HUMAN DIETARY EXPOSURE TO PBDEs AROUND E-WASTE RECYCLING SITES IN EASTERN CHINA

Iryna Labunska[1], Stuart Harrad[2], Mengjiao Wang[1],David Santillo[1] and Paul Johnston[1]

[1]Greenpeace Research Laboratories, University of Exeter, United Kingdom

[2]School of Geography, Earth and Environmental Sciences, University of Birmingham, United Kingdom

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PBDEs in duck eggs

Average ∑PBDE range: 52.7 -1778 ng/g lw
(control: 8 ng/g lw)
Max in a single sample: 7400 ng/g lw

Average estimated exposure to BDE-99 for a 3 year old male Chinese child:

30.4 ng/kg bw/day –

falls within the range of the NAEL for impaired neurodevelopmental toxicity (18.8 – 41.4 ng/kg bw/day)

Labunska, I., Harrad, S., Santillo, D., Johnston, P., & Yun, L. (2013). Domestic duck eggs: an important pathway of human exposure to PBDEs around e-waste and scrap metal processing areas in Eastern China. *Environmental Science & Technology*, 47(16), 9258–66.

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Current study objectives

•Determine concentrations of PBDEs in food samples originating from e-waste recycling sites in Taizhou and control sites in China including:

- chicken (meat) & chicken liver
- duck (meat) & duck liver
- chicken eggs
- fish & shrimps
- pork
- culinary oils

- Estimate dietary human exposure to PBDEs through foodstuffs produced from locally reared animals at e-waste sites in Taizhou

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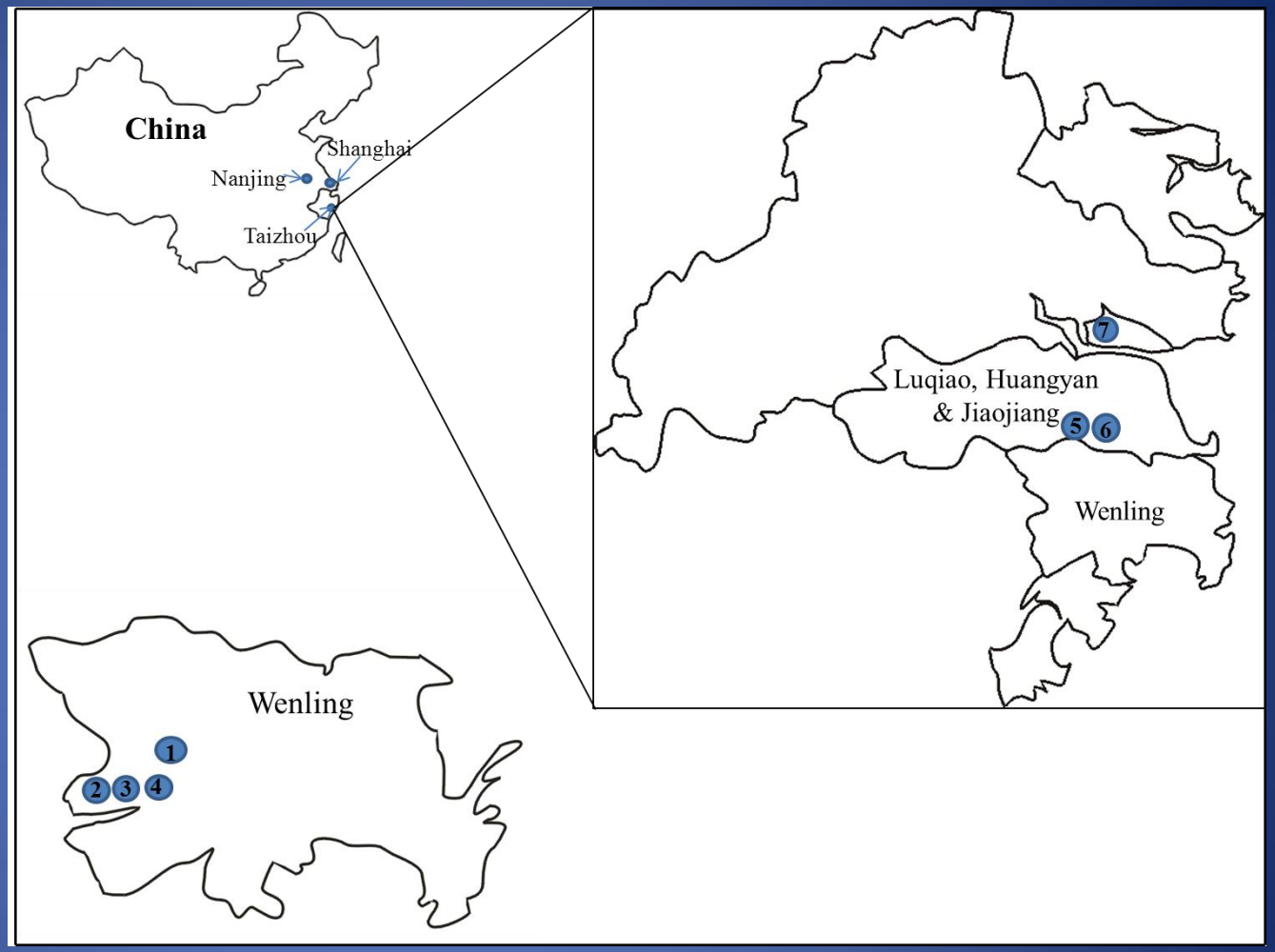
Samples & Sampling sites

Wenling – recycling of printed circuit boards and other computer components

Luqiao – dismantling of scrap metal items, transformers, capacitors, motors, cables and wires



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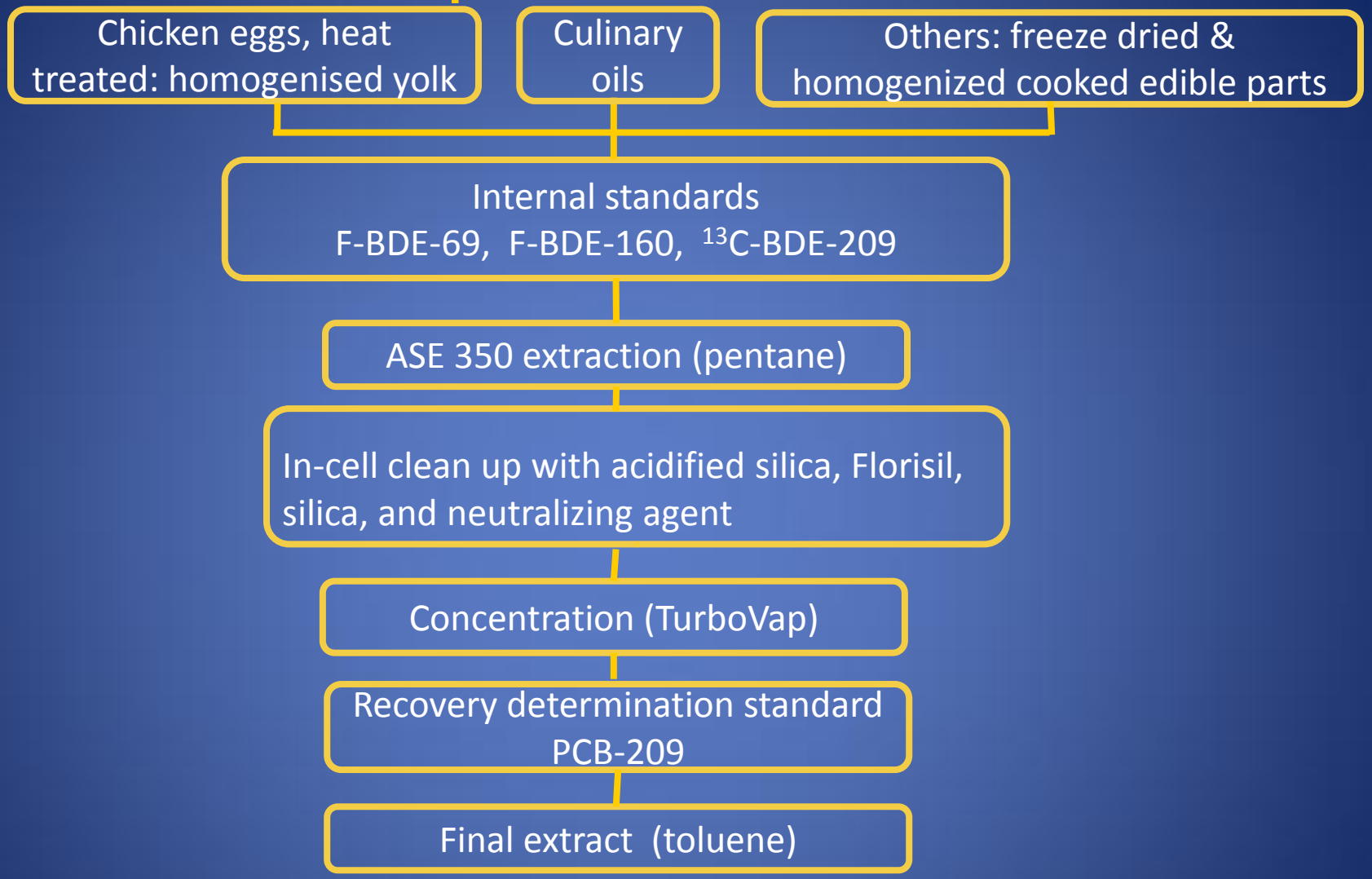
Sample extraction



Labunska, I., Harrad, S., Wang, M., Santillo, D., & Johnston, P. (2014). Human Dietary Exposure To PBDEs Around E-waste Recycling Sites In Eastern China. *Environmental Science & Technology*. doi:10.1021/es500241m

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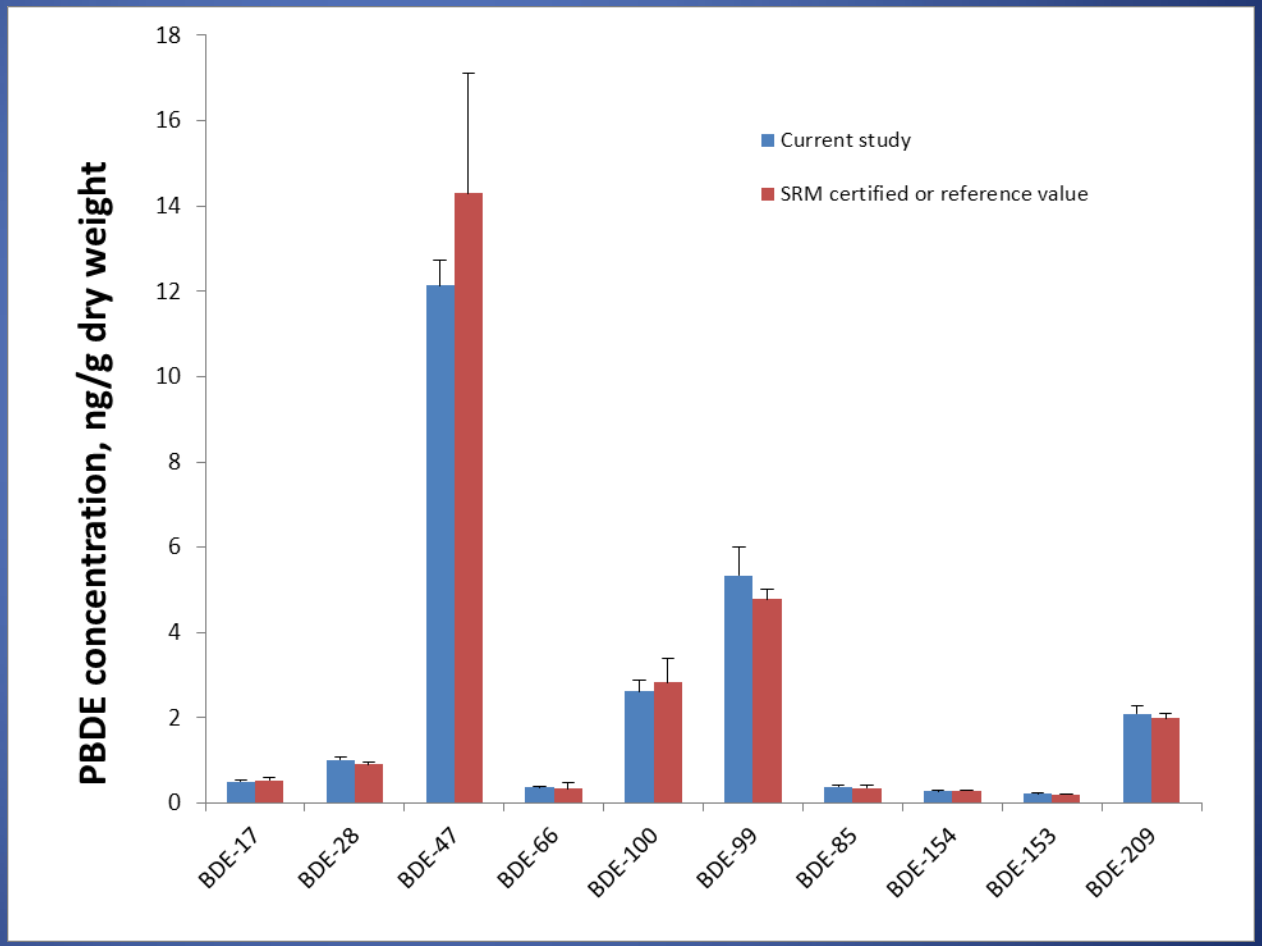
QA/QC and analysis of SRM2974A "Organics in freeze-dried mussel tissue (*Mytilus edulis*)" (NIST) (n=5). Error bar – SD

Homogeneity test for 10 aliquots of pork:
RSDs range 3.9 – 28%

Duplicate samples
RSDs range 1.3 – 28%

IS recoveries
range 63 – 101%

SDLs
0.002 – 0.007 ng/g dw for a 0.5 g sample



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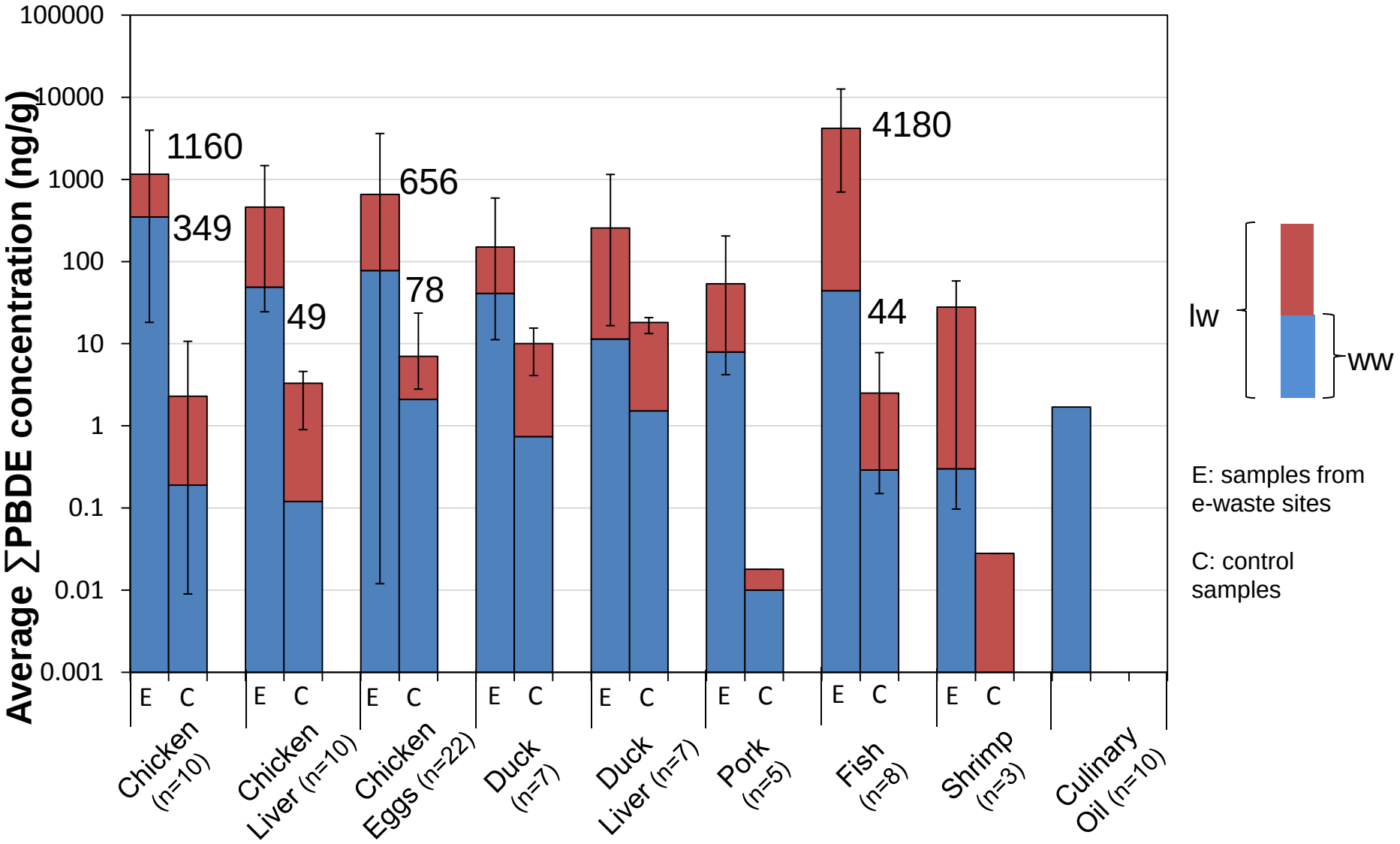
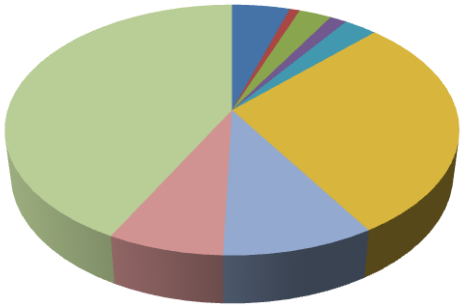
Average ∑PBDE concentration for each type of sample



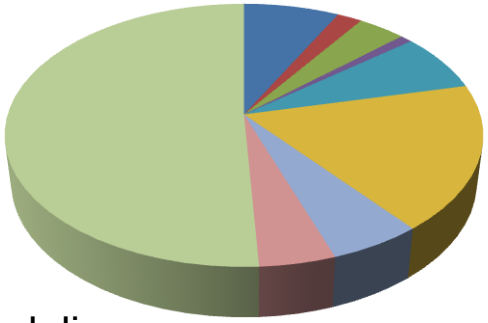
The **reading** of the upper end of the blue column is the average ∑PBDE concentration based on ww;
The **reading** of the upper end of the red column is the average ∑PBDE concentration based on lw;
The **reading** of the **upper end and the lower end of the error bar** is ∑PBDE concentrations range based on lw.

Contribution of individual BDEs to ∑ PBDE in each type of food collected from e-waste area in Taizhou, China

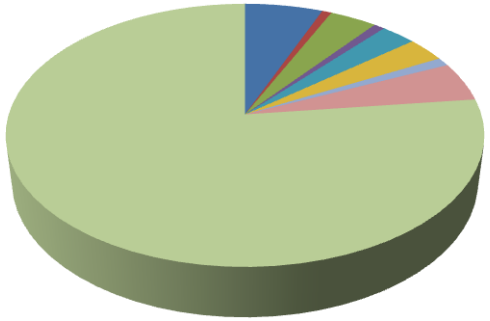
Chicken
(n=10)



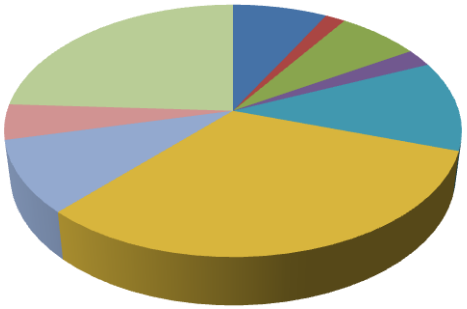
Chicken liver
(n=10)



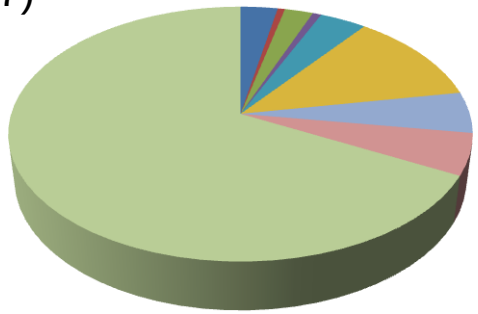
Chicken egg
(n=22)



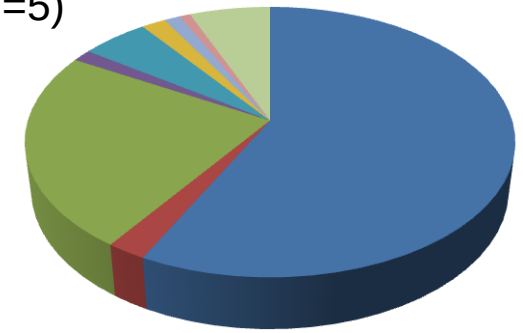
Duck
(n=7)



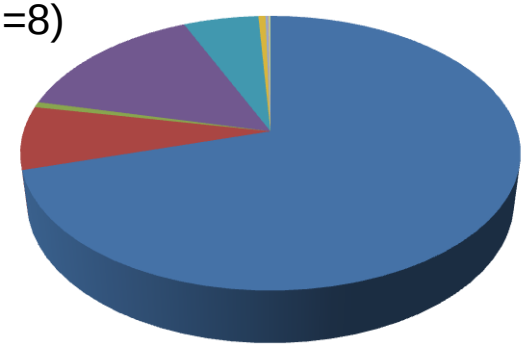
Duck liver
(n=7)



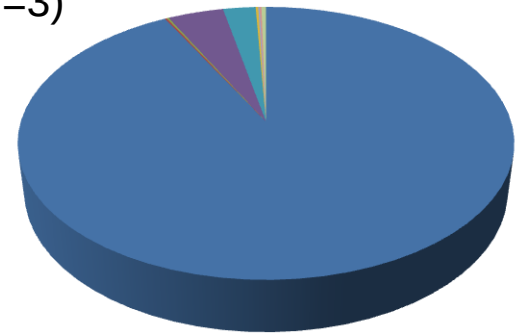
Pork
(n=5)



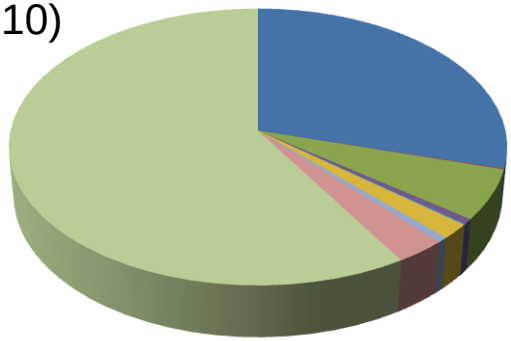
Fish
(n=8)



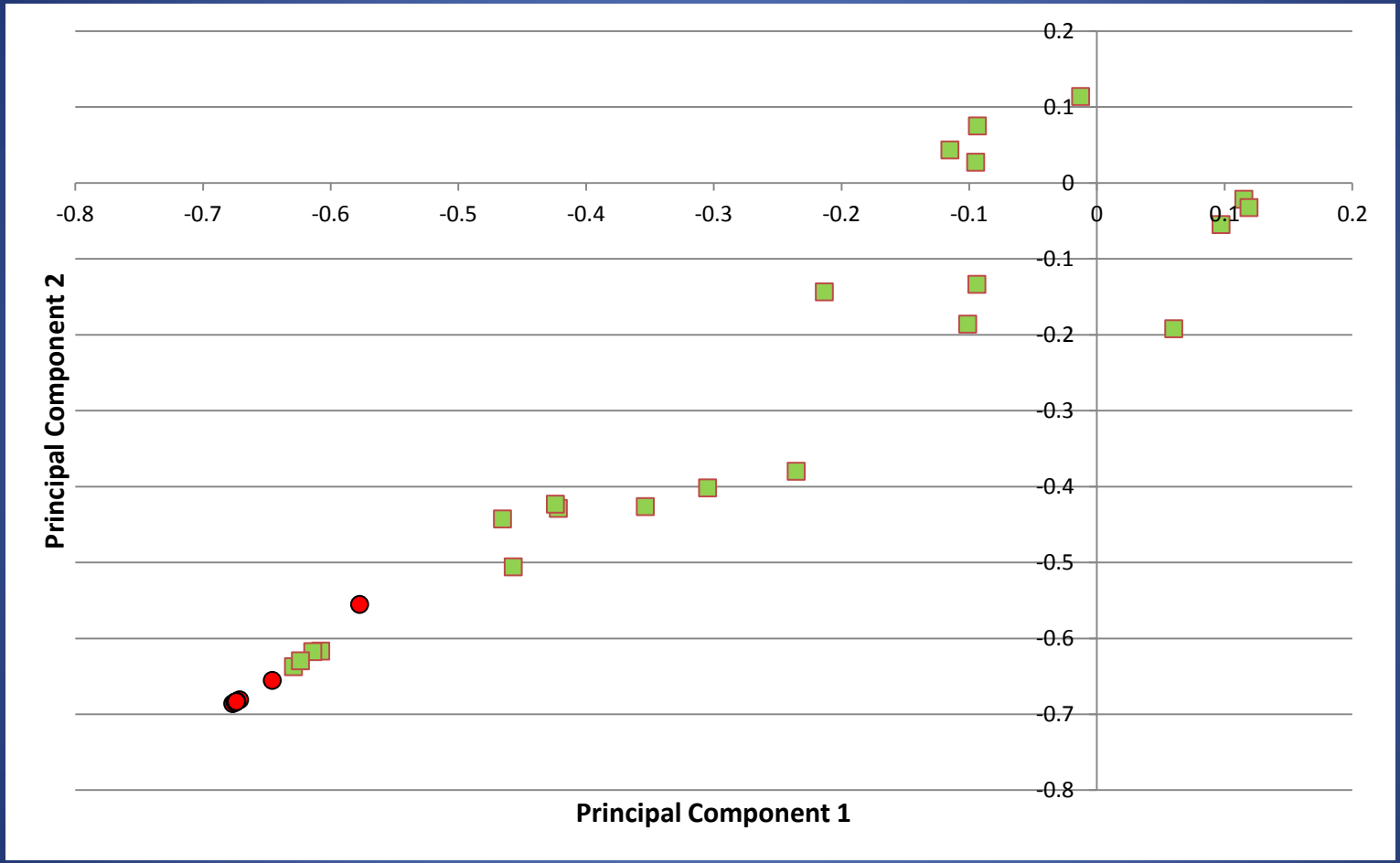
Shrimp
(n=3)



Culinary oil
(n=10)



PCA of the chicken egg samples (n=22) from e-waste sites of Taizhou, China & control samples (n=10)



– control samples

- e-waste related samples

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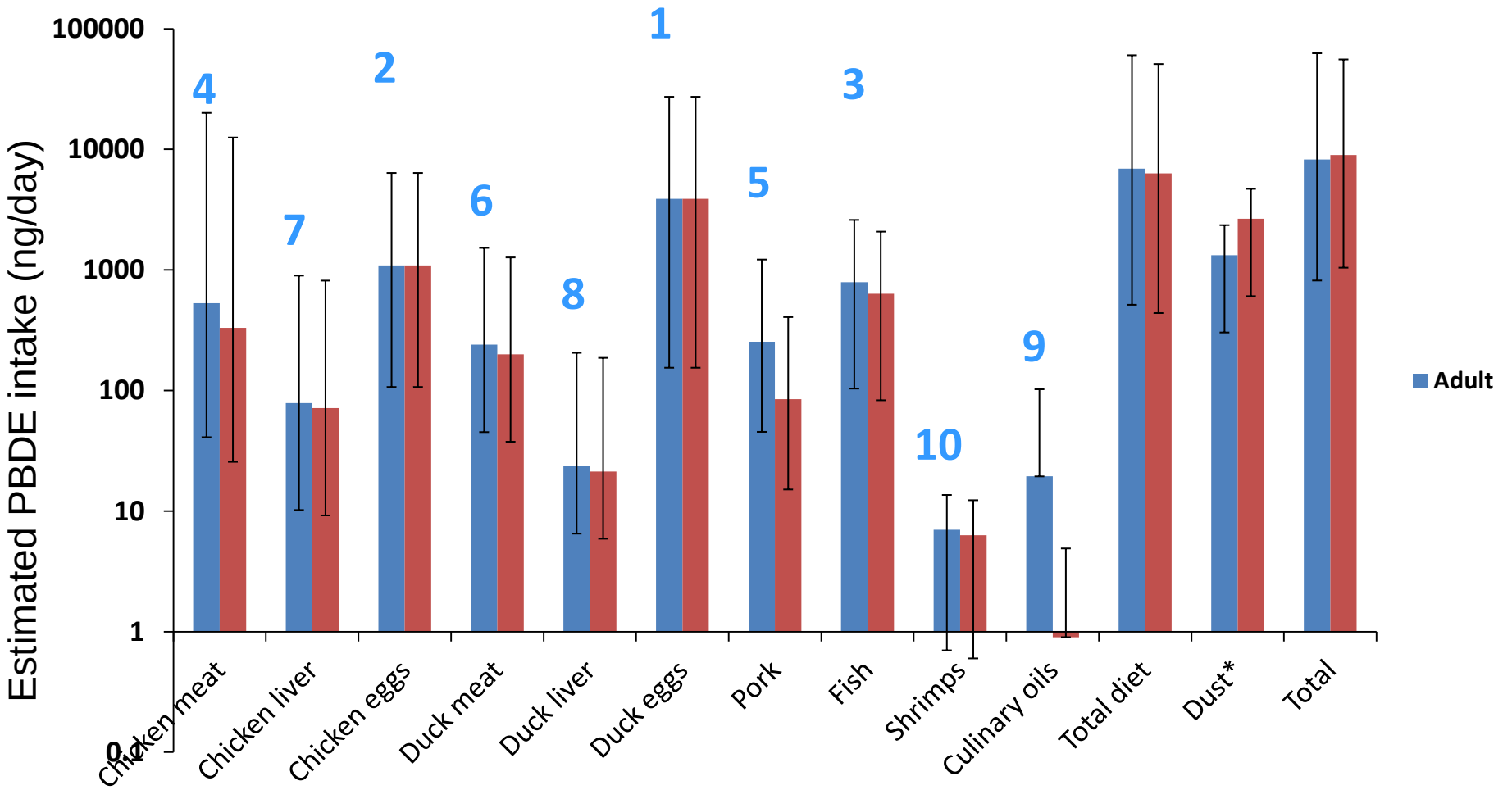
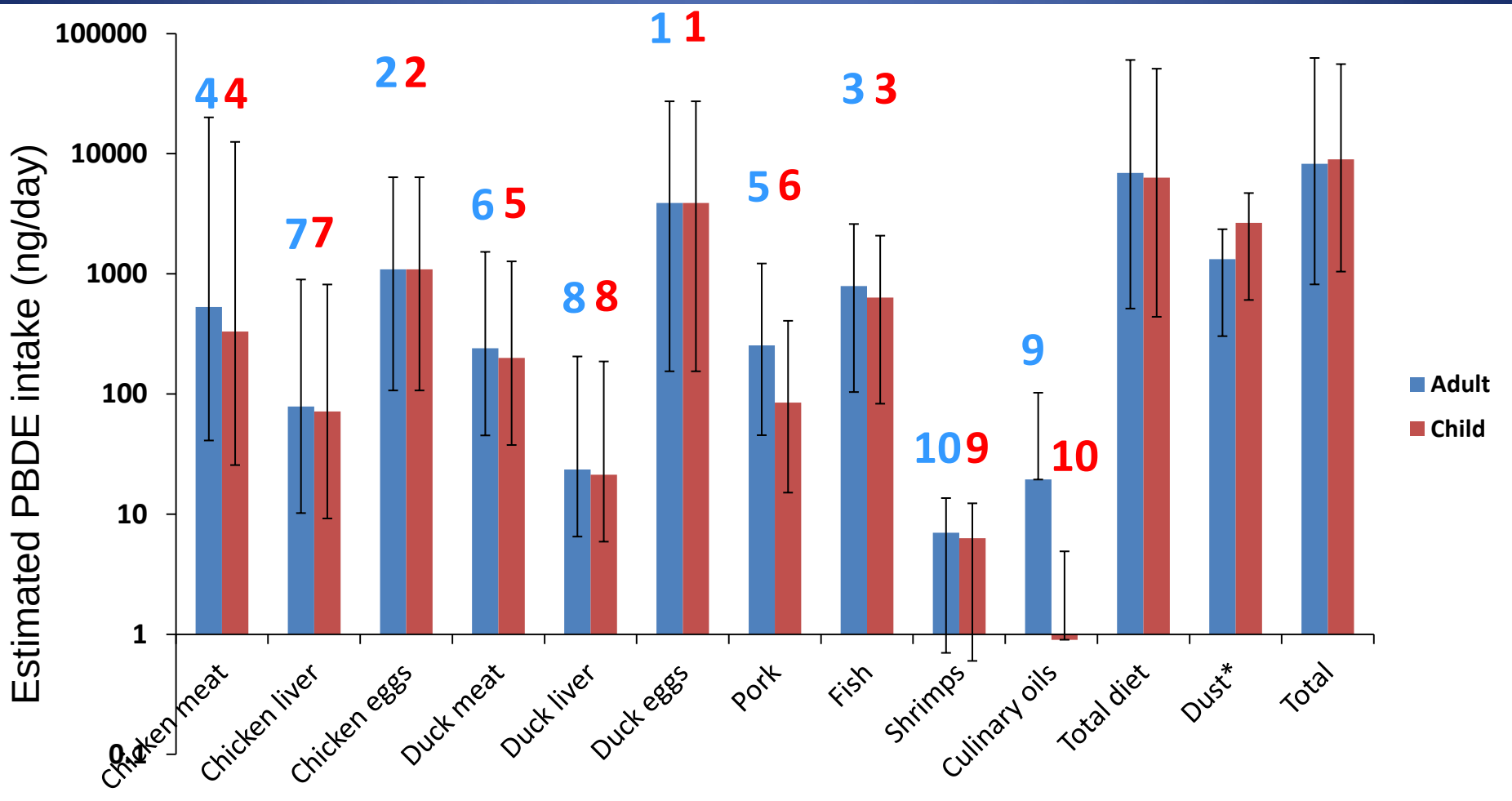
Estimated daily intakes of PBDEs via consumption of food originated from e-waste recycling sites in Taizhou, China



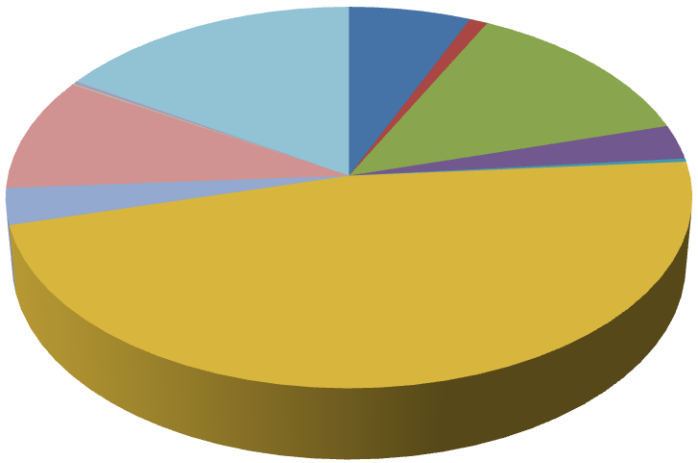
The reading of the lower end of the error bar, the upper end of the column, and the upper end of the error bar represent low, median, and high-end estimates of daily ∑PBDE intakes respectively, based on 5th, 50th , and 95th percentile PBDE concentrations. Duck eggs data – from our previous study (Labunska et al. 2013)

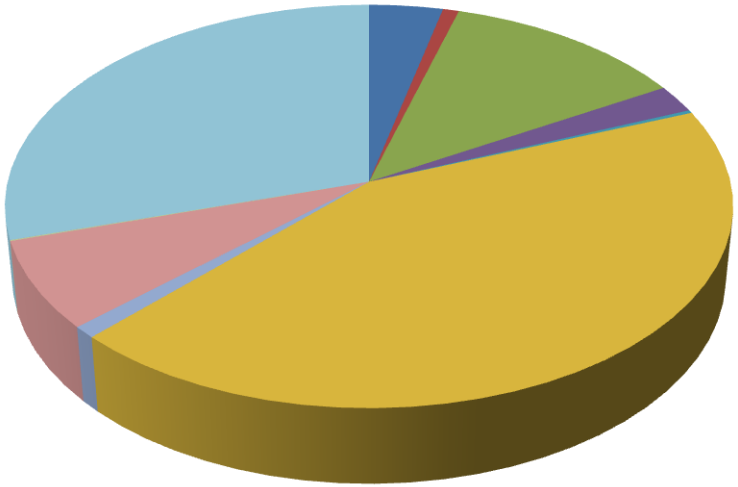
Estimated daily intakes of PBDEs via consumption of food originated from e-waste recycling sites in Taizhou, China



The reading of the upper end of the error bar, the upper end of the column, and the lower end of the error bar represent low, median, and high-end estimates of daily ∑PBDE intakes respectively, which were calculated by multiplying 5th, 50th , and 95th percentile concentrations respectively by average food consumption rates

Contribution of each food type and dust to the estimated daily dietary ∑PBDE median exposure dose in e-waste recycling sites in Taizhou, China





Adult

Child

*calculated based on previously reported data for PBDEs in indoor dust at e-waste sites in Taizhou (Ma *et al.*2009) and dust consumption rates of 0.03 and 0.06 ng/g for adults and children respectively (US EPA 2001).

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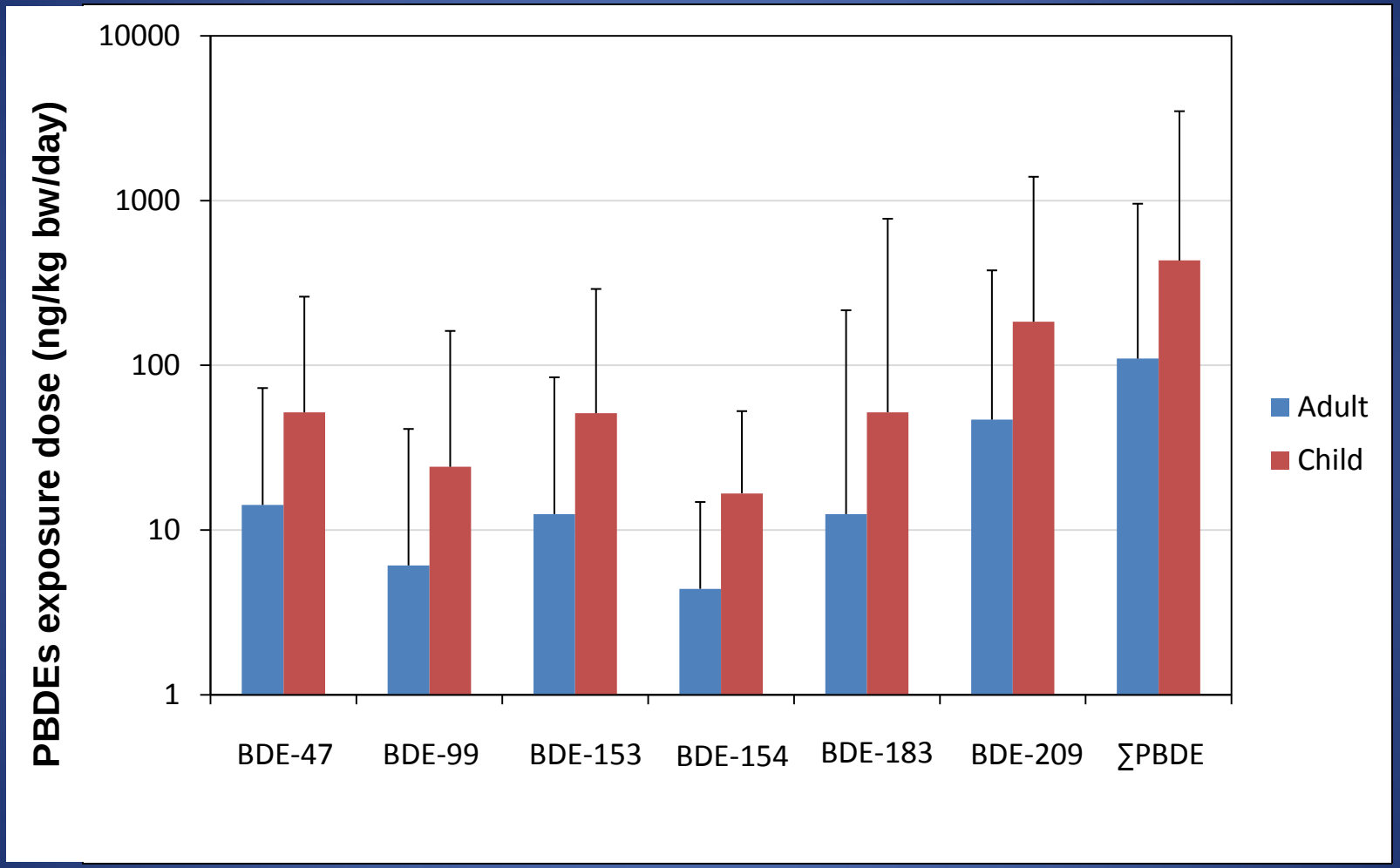
Estimated exposure to ΣPBDEs via consumption of food originating from e-waste recycling sites in Taizhou, China



The reading of the upper end of the column and the upper end of the error bar represents median and high-end estimates respectively.

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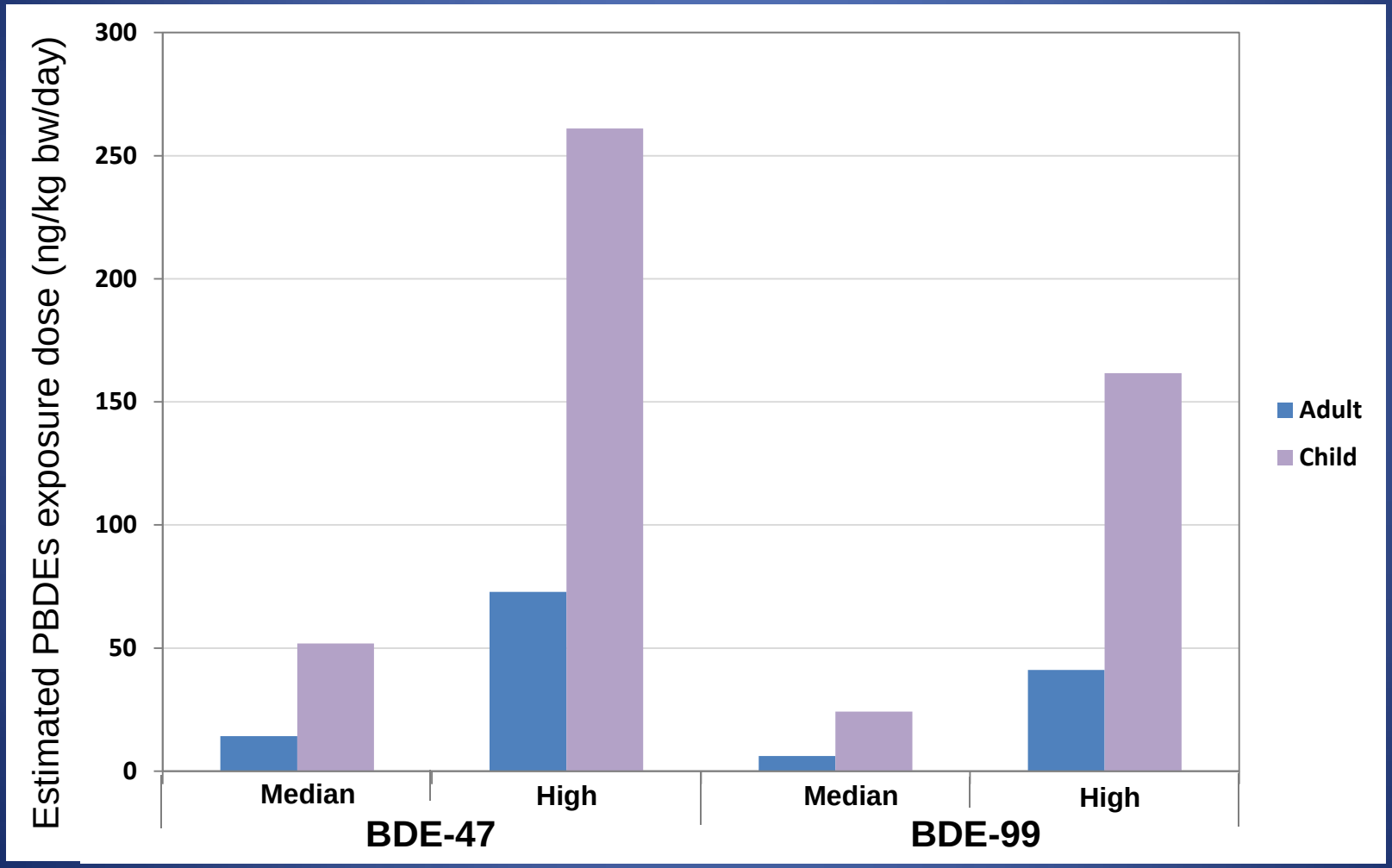
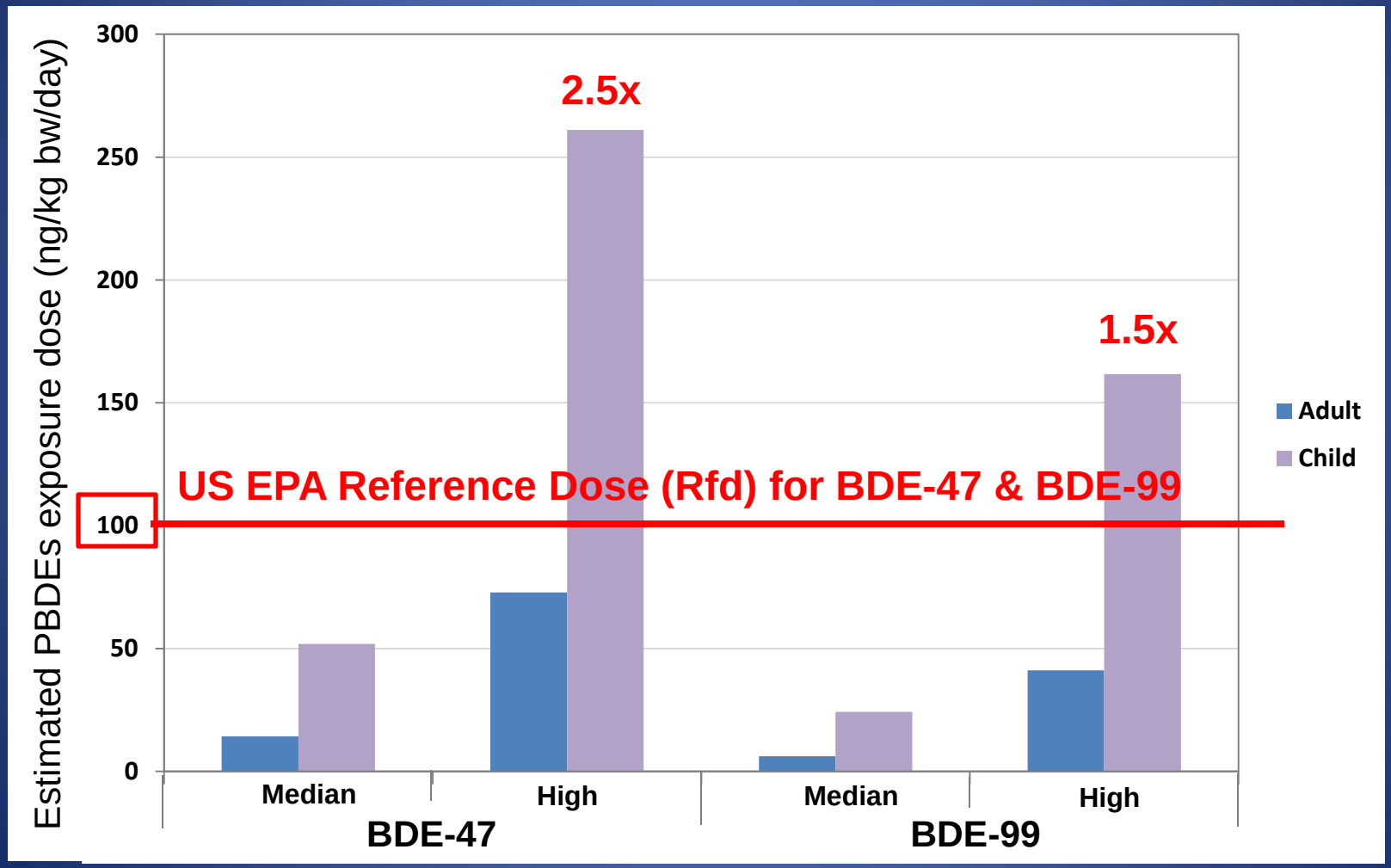
Estimated exposure to BDEs- 47 and -99 via consumption of food originating from e-waste recycling sites in Taizhou, China



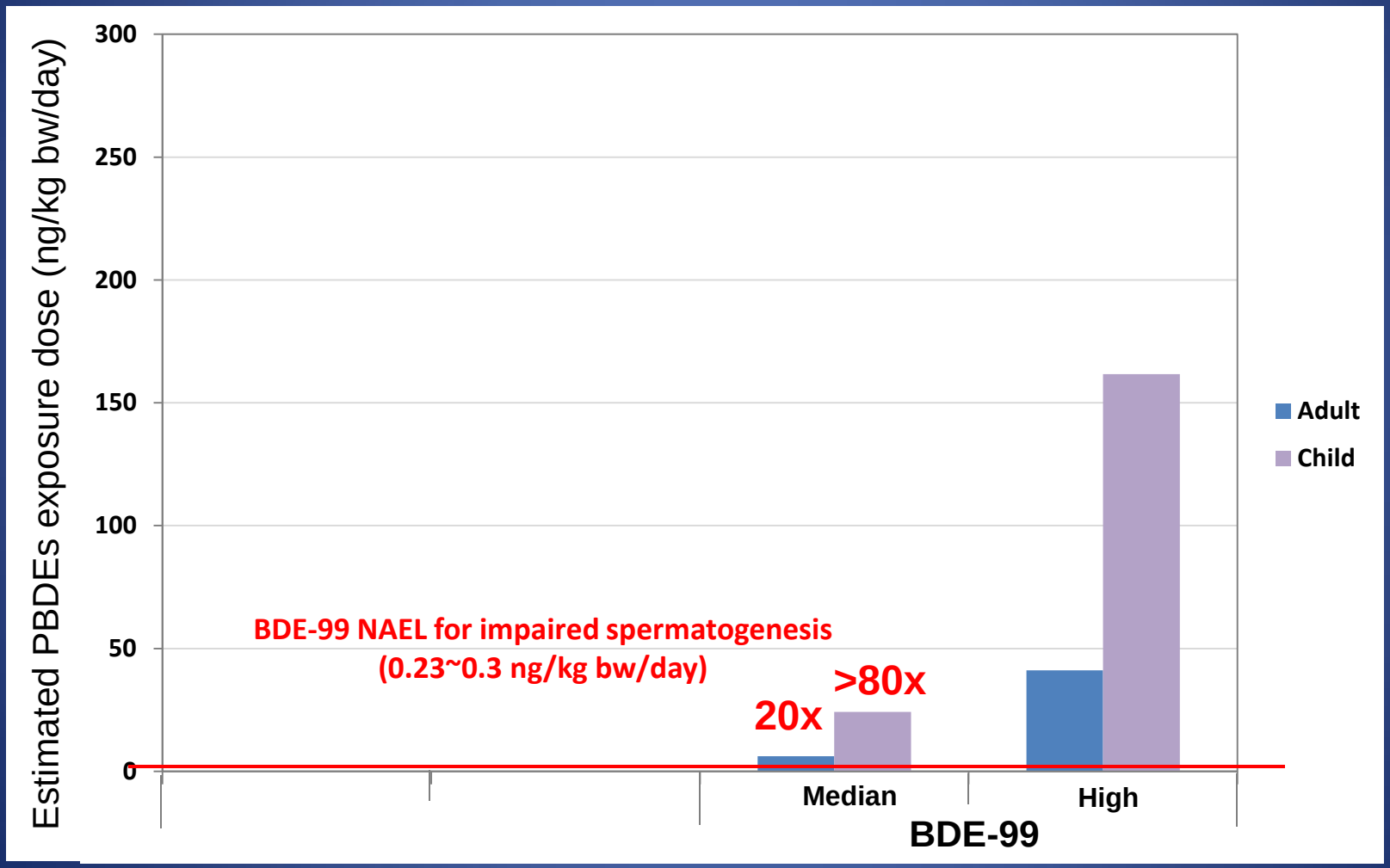
Median and high-end estimates were calculated by multiplying 50th and 95th percentile concentrations respectively by average food consumption rates.

Estimated exposure to BDEs- 47 and -99 via consumption of food originating from e-waste recycling sites in Taizhou, China



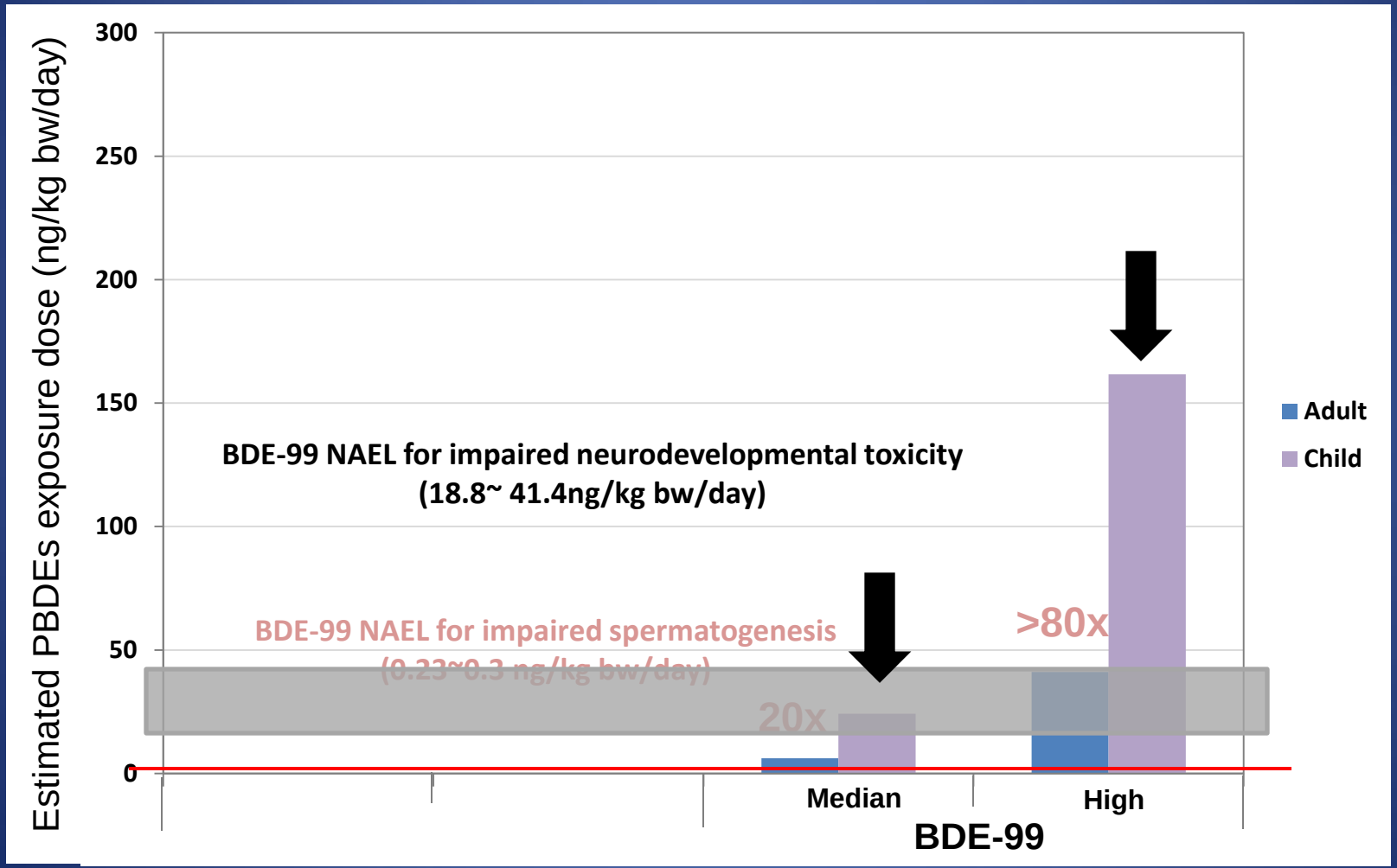
Median and high-end estimates were calculated by multiplying 50th and 95th percentile concentrations respectively by average food consumption rates.

Estimated exposure to BDE-99 via consumption of food originating from e-waste recycling sites in Taizhou, China



Median and high-end estimates were calculated by multiplying 50th and 95th percentile concentrations respectively by average food consumption rates.

Estimated exposure to BDE-99 via consumption of food originating from e-waste recycling sites in Taizhou, China



Median and high-end estimates were calculated by multiplying 50th and 95th percentile concentrations respectively by average food consumption rates.

Conclusions

• Over 120 samples comprising of 10 types of staple food were collected in e-waste recycling areas of Taizhou City, Zhejiang Province, and control sites in China, and analysed for 14 PBDE congeners (from tri- to deca-BDE).

• Average ∑PBDE concentrations in chicken meat, eggs, and liver and duck meat and liver were among the highest reported globally to date.

•The highest estimated contributions to median ∑PBDE intake were associated with consumption of duck eggs (3882 ng/day) and chicken eggs (1091 ng/day), and with consumption of fish by both adults (792 ng/day) and children (634 ng/day).

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Conclusions continued

• Including estimates for ingestion of contaminated dust reported elsewhere, increased ∑PBDE daily intakes by approximately 19% for adults and 42% for children.

• Normalised to body weight, high-end estimates of exposure for young children exceeded the USEPA reference doses (RfD) for BDE-47 and BDE-99 by factors of approximately 2.5 and 1.5 respectively.

•Estimates for median exposure to BDE-99 exceeded by around 20 and 80 times (for adults and children respectively) the no adverse effect level (NAEL) for impaired spermatogenesis. For children, estimates were also close to the NAEL for impaired neurodevelopmental toxicity, whereas the high end exposure estimates exceeded both NAELs.

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Next steps

- Currently underway: investigation of human dietary exposure in the Taizhou e-waste recycling area to a wider range of contaminants through the analysis of composite food samples subject to detailed PBDEs analysis in the current study. This will help identify potential health concerns related to consumption of food containing multiple contaminants.

- To compare estimated dietary exposures in both e-waste and non-e-waste impacted areas in China to evaluate the significance of e-waste treatment as a source of toxic and persistent contaminants in locally produced food.

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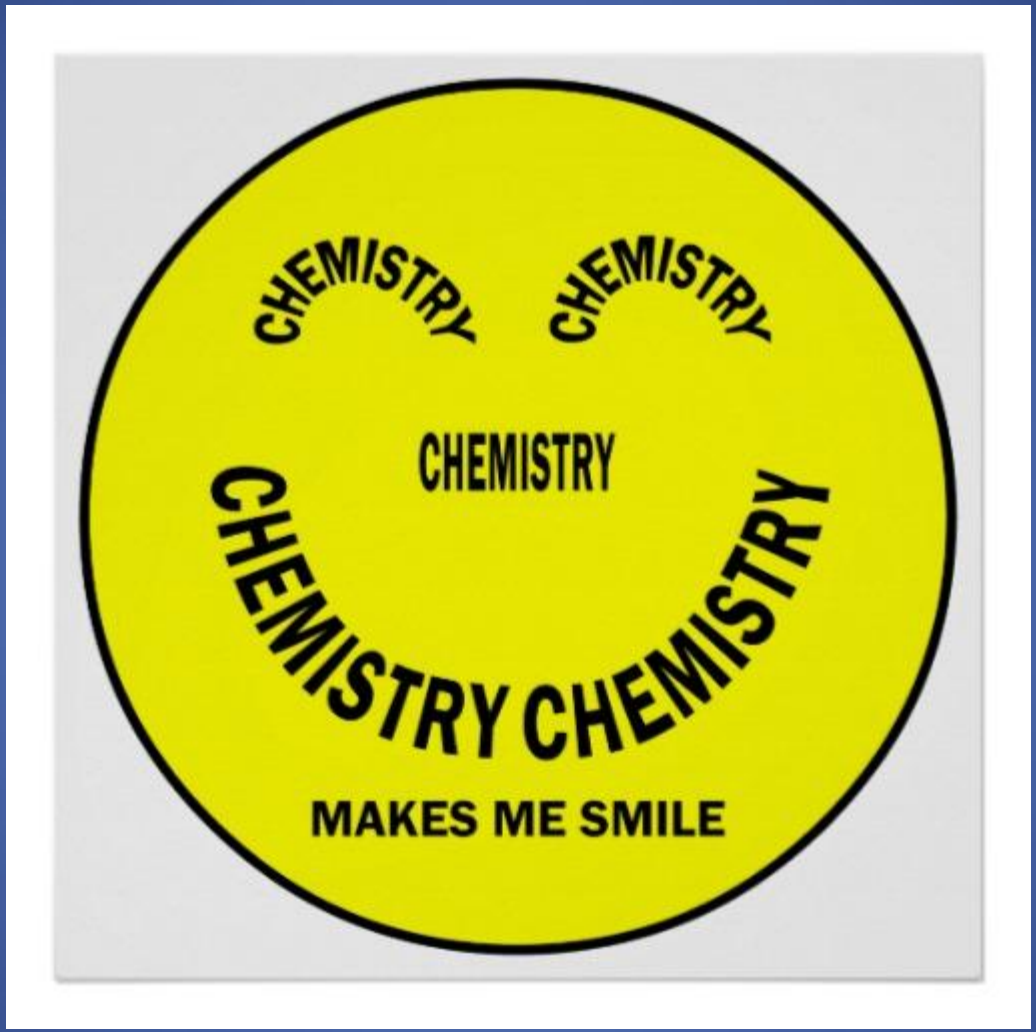
Acknowledgements

We gratefully acknowledge

Prof. Adrian Covaci from Toxicological centre, University of Antwerp, for valuable help in method development; and **Samantha Hetherington** (Greenpeace Research Laboratories) for assistance with samples preparation.

Thank you for your attention !



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References

Ma, J.; Addink, R.; Yun, S.H.; Cheng, J.; Wang, W.; Kannan, K. Polybrominateddibenzo-p-dioxins/ dibenzofurans and polybrominateddiphenyl ethers in soil, vegetation, workshop-floor dust, and electronic shredder residue from an electronic waste recycling facility and in soils from a chemical industrial complex in eastern China. *Environ. Sci. Technol.***2009,***43*, 7350–7356.

US EPA. Exposure factors handbook, EPA/600/R-090/052F. National Center for Environmental Assessment, Washington, DC (Chapter 5). **2011**http://www.epa.gov/ncea/efh/pdfs/efh-complete.pdf.

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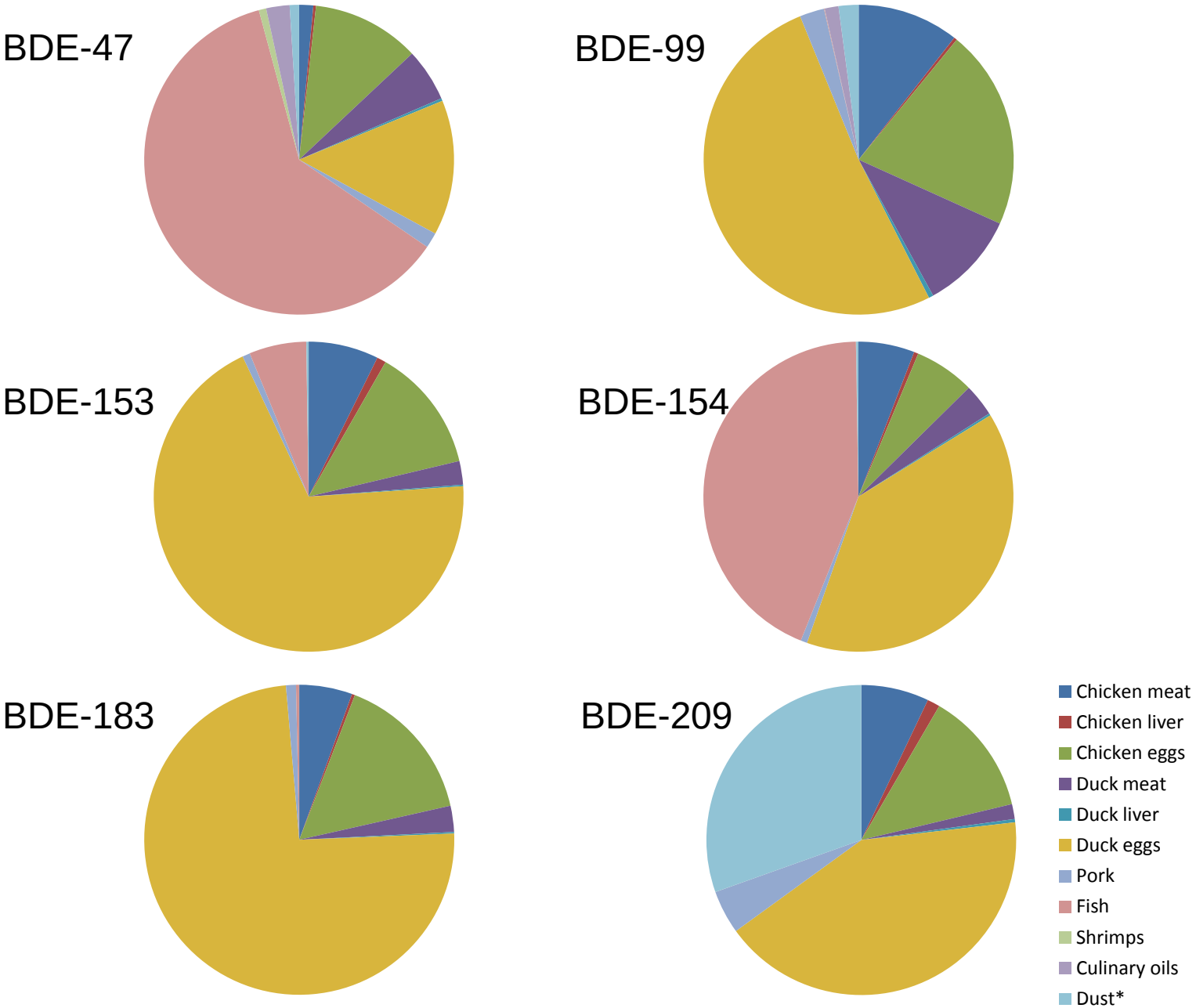
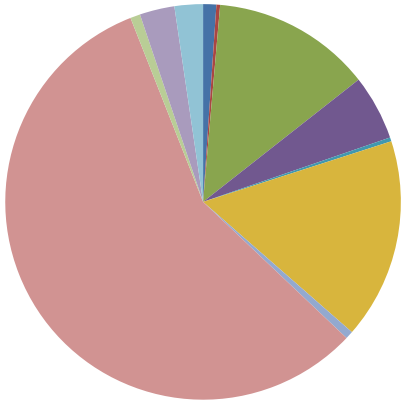
Daily dietary ∑PBDE exposure contribution: ADULT



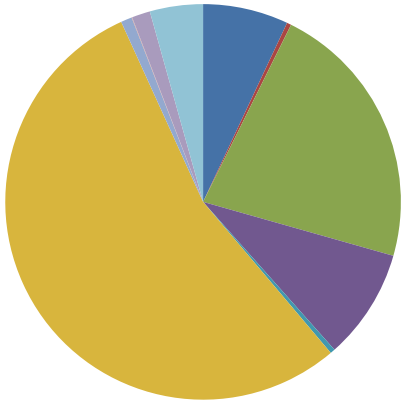
Note: Based on median exposure (50th percentile)

Daily dietary ∑PBDE exposure contribution: CHILD

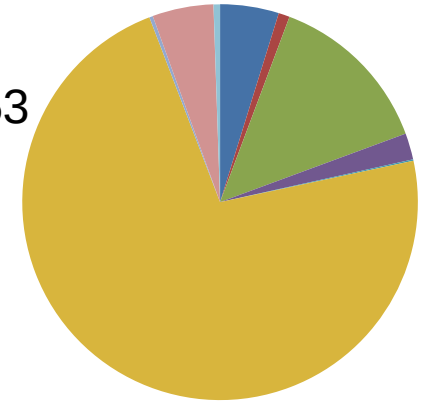
BDE-47



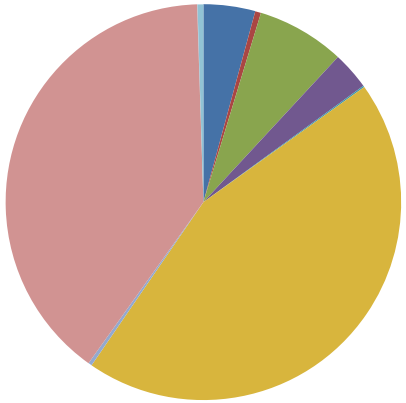
BDE-99



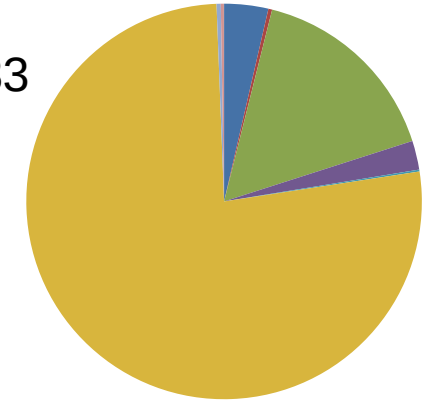
BDE-153



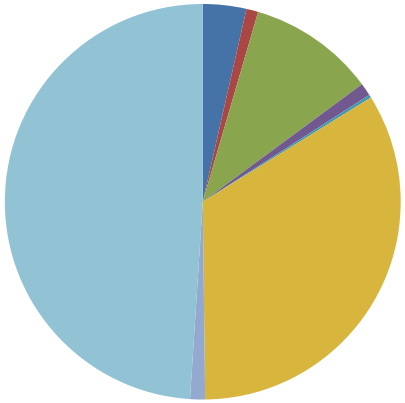
BDE-154



BDE-183



BDE-209



- Chicken meat
- Chicken liver
- Chicken eggs
- Duck meat
- Duck liver
- Duck eggs
- Pork
- Fish
- Shrimps
- Culinary oils
- Dust*

Note: Based on median exposure (50th percentile)