0.2
7	Level lipid	200.0	4300.0	43000.0	1300.0	780.0	<20.0	65.0	140.0	4700.0	15000.0	300.0	<10	<40.0	2000.0	7400.0	200.0	37.0	<20	<20
	Level fresh weight	1.4	30.0	300.0	9.2	5.4	<0.1	0.5	1.0	32.0	110.0	2.1	<0.1	<0.3	14.0	52.0	<2.0	0.3	<0.2	<0.2
8	Level lipid	260.0	4100.0	85000.0	2600.0	1600.0	<20.0	93.0	780.0	23000.0	27000.0	610.0	<30	500.0	4100.0	12000.0	500.0	58.0	<60	<50
	Level fresh weight	1.5	24.0	490.0	15.0	9.0	<0.1	0.5	4.5	130.0	160.0	3.6	<0.2	<3.0	24.0	70.0	<3.0	0.3	<0.3	<0.3

Footnotes:
1. This value has been estimated by the laboratory.
NQ - Not quantified. Some analytes were not recovered during the analysis of this batch of samples. This has been attributed to losses occurring during chromatographic clean up procedures.
All results reported in ng/g and required conversion

Table A4.10 2009 analytical results for PBDE continued

PBDE	Congener #	196	197	206	207	209	Lipid[1]	Total PBDE*
Composite	Sum of congeners	pg/g	pg/g	pg/g	pg/g	pg/g	% w/w	pg/g
1	Level lipid	400.0	500.0	82.0	98.0	860.0	0.83	78905.0
	Level fresh weight	<4.0	<4.0	0.7	0.8	7.2		670.0
2	Level lipid	300.0	200.0	460.0	350.0	4500.0	0.58	116496.0
	Level fresh weight	<2.0	<1.0	2.7	2.0	26.0		680.0
3	Level lipid	100.0	<20.0	45.0	48.0	<700.0	0.94	76864.0
	Level fresh weight	<0.9	<0.2	0.4	0.5	<7.0		720.0
3 QAQC	Level fresh weight	<1.38	<0.82	<25.4	<13.8	NQ	0.71	
4	Level lipid	400.0	200.0	170.0	200.0	<100.0	0.51	100491.0
	Level fresh weight	<2.0	<0.9	0.9	1.0	<0.7		520.0
5	Level lipid	<700	<40.0	<100.0	<600.0	2200.0	0.51	168872.0
	Level fresh weight	<3.0	<0.2	<0.6	<3.0	11.0		850.0
5 QAQC	Level fresh weight	<3.0	<0.87	<18.7	<10.2	NQ	0.66	
6	Level lipid	300.0	100.0	<70.0	<30.0	1100.0	0.81	74300.5
	Level fresh weight	<2.0	<1.0	<0.6	<0.3	8.6		620.0
7	Level lipid	200.0	90.0	<50.0	<80.0	<900	0.69	80037.0
	Level fresh weight	<2.0	<0.6	<0.4	<0.6	0.0		570.0
8	Level lipid	300.0	200.0	180.0	97.0	<200.0	0.58	162408.0
	Level fresh weight	<2.0	<1.0	1.0	0.6	<1.0		950.0

Footnotes:
* denotes total determined using half of the limit of reporting (LOR) for those values below reporting limit.
1. QAQC laboratory was not required to analyse the contaminants in lipids The lipid content in the sample was provided for information purposes.
NQ - Not quantitated. Some analytes were not recovered during the analysis of this batch of samples. This has been attributed to losses occurring during chromatographic clean up procedures.
All results reported in ng/g and required conversion

Congener #	Congener Name
17	2,2[1]4-Tribrominated diphenyl ether
28	2,4,4[1]-Tribrominated diphenyl ether
33	2[1],3,4-Tribrominated diphenyl ether
47	2,2[1],4,4[1]-Tetrabrominated diphenyl ether
49	2,2[1],4,5[1]-Tetrabrominated diphenyl ether
66	2,3[1],4,4[1]-Tetrabrominated diphenyl ether
71	2,3[1],4[1],6-Tetrabrominated diphenyl ether
77	3,3[1],4,4[1]-Tetrabrominated diphenyl ether
85	2,2',3,4,4'-Pentabrominated diphenyl ether
99	2,2',4,4',5-Pentabrominated diphenyl ether
100	2,2',4,4',6-Pentabrominated diphenyl ether
119	2,3',4,4',6-Pentabrominated diphenyl ether
126	3,3',4,4',5-Pentabrominated diphenyl ether
138	2,2',3,4,4',5'-Hexabrominated diphenyl ether
153	2,2',4,4',5,5'-Hexabrominated diphenyl ether
154	2,2',4,4',5,6'-Hexabrominated diphenyl ether
156	2,3,3',4,4',5-Hexabrominated diphenyl ether
166	2,3,4,4',5,6-Hexabrominated diphenyl ether
183	2,2',3,4,4',5',6-Heptabrominated diphenyl ether
184	2,2',3,4,4',6,6-Heptabrominated diphenyl ether
191	2,3,3',4,4',5',6-Heptabrominated diphenyl ether
196	2,2,3,3',4,4',5,6'-Octabrominated diphenyl ether
197	2,2,3,3',4,4',6,6'-Octabrominated diphenyl ether
206	2,2,3,3',4,4',5,5',6-Nonabrominated diphenyl ether
207	2,2,3,3',4,4',5,6,6-Nonabrominated diphenyl ether
209	Decabromodiphenyl ether

Table A4.11: Median and 95% upper confidence intervals

	Dioxins plus dioxin-like PCBs	Total Dioxins	Total Dioxin-like PCBs	Total PCBs	Total PBDE	Total DDT
	TEQ pg/g	TEQ pg/g	TEQ pg/g	mg/kg	pg/g	mg/kg
Median	0.78	0.08	0.71	0.026	666.8	0.02
~95%UCL	0.87	0.08	0.78	0.029	712.0	0.02

	Tributyltin as Sn	Total Arsenic	Copper	Lead	Total Mercury	Nickel	Selenium	Zinc
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Median	0.0027	1.5	0.17	<0.01	0.09	<0.01	0.4	3.9
~95%UCL	0.0029	1.7	0.18	0.01	0.10	<0.01	0.4	4.2

Note: Total PCBs, dioxins, dioxin-like PCBs, PBDE and DDT were calculated with all congener values reported below the LOR as half the LOR

APPENDIX 5: TABLES OF ANALYTICAL RESULTS FROM 2006 EPA STUDY

A5.1 Polychlorinated biphenyls (PCBs)

Table A5.1: 2006 analytical results for PCBs (congeners)

Composite number	PCB # 8	PCB # 18	PCB # 28	PCB # 44	PCB # 52	PCB # 66	PCB # 77	PCB # 101	PCB # 105	PCB # 118	PCB # 126	PCB # 128
Composite	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
28	<0.002	<0.002	<0.002	0.0025	0.0054	<0.002	<0.002	0.0120	<0.002	0.0098	<0.002	<0.002
29	<0.002	<0.002	<0.002	0.0042	0.0080	<0.002	<0.002	0.0170	<0.002	0.0170	<0.002	<0.002
30	<0.002	<0.002	<0.002	<0.002	0.0027	<0.002	<0.002	0.0058	<0.002	0.0110	<0.002	<0.002
37	<0.002	<0.002	<0.002	<0.002	0.0048	<0.002	<0.002	0.0073	<0.002	0.0070	<0.002	<0.002
38	<0.002	<0.002	<0.002	<0.002	0.0028	<0.002	<0.002	0.0042	<0.002	0.0029	<0.002	<0.002
39	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.0029	<0.002	0.0030	<0.002	<0.002

Table A5.1 cont: 2006 analytical results for PCBs (congeners)

Composite number	PCB # 138	PCB # 153	PCB # 169	PCB # 170	PCB # 180	PCB # 187	PCB # 195	PCB # 206	PCB # 209	Total PCB*
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
28	0.0180	0.0170	<0.002	<0.002	0.0031	0.0039	<0.002	<0.002	<0.002	0.0850
29	0.0230	0.0260	<0.002	0.0024	0.0058	0.0061	<0.002	<0.002	<0.002	0.1200
30	0.0091	0.0095	<0.002	<0.002	0.0022	0.0023	<0.002	<0.002	<0.002	0.0560
37	0.0100	0.0100	<0.002	<0.002	0.0033	0.0032	<0.002	<0.002	<0.002	0.0600
38	0.0052	0.0055	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.0370
39	0.0044	0.0047	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.0320

Footnotes:
* denotes total determined using half of the limit of reporting (LOR) for those values below reporting limit.

A5.2 Dioxins and dioxin-like PCBs

Table A5.2: 2006 analytical results for dioxins (fresh weight)

Composite number	PCDD/F CONGENERS (level pg/g fresh weight)																	Lipid	WHO TEQ (middle bound)*
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17		
	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	%	pg/g
29	0.8	0.16	0.03	0.16	0.13	<0.02	<0.02	<0.02	<0.02	0.021	0.072	<0.03	<0.01	<0.02	<0.07	<0.02	<0.2	2.8	0.47
29 duplicate	0.82	0.28	<0.04	0.16	0.12	<0.02	<0.02	<0.02	<0.02	0.027	<0.06	<0.02	<0.01	<0.009	<0.06	<0.02	<0.2	2.8	0.57
37	0.84	0.16	0.058	0.13	0.14	<0.03	<0.03	<0.03	<0.04	<0.03	0.073	<0.02	<0.03	<0.02	<0.1	<0.04	<0.9	2.2	0.47
37 duplicate	0.75	0.17	<0.05	0.14	0.13	<0.03	<0.03	<0.05	<0.03	<0.03	0.064	<0.02	<0.04	<0.02	<0.09	<0.05	<2	2	0.46
38	0.48	0.091	<0.06	0.12	<0.2	<0.03	<0.03	<0.03	<0.03	<0.03	0.1	<0.03	<0.03	<0.02	<0.09	<0.04	<0.9	1.8	0.3
38 QA/QC	0.59	0.114	0.115	0.155	0.18	0.038[1]	0.04	0.035[1]	ND	ND	0.091	ND	ND	ND	0.076	ND	0.23	2.1	0.46

Footnotes:
*defines all congener values reported below the limit of reporting as equal to half the LOR.
ND - Not detected

Congeners

1 =	2,3,7,8-TCDF	10 =	1,2,3,4,7,8-HxCDD
2 =	2,3,7,8-TCDD	11 =	1,2,3,6,7,8-HxCDD
3 =	1,2,3,7,8-PeCDF	12 =	1,2,3,7,8,9-HxCDD
4 =	2,3,4,7,8,-PeCDF	13 =	1,2,3,4,6,7,8-HpCDF
5 =	1,2,3,7,8-PeCDD	14 =	1,2,3,4,7,8,9-HpCDF
6 =	1,2,3,4,7,8-HxCDF	15 =	1,2,3,4,6,7,8-HpCDD
7 =	1,2,3,6,7,8-HxCDF	16 =	OCDF
8 =	2,3,4,6,7,8-HxCDF	17 =	OCDD
9 =	1,2,3,7,8,9-HxCDF		

Table A5.3: 2006 analytical results for dioxin-like PCBs (fresh weight)

Composite number	77	81	105	114	118	123	126	156	157	167	169	189	Lipid	WHO TEQ (middle bound)*
	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	%	pg/g
29	87	5.9	1610	76	5010	94	18	430	100	250	0.39	24	2.8	2.8
29 duplicate	87	6	1610	71	4850	88	17	410	98	220	0.36	24	2.8	2.7
37	100	6.7	1130	64	3480	78	12	330	79	180	0.26	20	2.2	1.9
37 duplicate	100	7	1180	69	3550	82	12	340	80	170	0.22	20	2	1.9
38	77	5.4	820	49	2560	62	8.5	250	57	130	0.25	16	1.8	1.4
38 QA/QC	75.1	20.5	829	51.6	2680	62.6	11.4	260	66.2	139	ND	18	2.1	1.7

Table A5.4: 2006 analytical results for dioxins and dioxin-like PCBs

Middle bound TEQ		Dioxin WHO-TEQ	Dioxin-like PCBs WHO-TEQ	Dioxin plus Dioxin-like PCBs WHO-TEQ	Dioxin plus Dioxin-like PCBs WHO-TEQ
Composite		mg/kg	mg/kg	mg/kg	pg/g
29	Level fresh weight	4.7E-07	2.8E-06	3.3E-06	3.27
29 duplicate	Level fresh weight	5.7E-07	2.7E-06	3.3E-06	3.27
37	Level fresh weight	4.7E-07	1.9E-06	2.4E-06	2.37
37 duplicate	Level fresh weight	4.6E-07	1.9E-06	2.4E-06	2.36
38	Level fresh weight	3.0E-07	1.4E-06	1.7E-06	1.7
38 QA/QC	Level fresh weight	4.7E-07	1.7E-06	2.2E-06	2.17

A5.3 Organochlorine pesticides

Table A5.5: 2006 analytical results for organochlorine pesticides

Composite number	HCB	Heptachlor	Heptachlor epoxide	Aldrin	gamma-BHC (Lind ane)	alpha-BHC	beta-BHC	delta-BHC	trans-chlordane	cis-chlordane	Oxychlordane	Dieldrin	pp-DDE	pp-DDD	pp-DDT	Endrin	Endrin aldehyde	Endrin Ketone	alpha-endosulfan	beta-endosulfan	Endosulfan sulfate	Methoxychlor
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
28	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.013	0.017	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
29	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.016	0.014	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
30	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
37	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.019	0.024	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
38	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.011	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
39	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.011	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

A5.4. Organophosphate pesticides

Table A5.6: 2006 analytical results for organophosphate pesticides

Composite number	Dichlorvos	Demeton-S-methyl	Diazinon	Dimethoate	Chlorpyrifos	Chlorpyrifos methyl	Malathion (Maldison)	Fenthion	Ethion	Fenitrothion	Chlorfenvinphos (E)	Chlorfenvinphos (Z)	Parathion (ethyl)	Parathion methyl	Pirimiphos methyl	Pirimiphos ethyl	Azinphos methyl	Azinphos ethyl
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
28	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
29	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
30	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
37	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
38	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
39	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10

A5.5 Polycyclic aromatic hydrocarbons

Table A5.7: 2006 analytical results for PAHs

Composite number	Naphthalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benz(a)anthracene	Chrysene	Benzo(b)&(k) fluoranthene	Benzo(a)pyrene	Indeno(1,2,3-cd)pyrene	Dibenz(ah)anthracene	Benzo(ghi)perylene
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
28	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01
29	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01
30	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01
37	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01
38	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01
39	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01

A5.6 Metals and metalloids

Table A5.8: 2006 analytical results for metals and metalloids

Composite number	Total arsenic	Arsenic (inorganic)	Cadmium	Chromium	Copper	Lead	Total mercury	Selenium	Zinc	Moisture
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%
28	2.3	<0.04	<0.005	<0.05	0.23	<0.01	0.09	0.48	5.3	75.7
29	2.8	<0.04	<0.005	<0.05	0.22	<0.01	0.12	0.44	4.3	75.1
30	3.1	<0.04	<0.005	<0.05	0.19	<0.01	0.08	0.49	5.2	75.9
37	2	<0.04	<0.005	<0.05	0.45	0.01	0.1	0.38	5	76
38	2.3	<0.04	<0.005	<0.05	0.3	<0.01	0.11	0.37	4.5	75.4
39	2.2	<0.04	<0.005	<0.05	0.26	<0.01	0.08	0.39	5.4	75.9

A5.7 Tributyltin

Table A5.9: 2006 analytical results for tributyltins

Composite number	Mono butyltin as Sn	Dibutyltin as Sn	Tributyltin as Sn
	mg/kg	mg/kg	mg/kg
28	<0.001	<0.001	0.0014
29	<0.001	<0.001	0.002
30	<0.001	<0.001	0.0024
37	<0.001	<0.001	0.0024
38	<0.001	<0.001	0.0014
39	<0.001	<0.001	0.0019

A5.8. Polybrominated diphenyl ethers

Table A5.10: 2006 analytical results for PBDE

PBDE	Congener #	17	28 & 33	47	49	66	71	77	85	99	100	119	126	138 & 166	153	154	156 & 169	183	184	191	196	197
Composite	Sum of congeners	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g
29	Level lipid	140	<2000	59000	4700	1010	<30	<200	<10	<3000	14700	560	<10	<7	3990	8080	<10	110	17	<2	<20	<60
	Level fresh weight	4.1	<60	1680	130	29	<0.9	<6	<0.3	<90	420	16	<0.3	<0.2	110	230	<0.3	3	0.49	<0.06	<0.6	<2
29 duplicate	Level lipid	160	<2000	59300	4700	700	<90	<20	<20	2630	14900	510	<9	<10	4190	8000	<10	95	14	<10	<40	<10
	Level fresh weight	4.5	<60	1690	130	20	<3	<0.6	<0.6	75	420	15	<0.3	<0.3	120	230	<0.3	2.7	0.41	<0.3	<1	<0.3
37	Level lipid	150	<2000	39300	3690	1240	<10	<20	<20	<2000	11000	420	<7	<9	3130	5900	<9	75	27	<10	<40	<30
	Level fresh weight	3.3	<40	850	80	27	<0.2	<0.4	<0.4	<40	240	9.1	<0.2	<0.2	68	130	<0.2	1.6	0.58	<0.2	<0.9	<0.7
37 duplicate	Level lipid	120	<2000	39200	3600	1230	<70	<10	<30	<2000	11300	460	<10	<10	3110	5780	<8	59	21	<10	<50	<60
	Level fresh weight	2.6	<40	850	78	27	<2	<0.2	<0.7	<40	250	10	<0.2	<0.2	67	130	<0.2	1.3	0.47	<0.2	<1	<1
38	Level lipid	100	<3000	36800	2580	840	<30	<20	<30	<2000	8490	260	<10	<6	2040	4430	<8	39	25	<1	15	<10
	Level fresh weight	1.8	<50	650	46	15	<0.5	<0.4	<0.5	<40	150	4.5	<0.2	<0.1	36	78	<0.1	0.68	0.44	<0.02	0.26	<0.2
38 QA/QC	Level fresh weight			470						25	130				25	57		0.8				

Table A5.10 cont 2006 analytical results for PBDE

PBDE	Congener #	206	207	209	Lipid	Total PBDE*
Composite	Sum of congeners	pg/g	pg/g	pg/g	% w/w	pg/g
29	Level lipid	<600	<500	<20000	3	92200
	Level fresh weight	<20	<10	<600		2630
29 duplicate	Level lipid	<70	<50	<2000	3	95200
	Level fresh weight	<2	<1	<60		2710
37	Level lipid	<20	<50	<600	2	64900
	Level fresh weight	<0.4	<1	<10		1410
37 duplicate	Level lipid	<30	<40	<1000	2	64900
	Level fresh weight	<0.7	<0.9	<20		1410
38	Level lipid	<30	<60	<600	2	55600
	Level fresh weight	<0.5	<1	<10		980
38 QA/QC	Level fresh weight			23		

Footnote:
* defines all congener values reported below the limit of reporting as equal to zero.

Congener no.	Congener name	Congener no.	Congener name
17	2,2'4-Tribrominated diphenyl ether	138	2,2',3,4,4',5'-Hexabrominated diphenyl ether
28	2,4,4'-Tribrominated diphenyl ether	153	2,2',4,4',5,5'-Hexabrominated diphenyl ether
33	2',3,4-Tribrominated diphenyl ether	154	2,2',4,4',5,6'-Hexabrominated diphenyl ether
47	2,2',4,4'-Tetrabrominated diphenyl ether	156	2,3,3',4,4',5-Hexabrominated diphenyl ether
49	2,2',4,5'-Tetrabrominated diphenyl ether	166	2,3,4,4',5,6-Hexabrominated diphenyl ether
66	2,3',4,4'-Tetrabrominated diphenyl ether	183	2,2',3,4,4',5',6-Heptabrominated diphenyl ether
71	2,3',4',6-Tetrabrominated diphenyl ether	184	2,2',3,4,4',6,6-Heptabrominated diphenyl ether
77	3,3',4,4'-Tetrabrominated diphenyl ether	191	2,3,3',4,4',5',6-Heptabrominated diphenyl ether
85	2,2',3,4,4'-Pentabrominated diphenyl ether	196	2,2,3,3',4,4',5,6'-Octabrominated diphenyl ether
99	2,2',4,4',5-Pentabrominated diphenyl ether	197	2,2,3,3',4,4',6,6'-Octabrominated diphenyl ether
100	2,2',4,4',6-Pentabrominated diphenyl ether	206	2,2,3,3',4,4',5,5',6-Nonabrominated diphenyl ether
119	2,3',4,4',6-Pentabrominated diphenyl ether	207	2,2,3,3',4,4',5,6,6-Nonabrominated diphenyl ether
126	3,3',4,4',5-Pentabrominated diphenyl ether	209	Decabromodiphenyl ether

APPENDIX 6: LIPID WEIGHT CONSIDERATION

The 2006 and 2009 sampling periods occurred at different times of year relative to the spawning cycle of bream. Bream start spawning in October and hit the peak of their spawning in January (pers com Dr Patrick Coutin, 07/05/2009). The 2006 samples were collected in April/May, after the spawning period and during a time when the fish would be expected to be feeding actively and increasing their energy (lipid) reserves. The 2009 samples were collected in January, during or soon after the peak of the spawning period, when lipid would be expect to pass to the gametes and therefore removed resulting in lower lipid content.

When comparing the accumulation of lipophilic contaminants the analysis should consider variations in lipid content (USEPA 2000). Statistical analysis (general linear models based on log10-transformed values) was undertaken on the concentrations of lipophilic compounds to determine if the results could be lipid-weighted to account for the difference in lipophilic compounds found in fish sampled in 2006 and 2009. Only those compounds where at least half of the observations in both years were above their respective reporting limits were analysed. This was done to ensure that the median values being inferred were outside censored regions (i.e. we are only making inferences about values that are not below reporting limits). The few remaining values below reporting limits were set at the reporting limit for the compound.

The results of the statistical analysis proved inconclusive for most analytes in 2009, with the concentrations of most contaminants not significantly related to lipid content. The results for 2006 showed that there is generally good agreement between PCB levels and lipid content. For the other lipophilic contaminants (dioxins, dioxin-like PCBs and PBDEs), only three composite samples were analysed in 2006 which is too few for meaningful statistical analysis.

Deriving the concentrations in the lipid from the concentration in the fresh weight by dividing by the percentage of lipid may "overcompensate" for the lipid content especially if the lipid content is below 1% (Prof A. Bignert pers. comm. 15th May 2009). This is the case for the 2009 samples where the median lipid content is 0.6%. The determination of the amount of lipid in the composite samples has itself a level of analytical uncertainty and can therefore introduce additional uncertainty in the resultant calculations.

The lipid-weighted data for the congeners of all compounds that were detected in 2009 is provided in the tables below together with results from similar congeners detected in 2006. The concentration of lipophilic compounds on a lipid-weighted basis for the 2006 and 2009 data was calculated by multiplying the fresh weight concentration by one hundred and dividing by the lipid percentage content. This was completed for all organics which were detectable. This has been provided to allow comparison, however it should be assessed with caution based on the information provided above.

Table A6.1: Lipid-weighted data PCB congeners

Study	Composite	Lipid Content (%)	Data type	#101	#118	#138	#153	#180	#187
				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
2006	28	2.5	lipid weight	0.480	0.392	0.720	0.680	0.124	0.156
2006	29	2.8	lipid weight	0.607	0.607	0.821	0.929	0.207	0.218
2006	30	2.1	lipid weight	0.276	0.524	0.433	0.452	0.105	0.110
2006	37	2.1	lipid weight	0.348	0.333	0.476	0.476	0.157	0.152
2006	38	1.8	lipid weight	0.233	0.161	0.289	0.306		
2006	39	1.3	lipid weight	0.223	0.231	0.338	0.362		
2009	2	0.58	lipid weight				0.586		
2009	3	0.94	lipid weight			0.277	0.468		
2009	4	0.51	lipid weight	0.549	0.608	0.706	1.235	0.471	0.451
2009	5	0.51	lipid weight		0.471	0.569	0.941	0.412	
2009	6	0.81	lipid weight	0.309	0.395	0.506	0.938	0.481	0.296
2009	7	0.69	lipid weight		0.319	0.333	0.551		
2009	8	0.58	lipid weight				0.431		

Table A6.2: Lipid-weighted data dioxin-like PCB congeners

Study	Composite	Lipid Content (%)	Data type	77	81	126	169	105	114	118	123	156	157
				pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g
2006	29	2.8	lipid weight	3107.14	210.71	642.86	13.93	57500.00	2714.29	178928.57	3357.14	15357.14	3571.43
2006	37	2.1	lipid weight	4761.90	319.05	571.43	12.38	53809.52	3047.62	165714.29	3714.29	15714.29	3761.90
2006	38	1.8	lipid weight	4277.78	300.00	472.22	13.89	45555.56	2722.22	142222.22	3444.44	13888.89	3166.67
2009	1	0.83	lipid weight	1807.23	180.72	590.36	11.57	73493.98	3253.01	219277.11	3493.98	27710.84	5903.61
2009	2	0.58	lipid weight	1396.55	137.93	637.93		65517.24	2586.21	201724.14	3275.86	25862.07	5862.07
2009	3	0.94	lipid weight	1382.98	148.94	489.36	5.74	63829.79	2553.19	205319.15	4468.09	28723.40	4680.85
2009	4	0.51	lipid weight	1823.53	178.43	705.88		66666.67	3137.25	198039.22	3725.49	23529.41	4901.96
2009	5	0.51	lipid weight	1941.18	166.67	882.35		70588.24	3137.25	209803.92	3137.25	25490.20	5098.04
2009	6	0.81	lipid weight	96.30	10.00	54.32	0.99	5802.47	246.91	18148.15	320.99	2839.51	493.83
2009	7	0.69	lipid weight	1449.28	123.19	521.74		56521.74	3043.48	179710.14	3188.41	27536.23	4782.61
2009	8	0.58	lipid weight	1689.66	136.21	741.38		72413.79	3448.28	232758.62	4827.59	27586.21	5689.66

Table A6.3: Lipid-weighted data PCDD/F congeners

Study	Composite	Lipid Content (%)	Data type	167	189	1	2	3	4	5	17
				pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g
2006	29	2.8	lipid weight	8928.57	857.14	28.57	5.71	1.07	5.71	4.64	
2006	37	2.1	lipid weight	8571.43	952.38	40.00	7.62	2.76	6.19	6.67	
2006	38	1.8	lipid weight	7222.22	888.89	26.67	5.06		6.67		
2009	1	0.83	lipid weight	14457.83	1686.75	8.25	4.13	1.50	1.50		
2009	2	0.58	lipid weight	13275.86	2241.38	10.67	5.50	1.83	5.50		
2009	3	0.94	lipid weight	12765.96	2127.66	6.89	3.56			3.11	
2009	4	0.51	lipid weight	11960.78	1862.75	9.60	6.00		5.80		
2009	5	0.51	lipid weight	11176.47	1960.78	12.20	5.00		5.60	5.20	
2009	6	0.81	lipid weight	1358.02	222.22	5.63	4.75		6.88		
2009	7	0.69	lipid weight	12318.84	2028.99	7.71	4.71		4.86		10.29
2009	8	0.58	lipid weight	15000.00	2068.97	12.33			6.33	4.00	23.33

Table A6.4: Lipid-weighted data PBDE congeners

Study	Composite	Lipid Content (%)	Data type	17	47	49	66	99	100	119	153	154	183	184
				pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g
2006	29	2.8	lipid weight	146.4	60000.0	4642.9	1035.7		15000.0	571.4	3928.6	8214.3	107.1	17.5
2006	37	2.1	lipid weight	157.1	40476.2	3809.5	1285.7		11428.6	433.3	3238.1	6190.5	76.2	27.6
2006	38	1.8	lipid weight	100.0	36111.1	2555.6	833.3		8333.3	250.0	2000.0	4333.3	37.8	24.4
2009	1	0.83	lipid weight	60.2	44578.3	1807.2	1325.3	4578.3	14457.8	397.6	1927.7	6265.1	132.5	
2009	2	0.58	lipid weight	153.4	56896.6	3793.1	1724.1	6206.9	22413.8	396.6	3620.7	10517.2	65.5	
2009	3	0.94	lipid weight	92.6	42553.2	1063.8	957.4	2872.3	14893.6	468.1	2234.0	6914.9		
2009	4	0.51	lipid weight	121.6	56862.7	1862.7	1451.0	7254.9	17254.9	431.4	2352.9	7254.9		25.5
2009	5	0.51	lipid weight	274.5	98039.2	3529.4	3725.5	5294.1	29411.8	764.7	4313.7	12745.1		
2009	6	0.81	lipid weight	72.8	40740.7	753.1	753.1	2469.1	17284.0	234.6	2345.7	7777.8		
2009	7	0.69	lipid weight	202.9	43478.3	1333.3	782.6	4637.7	15942.0	304.3	2029.0	7536.2	37.7	
2009	8	0.58	lipid weight	258.6	84482.8	2586.2	1551.7	22413.8	27586.2	620.7	4137.9	12069.0	58.6	

APPENDIX 7: GUIDELINE LEVELS

Contaminant group	Contaminant	LOR (mg/kg)*1	Reference levels		
			FSANZ (mg/kg)	USEPA screening values (mg/kg)	
				Non carcinogens	Carcinogens
Organochlorine pesticides	HCB	0.01			
	Heptachlor	0.01	0.05*2		
	Heptachlor epoxide	0.01		0.52	0.00439
	Aldrin	0.01	0.1*2		
	gamma-BHC (lindane)	0.01	1*2	1.2	0.0307
	alpha-BHC	0.01	Total 0.01[2]		0.0063
	beta-BHC	0.01			0.0223
	delta-BHC	0.01			0.0223
	trans-chlordane	0.01	Total 0.05	Total 2	Total 0.114
	cis-chlordane	0.01			
	Oxychlordane	0.01			
	Dieldrin	0.01	0.1*2	0.2	0.0025
	p,p (4,4')-DDE	0.01	Total 1*2	Total 2	Total 0.117
	p,p (4,4')-DDD	0.01			
	p,p (4,4')-DDT	0.01			
	Endrin	0.01		1.2	
	Endrin aldehyde	0.01			
	Endrin ketone	0.01			
	alpha-endosulfan	0.01		Total 24	
	beta-endosulfan	0.01			
	Endosulfan sulfate	0.01			
	Methoxychlor	0.01			
Organophosphate pesticides	Dichlorvos	0.1			
	Demeton-S-methyl	0.1			
	Diazinon	0.1		2.8	
	Dimethoate	0.1			
	Chlorpyrifos	0.1		1.2	
	Chlorpyrifos methyl	0.1			
	Malathion	0.1			
	Fenthion	0.1			
	Ethion	0.1		2	
	Fenitrothion	0.1			
	Chlorfenvinphos (E)	0.1			
	Chlorfenvinphos (Z)	0.1			
	Parathion (ethyl)	0.1			
	Parathion methyl	0.1			
	Pirimphos methyl	0.1			
	Pirimphos ethyl	0.1			
	Azinphos methyl	0.1			
	Azinphos ethyl	0.1			

Footnotes
1. LOR for the primary laboratory with units provided as mg/kg unless otherwise stated
2. Extraneous Residue Limit

Contaminant group	Contaminant	LOR (mg/kg)*1	Reference levels		
			FSANZ (mg/kg)	USEPA screening values (mg/kg)	
				Non carcinogens	Carcinogens
Polycyclic aromatic hydrocarbons	Naphthalene	0.01			0.00547
	Acenaphthylene	0.01			
	Acenaphthene	0.01			
	Fluorene	0.01			
	Phenanthrene	0.01			
	Anthracene	0.01			
	Fluoranthene	0.01			
	Pyrene	0.01			
	Benz[a]anthracene	0.01			
	Chrysene	0.01			
	Benzo[b,k]fluoranthene	0.02			
	Benzo[a]pyrene	0.01			
	Indeno[1,2,3-cd]pyrene	0.01			
	Dibenz[a,h]anthracene	0.01			
	Benzo[g,h,i,]perylene	0.01			
Polychlorinated biphenyls (PCBs) congeners	PCB#8 2,4'-Dichlorobiphenyl	0.002	0.5	0.08	0.02
	PCB#18 2,2',5-Trichlorobiphenyl	0.002			
	PCB#28 2,4,4,'-Trichlorobiphenyl	0.002			
	PCB#44 2,2',3,5'-Tetrachlorobiphenyl	0.002			
	PCB#52 2,2',5,6'-Tetrachlorobiphenyl	0.002			
	PCB#66 2,3',4,4'-Tetrachlorobiphenyl	0.002			
	PCB#77 3,3',4,4'-Tetrachlorobiphenyl	0.002			
	PCB#101 2,2',4,5,5'-Pentachlorobiphenyl	0.002			
	PCB#105 2,3,3',4,4'-Pentachlorobiphenyl	0.002			
	PCB#118 2,3',4,4',5-Pentachlorobiphenyl	0.002			
	PCB#126 3,3',4,4',5-Pentachlorobiphenyl	0.002			
	PCB#128 2,2',3,3',4,4'-Hexachlorobiphenyl	0.002			
	PCB#138 2,2',3,4,4',5-Hexachlorobiphenyl	0.002			
	PCB#153 2,2',4,4',5,5'-Hexachlorobiphenyl	0.002			
	PCB#169 3,3',4,4',5,5'-Hexachlorobiphenyl	0.002			
	PCB#170 2,2',3,3',4,4',5-Heptachlorobiphenyl	0.002			
	PCB#180 2,2',3,4,4',5,5'-Heptachlorobiphenyl	0.002			
	PCB#187 2,2',3,4',5,5',6-Heptachlorobiphenyl	0.002			
	PCB#195 2,2',3,3',4,4',5,6-Octachlorobiphenyl	0.002			
	PCB#206 2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	0.002			
	PCB#209 Decachlorobiphenyl	0.002			

Footnotes

1. LOR for the primary laboratory with units provided as mg/kg unless otherwise stated

Contaminant Group	Contaminant	LOR (mg/kg)*1	Reference Levels		
			FSANZ (mg/kg)	USEPA Screening Values (mg/kg)	
				Non carcinogens	Carcinogens
Metals and metalloids	Arsenic	0.1			
	Inorganic Arsenic	0.05	2	1.2	0.026
	Cadmium	0.01		4	
	Chromium	0.05			
	Copper	0.10			
	Lead	0.01	0.5		
	Mercury	0.01	0.5	0.4	
	Nickel	0.01			
	Selenium	0.10	0.1	20	
	Zinc	0.1			
Organotins	Tributyl tin as Sn	0.0010		1.2	
Ultra trace dioxins (PCDD), furans (PCDF), dioxin-like PCBs (fresh weight)		0.01 – 0.20 pg/g	6 pg/g[2]		0.256 pg/g
Polybrominated diphenyl ethers (PBDEs) congener (fresh weight)		0.1 - 9.0 pg/g			

Footnotes
1. LOR for the primary laboratory with units provided as mg/kg unless otherwise stated
2. NSW Food Authority Temporary Action level

APPENDIX 8: TISSUE COMPOSITES AND ANALYSIS DETAILS

Table A8.1: Details of composites and analysis

Composite number	Number of fillets per composite	Sample ID numbers	Primary analysis	QA/QC analysis
1	10	4BB1 - 4BB10	✓	M
2	10	4BB11 - 4BB20	✓	M
3	10	4BB21 - 4BB30	✓	✓
4	10	4BB31 - 4BB40	✓	
5	10	4BB41 - 4BB50	✓	✓
6	10	4BB51 - 4BB60	✓	
7	10	4BB61 - 4BB70	✓	
8	10	4BB71 - 4BB81*	✓	M

Footnotes:
*4BB80 not included in composite sample due to it small size.
✓ - all parameters tested for QA/QC
M – metals and metalloids QA/QC testing only

Table A8.2: Physical data

Reach 4 – Docklands – Urban Yarra

Fish ID	Total length (mm)	Caudal fork length (mm)	Weight (g)	Sex (M/F)	
Black bream (*Acanthopagrus butcheri*)					
4BB1	315	287	488	M	**Composite 1**
4BB2	320	290	470	F	
4BB3	322	298	534	F	
4BB4	309	280	474	F	
4BB5	280	260	392	F	
4BB6	346	312	644	F	
4BB7	260	238	256	F	
4BB8	269	244	276	M	
4BB9	356	325	652	F	
4BB10	322	295	516	F	
4BB11	285	258	306	F	**Composite 2**
4BB12	290	272	376	F	
4BB13	326	300	580	M	
4BB14	329	304	584	F	
4BB15	294	267	360	F	
4BB16	294	267	354	F	
4BB17	312	286	496	F	
4BB18	303	278	468	F	
4BB19	321	295	560	M	
4BB20	276	259	356	M	

Fish ID	Total length (mm)	Caudal fork length (mm)	Weight (g)	Sex (M/F)	
Black bream (*Acanthopagrus butcheri*)					
4BB21	272	251	344	M	**Composite 3**
4BB22	322	291	542	F	
4BB23	312	284	460	F	
4BB24	260	242	264	F	
4BB25	261	240	256	M	
4BB26	294	279	388	M	
4BB27	295	268	386	F	
4BB28	293	268	356	M	
4BB29	300	275	422	F	
4BB30	322	299	536	M	
4BB31	294	269	408	M	**Composite 4**
4BB32	315	290	484	M	
4BB33	296	268	424	F	
4BB34	285	260	358	F	
4BB35	276	257	372	F	
4BB36	305	282	444	F	
4BB37	268	242	290	F	
4BB38	320	294	482	F	
4BB39	316	287	500	F	
4BB40	333	301	582	M	

Fish ID	Total length (mm)	Caudal fork length (mm)	Weight (g)	Sex (M/F)	
Black bream (*Acanthopagrus butcheri*)					
4BB41	297	267	382	F	**Composite 5**
4BB42	334	305	646	F	
4BB43	365	332	696	F	
4BB44	339	309	556	M	
4BB45	302	280	454	F	
4BB46	348	317	642	F	
4BB47	307	278	433	F	
4BB48	319	290	506	M	
4BB49	344	312	616	F	
4BB50	304	275	462	F	
4BB51	305	280	414	F	**Composite 6**
4BB52	288	258	396	M	
4BB53	342	310	620	M	
4BB54	331	302	598	F	
4BB55	292	263	416	F	
4BB56	279	257	354	M	
4BB57	262	238	270	M	
4BB58	261	242	264	I	
4BB59	260	235	254	I	
4BB60	262	240	276	M	

Fish ID	Total length (mm)	Caudal fork length (mm)	Weight (g)	Sex (M/F)	
Black bream (*Acanthopagrus butcheri*)					
4BB61	312	283	464	F	**Composite 7**
4BB62	283	256	376	F	
4BB63	288	262	358	F	
4BB64	305	270	432	F	
4BB65	284	256	386	M	
4BB66	267	240	368	F	
4BB67	295	266	362	F	
4BB68	296	266	474	F	
4BB69	315	288	478	F	
4BB70	288	262	369	M	
4BB71	302	272	448	M	**Composite 8**
4BB72	296	271	386	F	
4BB73	307	278	396	M	
4BB74	266	243	284	I	
4BB75	264	244	305	F	
4BB76	294	265	380	F	
4BB77	326	298	552	M	
4BB78	298	273	414	M	
4BB79	288	262	334	F	
4BB81	286	258	336	F	
4BB80	263	242	254	M	*not included

Reach 5 – The Warmies

Fish ID	Total length (mm)	Caudal fork length (mm)	Weight (g)	Sex (M/F)
Yellow-eye mullet (*Aldrichetta forsteri*)				
5MUL1	278	253	202	M
5MUL2	266	242	160	M
5MUL3	285	259	225	F
5MUL4	275	254	179	M
5MUL5	278	255	207	M
5MUL6	260	236	162	M
5MUL7	254	230	146	F

Reach 5 – The Warmies

Fish ID	Total length (mm)	Caudal fork length (mm)	Weight (g)	Sex (M/F)
Black bream (*Acanthopagrus butcheri*)				
5BB1	277	249	302	F
5BB2	274	254	328	F
5BB3	260	239	238	F