

A Comparison of Halogenated Fire Retardant Levels and Known Health Effects in Humans and Wildlife

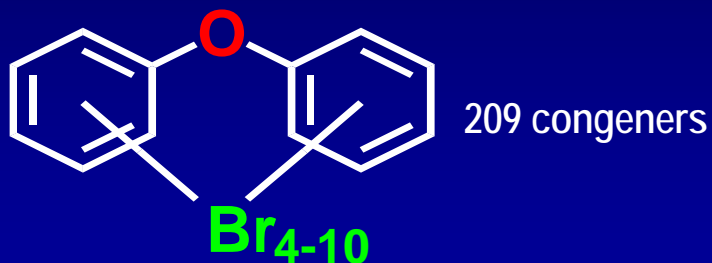
Susan D. Shaw, DrPH
Director

Marine Environmental Research Institute
Center for Marine Studies USA

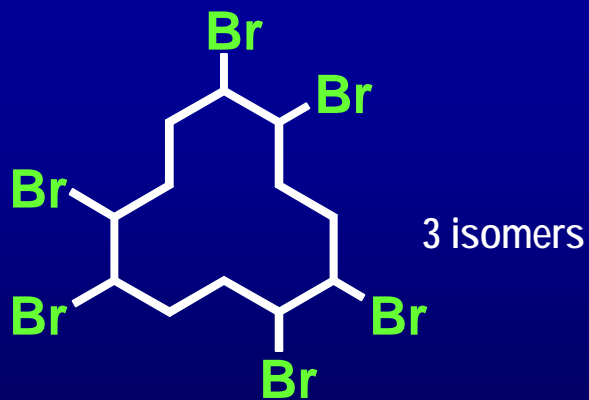
The Fire Retardant Dilemma in China: Exposure and Epidemiology Issues
Green Science Policy Symposium, Western Academy of Beijing, China
August 22, 2009

Brominated Flame Retardants

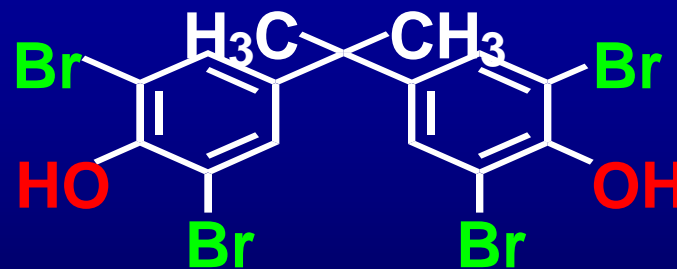
Persistent, bioaccumulative, toxic



Polybrominated diphenyl ethers (PBDEs)

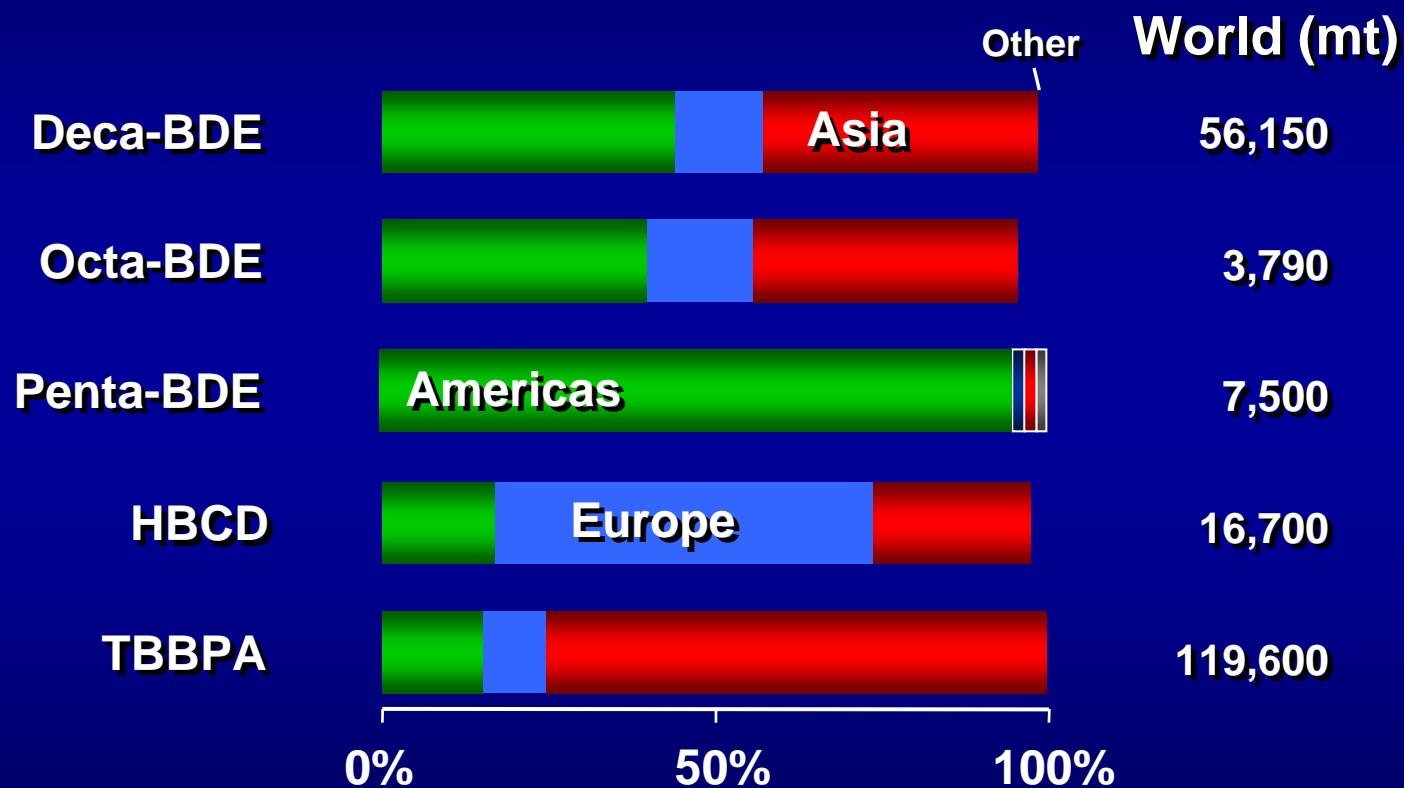


Hexabromocyclododecane (HBCD)



Tetrabromobisphenol A (TBBPA)

Global Consumption of BFRs in 2001



Data: BSEF 2003, Watanabe & Sakai, 2003

PBDE Levels in Americans

ng/g lipid

20 ng/g lw

blood/serum

milk

cord serum

adipose

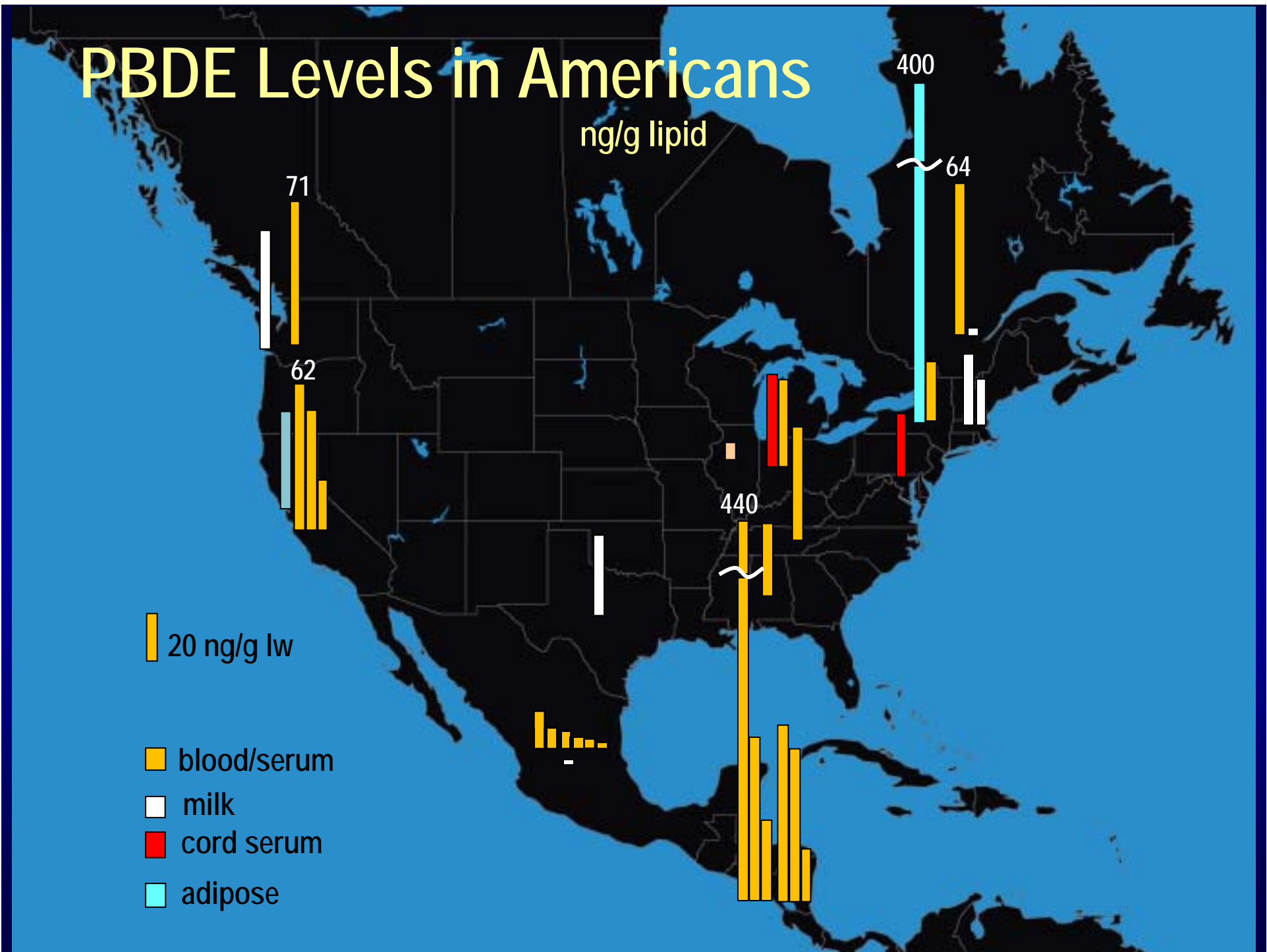
71

62

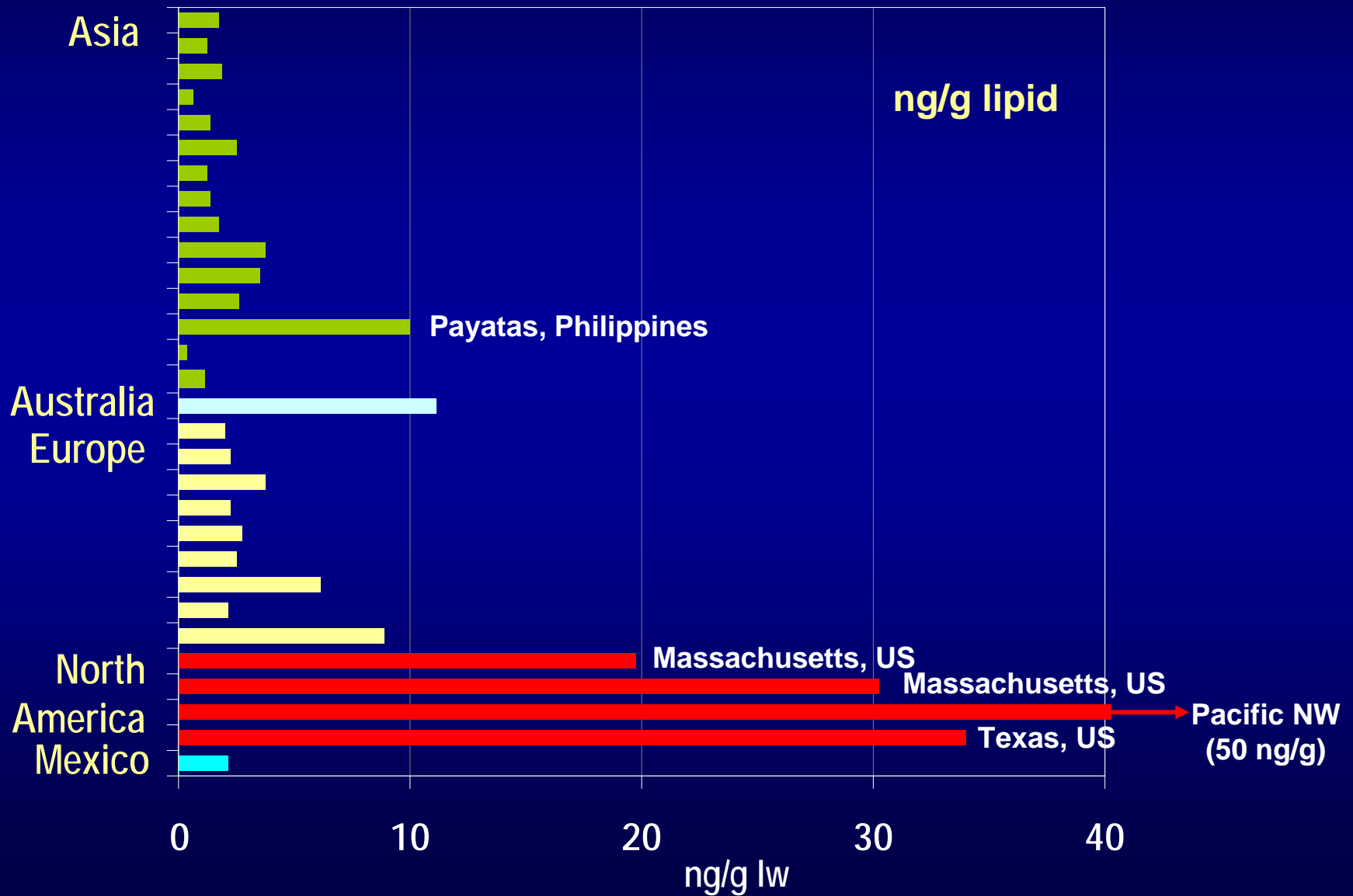
440

400

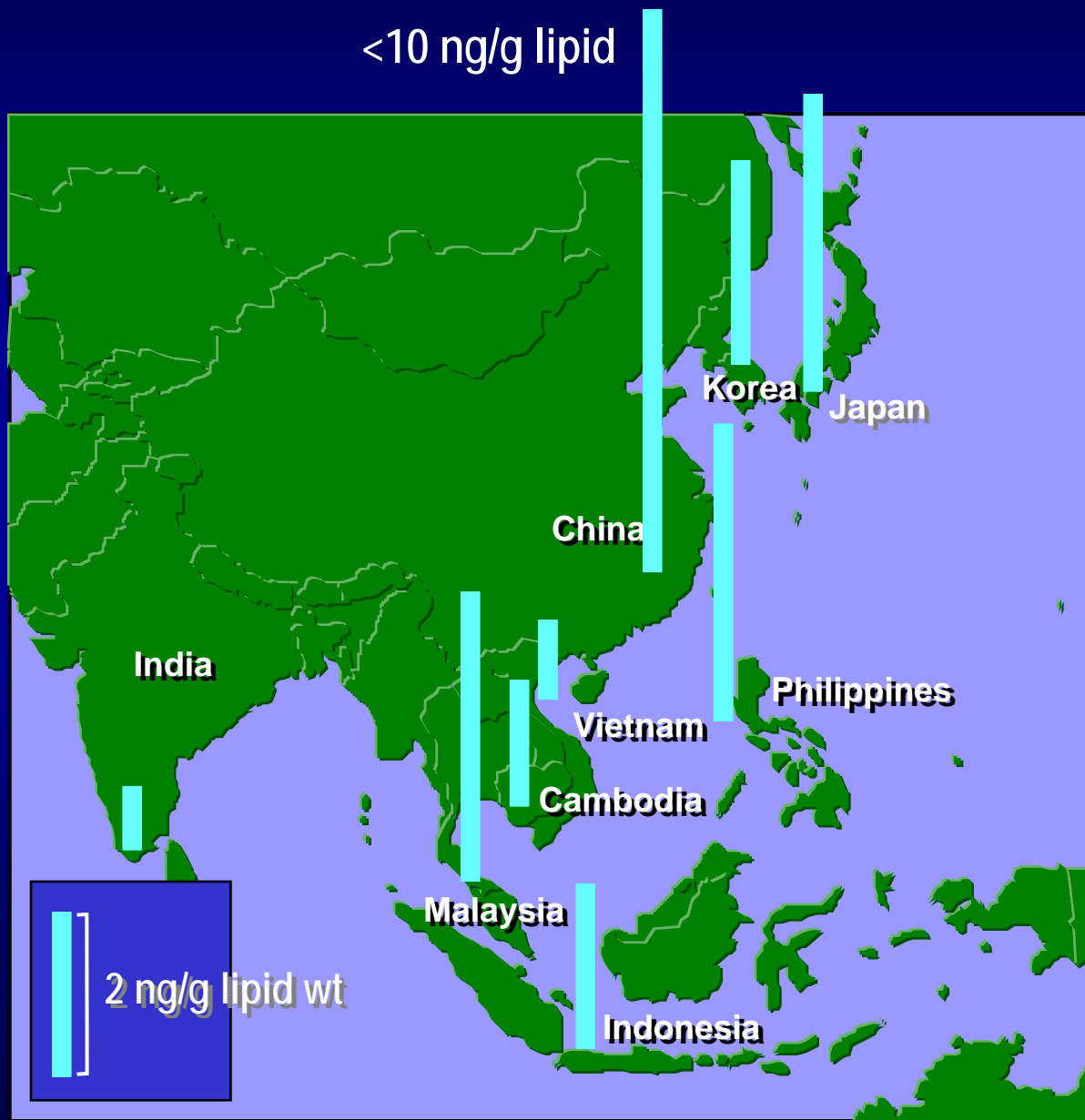
64



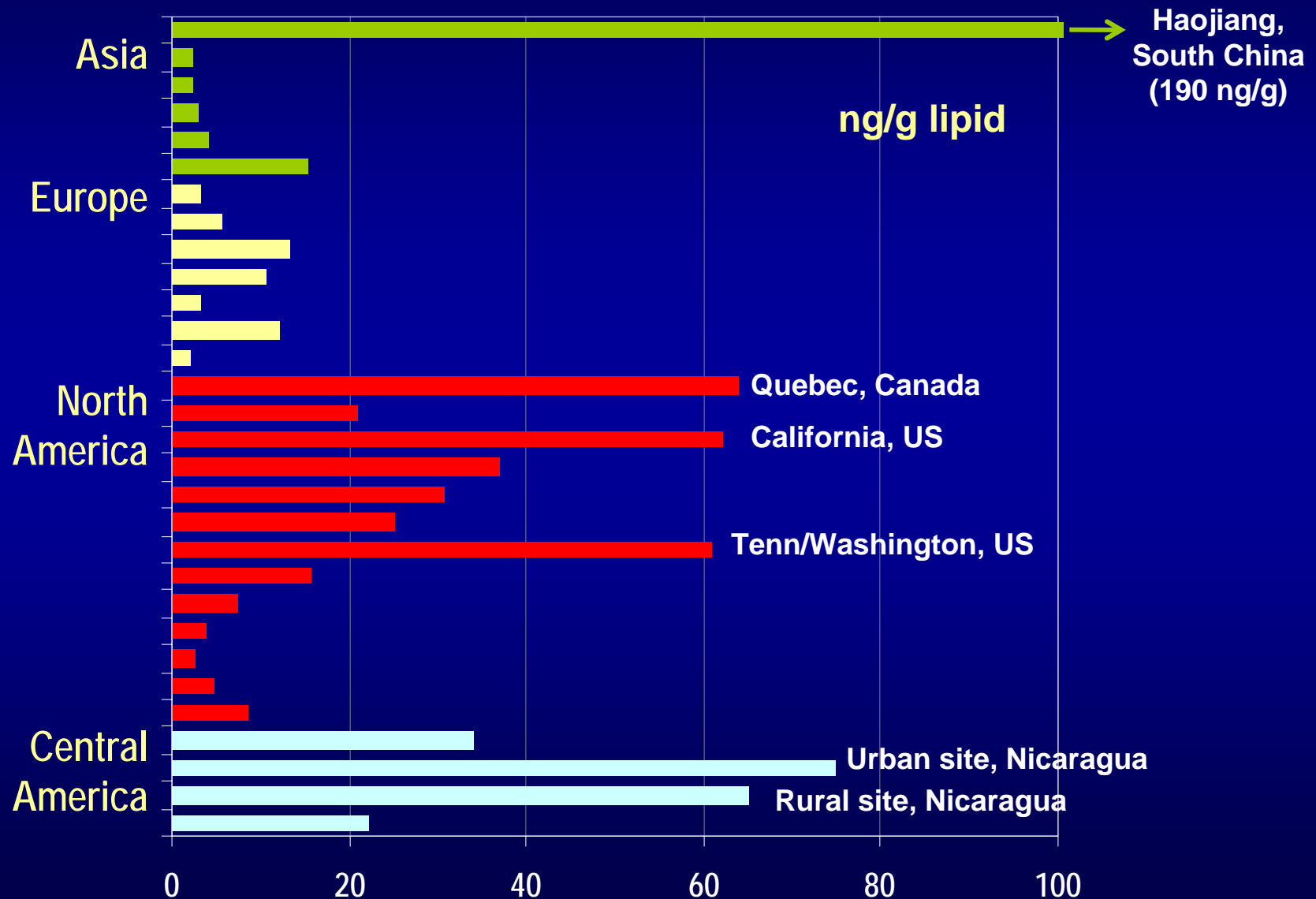
Comparison of PBDE Levels in Human Milk



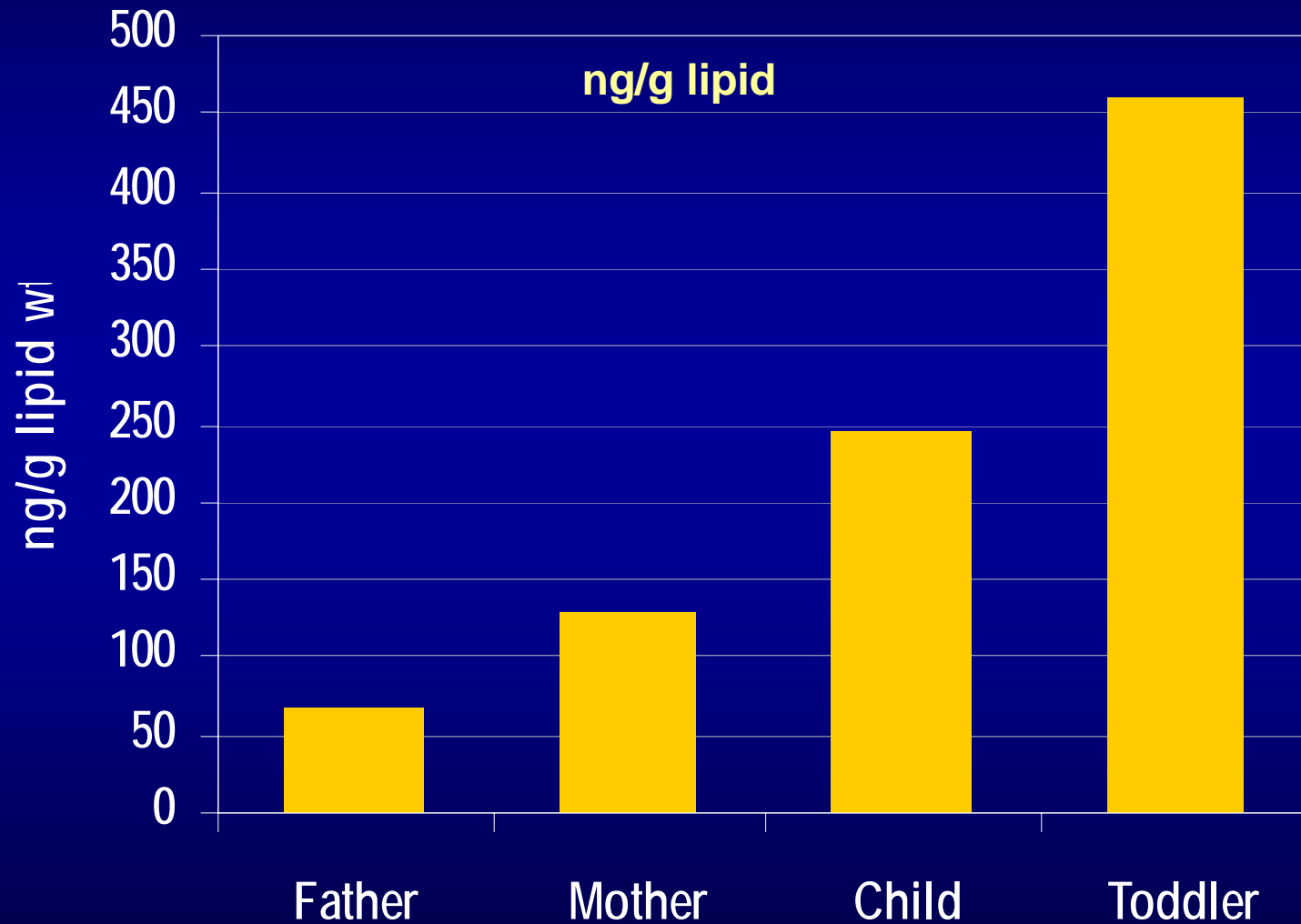
PBDEs in Human Breast Milk from Asia



Comparison of PBDE Levels in Human Blood



Serum PBDE Levels in a California Family



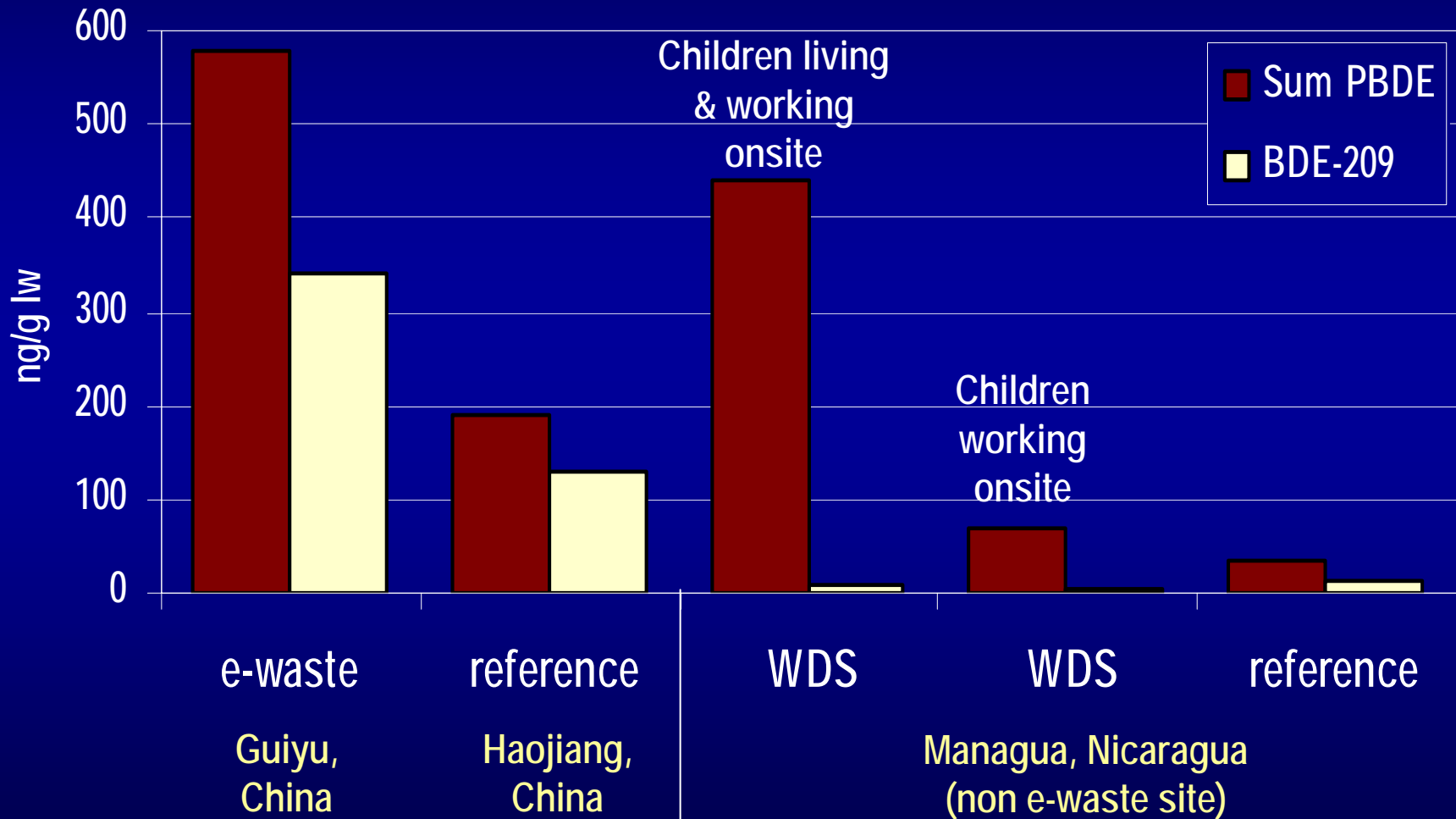
Fisher et al. EHP 2006

Highly Exposed Populations



E-waste Recycling
Guangdong Province
South China

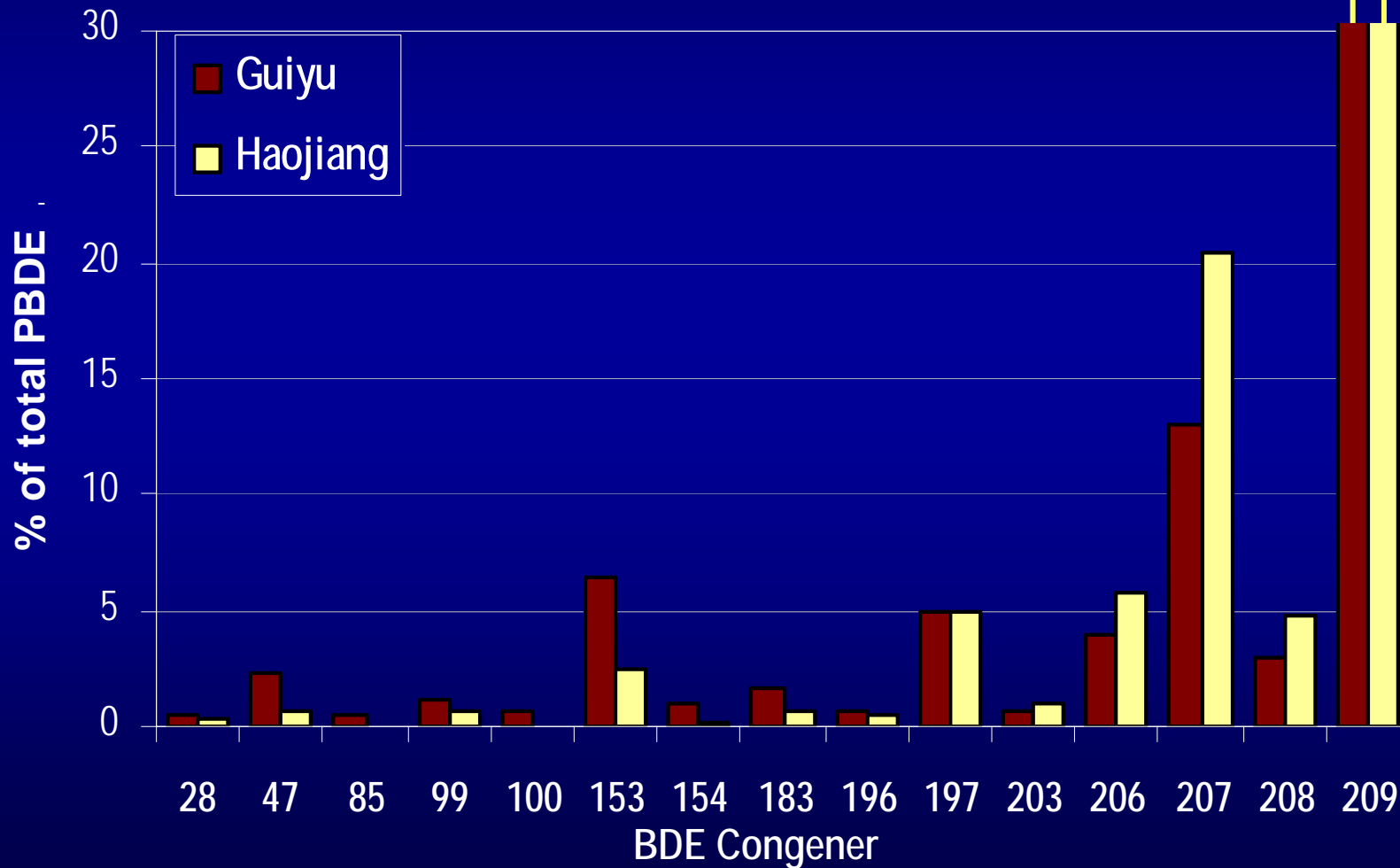
Highest PBDE Levels in Blood of Humans at Waste Disposal Sites



Data: Bi et al. *ES&T* 2007, Athanasiadou et al. *EHP* 2007

PBDE Congeners in Blood of Humans, Guiyu and Haojiang, South China

Deca-BDE 59% 68%



Data: Bi et al 2007

BFRs in Wildlife: Raptors



Peregrine Falcon (*Falco peregrinus*)
Potter et al. *ET&C* 2009, Johansson et al. *ET&C* 2009



Bald Eagle (*H. leucocephalus*)
McKinney et al. 2006, *ES&T*,
Gooddale 2008, BRDI



Osprey (*Pandion haliaetus*)
Goodale *BDR* 2008, Rattner et al.
Arch Env Cont Tox 2004, Toschik et al.
ET&C 2005



Sparrow Hawk (*Accipiter nisus*)
Chen et al. *ES&T* 2007, Voorspoels et al. *ES&T* 2007

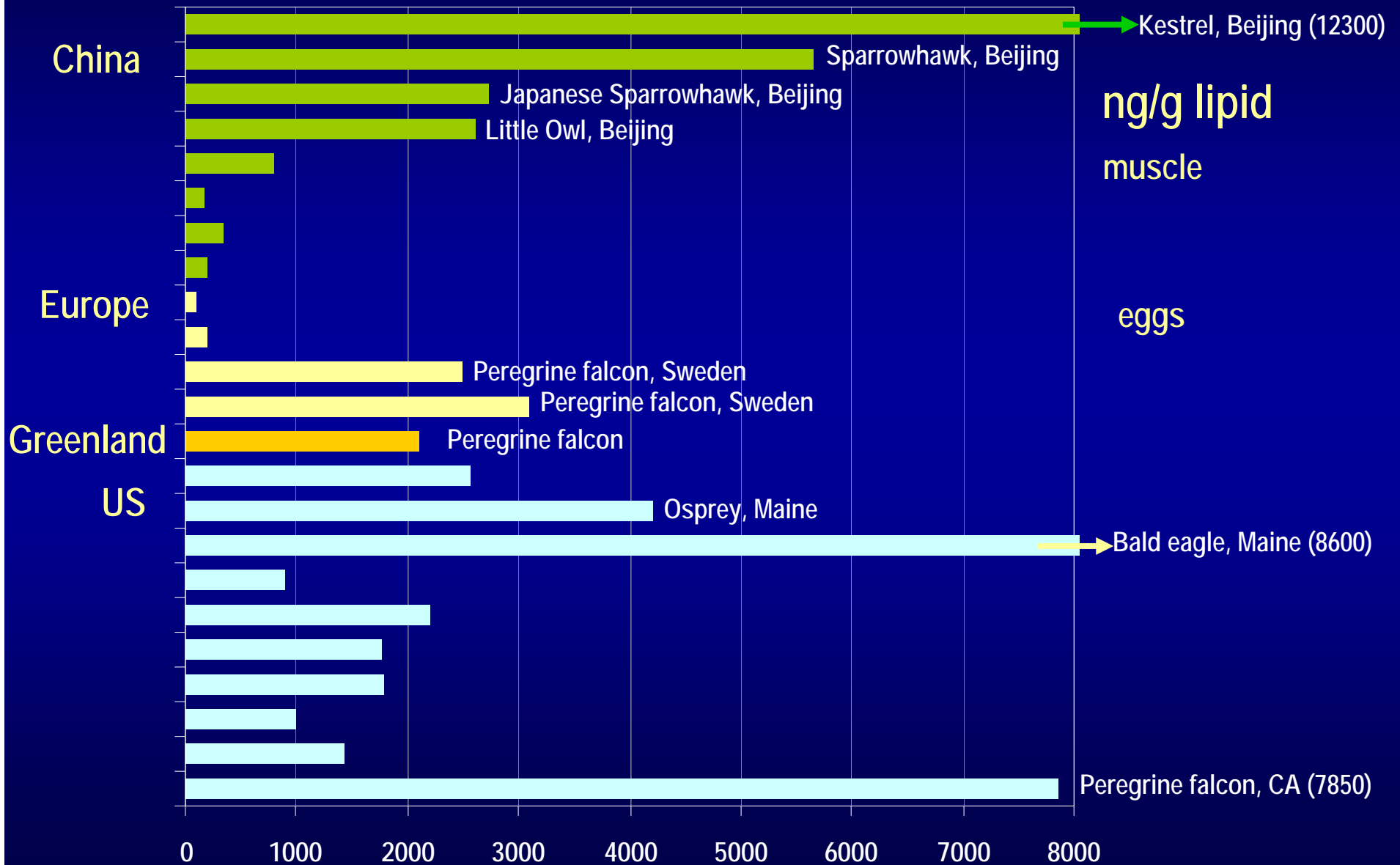


Buzzard (*Buteo buteo*) Chen et al.
ES&T 2007, Voorspoels et al. *ES&T*
2007



Common Kestrel (*Falco tinnunculus*) Chen et al. *ES&T* 2007

Comparison of PBDE Levels in Raptors



BFRs in Seabirds



Caspian Tern (*Sterna caspia*)
She et al. Chemosphere 2008



Least Tern (*Sterna antillarum*)
She et al. Chemosphere 2008,
Gooddale BRDI 2008



Forster's Tern (*Sterna forsteri*)
She et al. Chemosphere 2008



Herring Gull (*Larus argentatus*)
Gooddale BRDI 2008, Helgason et
al. ET&C 2009

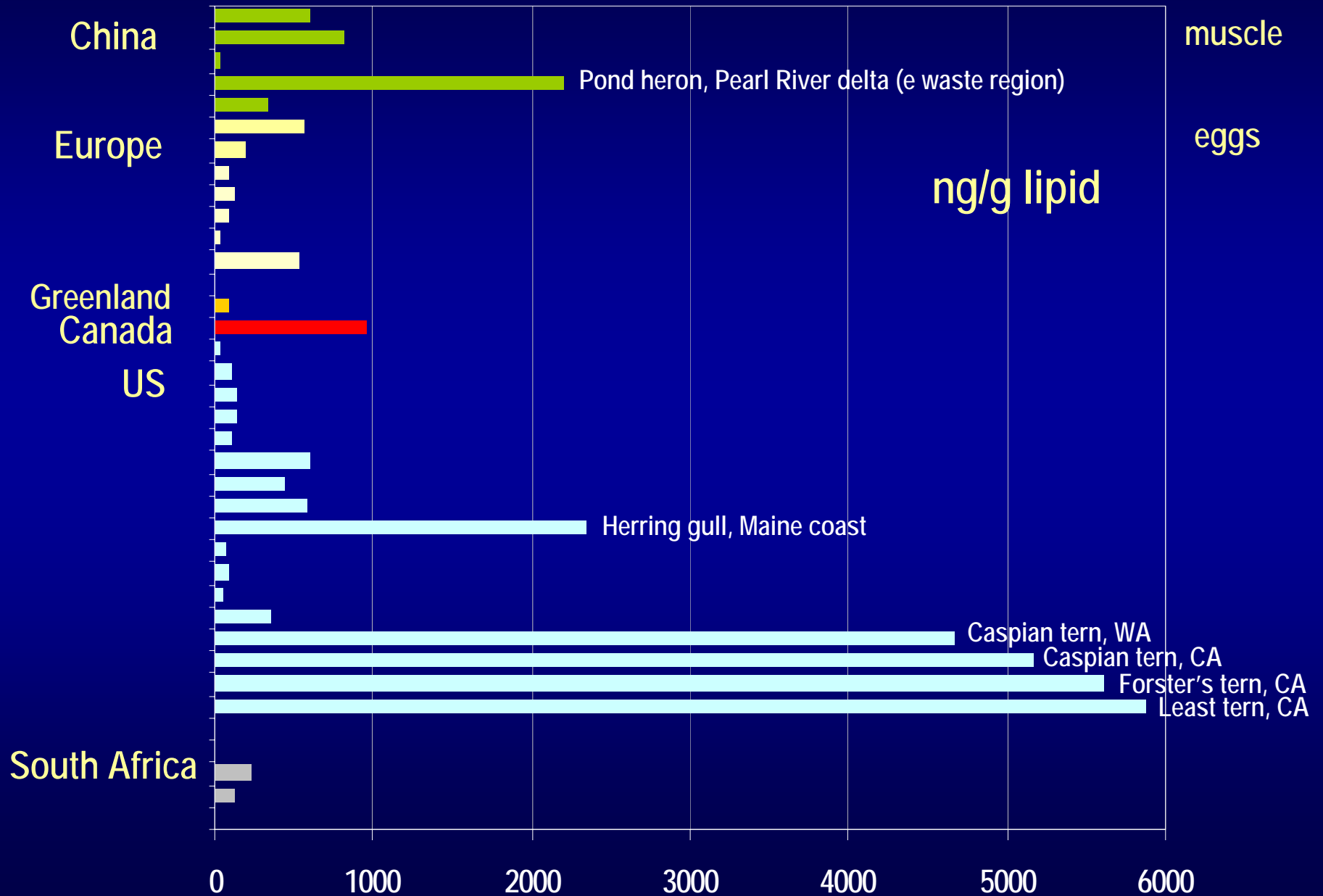


Chinese Pond Heron
(*Ardeola bacchus*) Luo et al. ES&T
2008



Glaucous Gull (*Larus hyberboreus*)
Vander Pol et al. Env Poll 2009, Verreault
et al. ES&T 2005

Comparison of PBDE Levels in Seabirds



BFRs in Pinnipeds



Harbor seal (*Phoca vitulina*)

Shaw et al. 2008, Meng et al. 2009, Law et al. 2003



Sea lion (*Zalophus californianus*)

Meng et al. 2009, Stapleton et al. 2006



Gray seal (*Halichoerus grypus*)

Ikonomou & Addison 2008



Ringed seal (*Pusa hispida*)

Riget et al. 2006, Johansen et al. 2004



No. elephant seal (*M. angustirostris*)

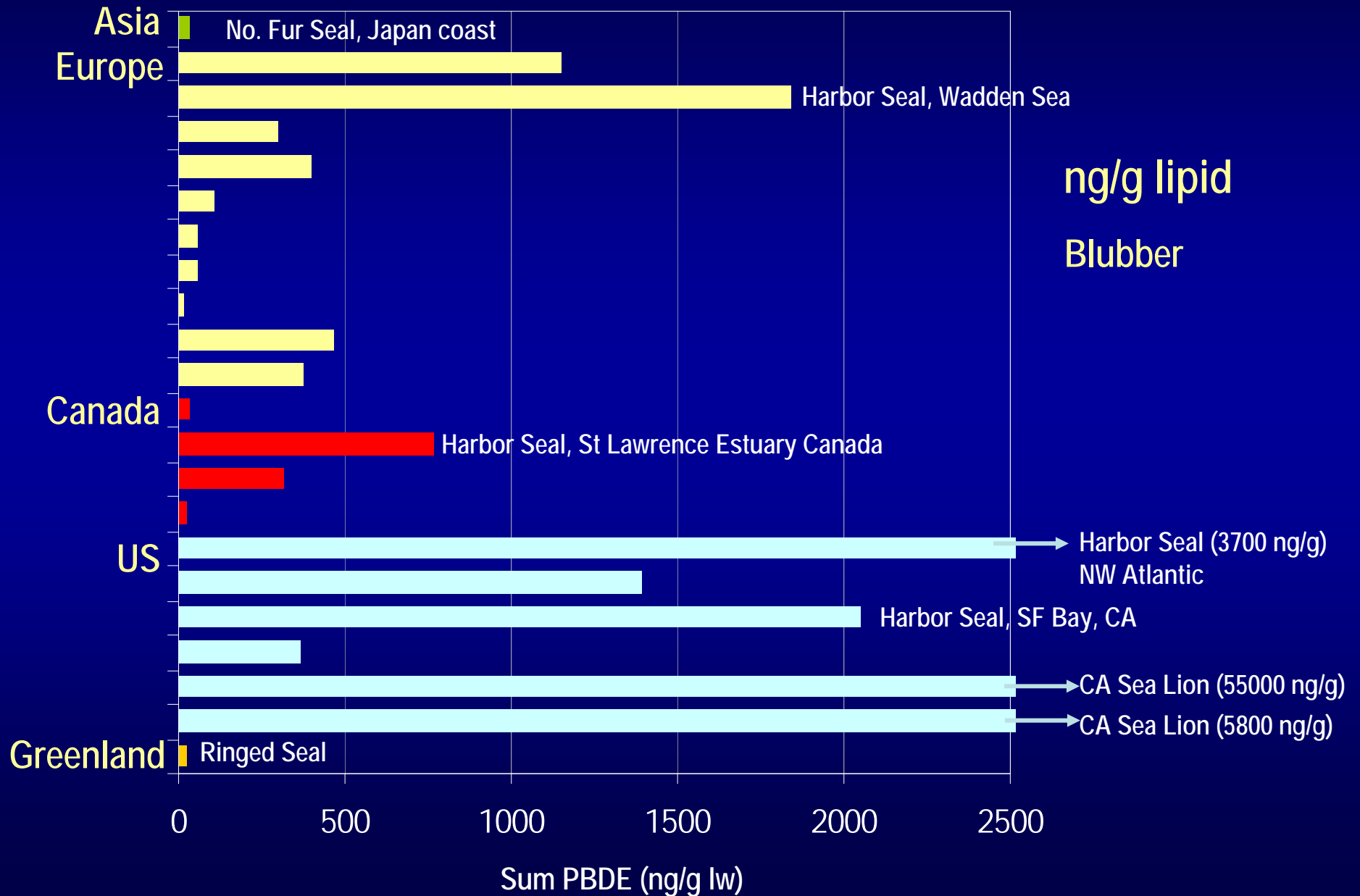
Meng et al. 2009



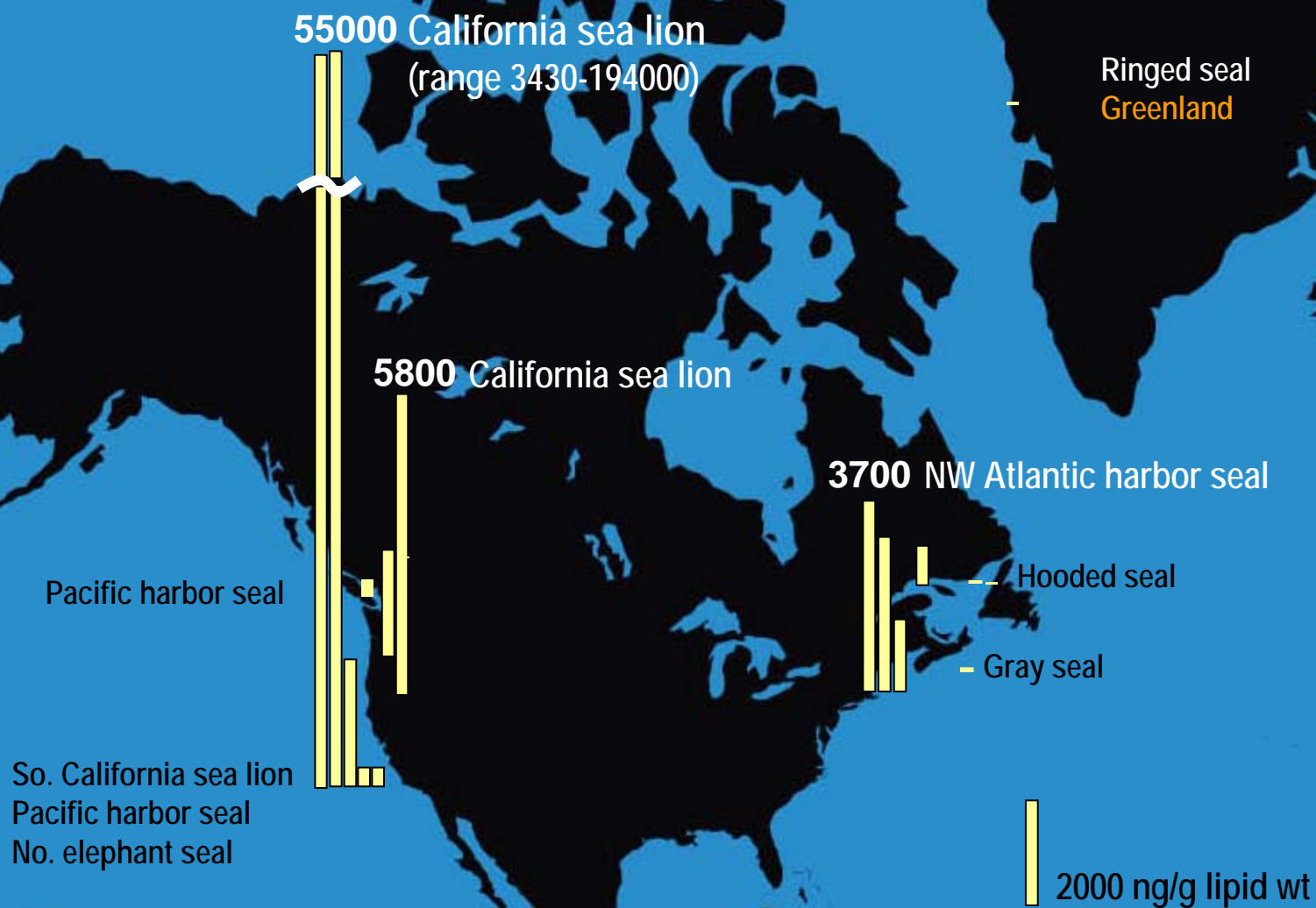
Harp seal (*P. groenlandica*)

Johansen et al. 2004

Comparison of PBDE Levels in Pinnipeds



PBDEs in North American Pinnipeds



BFRs in Cetaceans



Beluga whale (*Delphinapterus leucas*)
Law et al. 2003, Lebeuf et al. 2004



Harbor porpoise (*Phocoena phocoena*)
Law et al. 2002, Beineke et al. 2005



Killer whale (*Orcinus orca*)
Rayne et al. 2002, Krahn et al. 2007



Bottlenose dolphin (*T. truncatus*)
Fair et al. 2007, Johnson-Restrepo et al. 2005

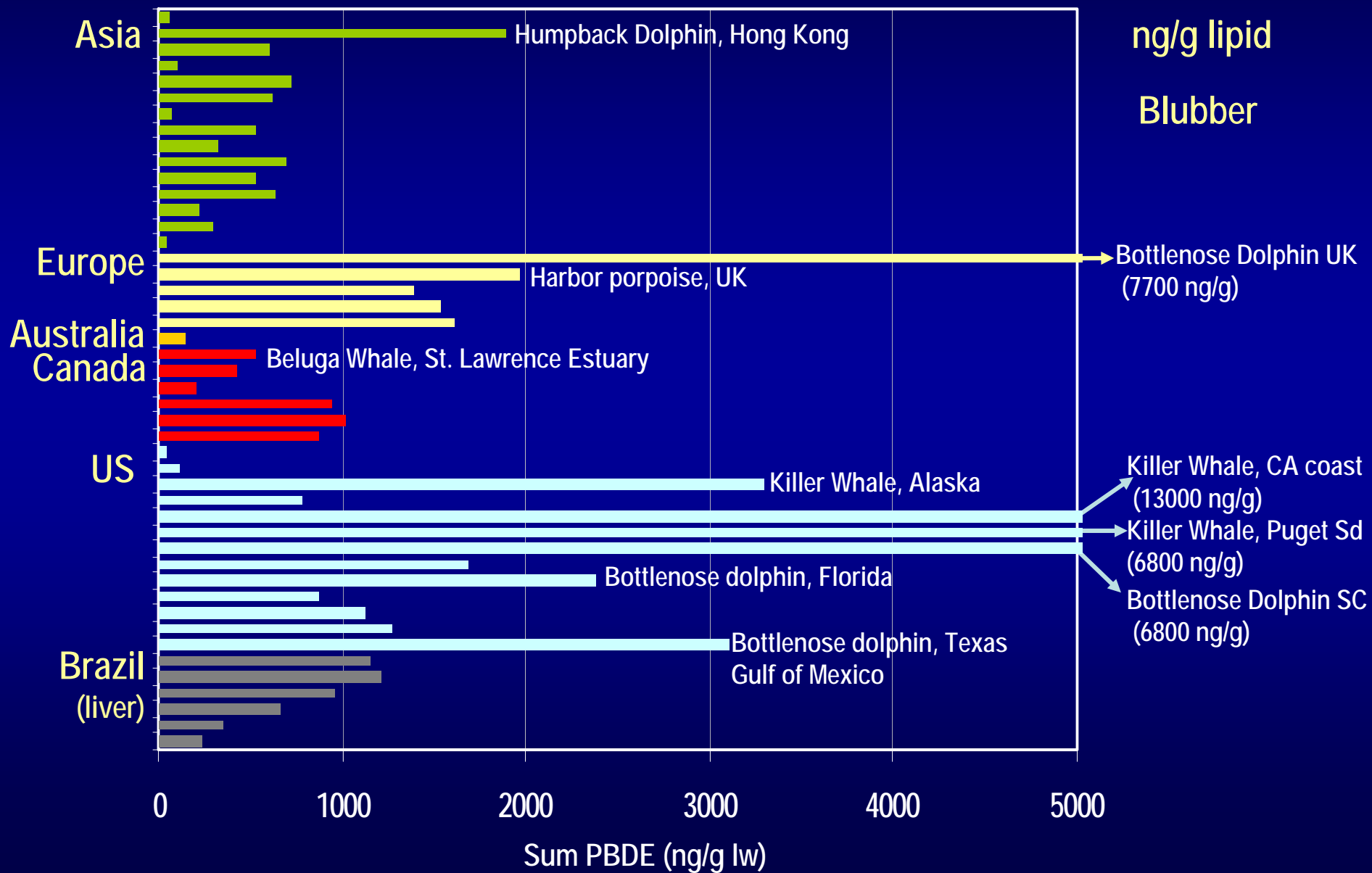


White-sided dolphin (*L. obliquidens*)
Tuerk et al. 2005

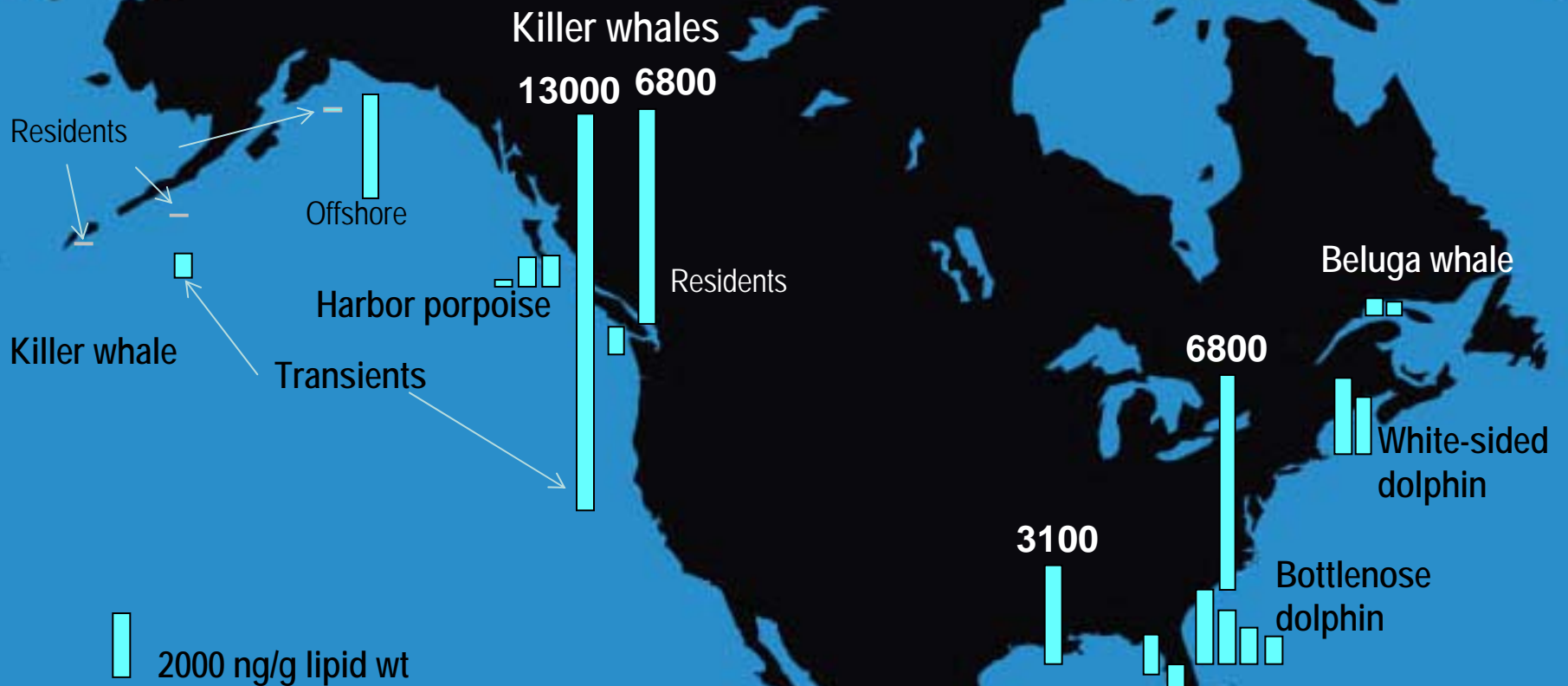


Striped dolphin (*S. coeruleoalba*)
Isobe et al. 2009

Comparison of PBDE Levels in Cetaceans



PBDE Levels in North American Cetaceans



PBDE Levels in Cetaceans from Asia

Finless porpoise



Striped dolphin



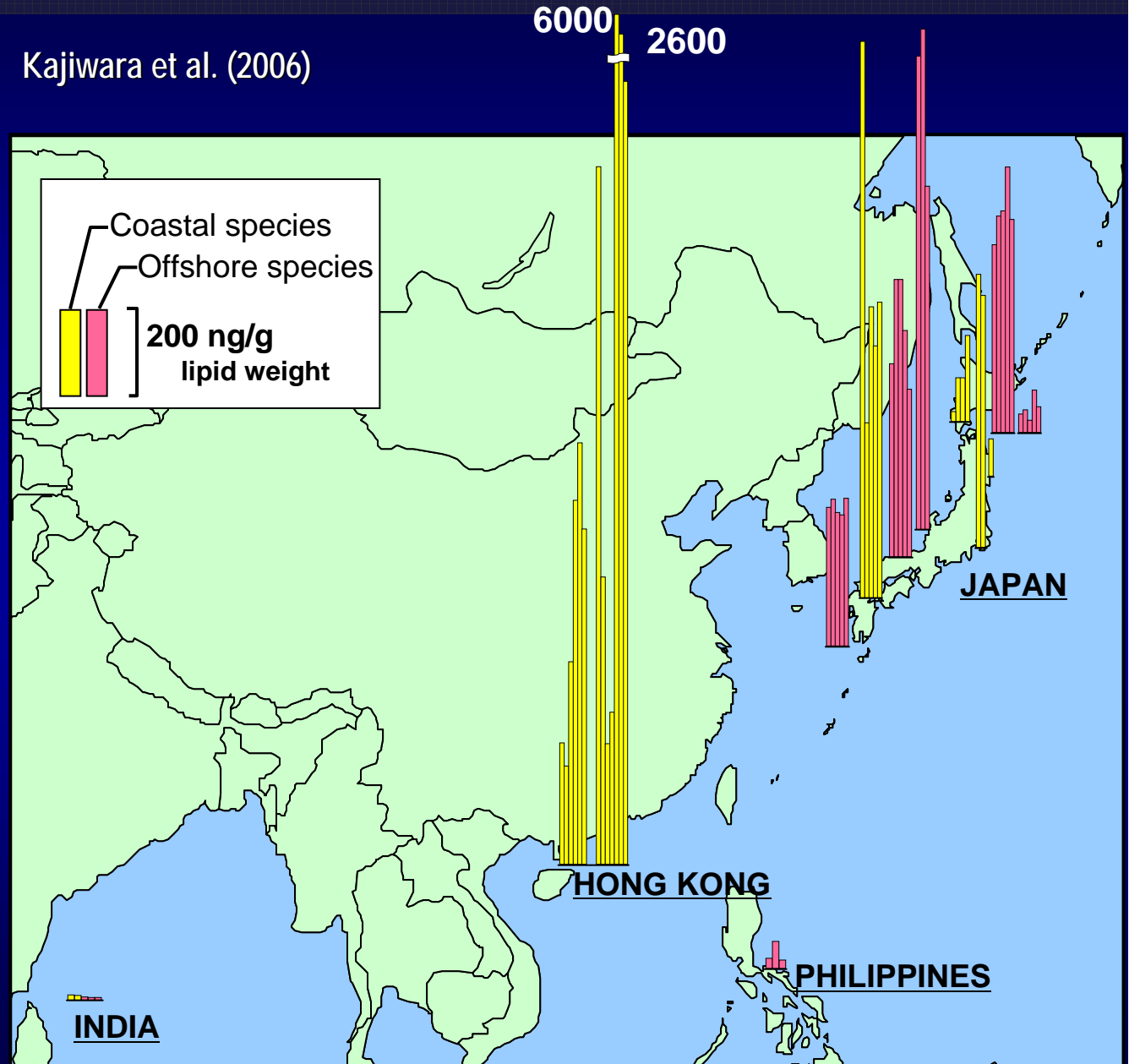
Melon-headed Whale



Dall's porpoise



Kajiwara et al. (2006)



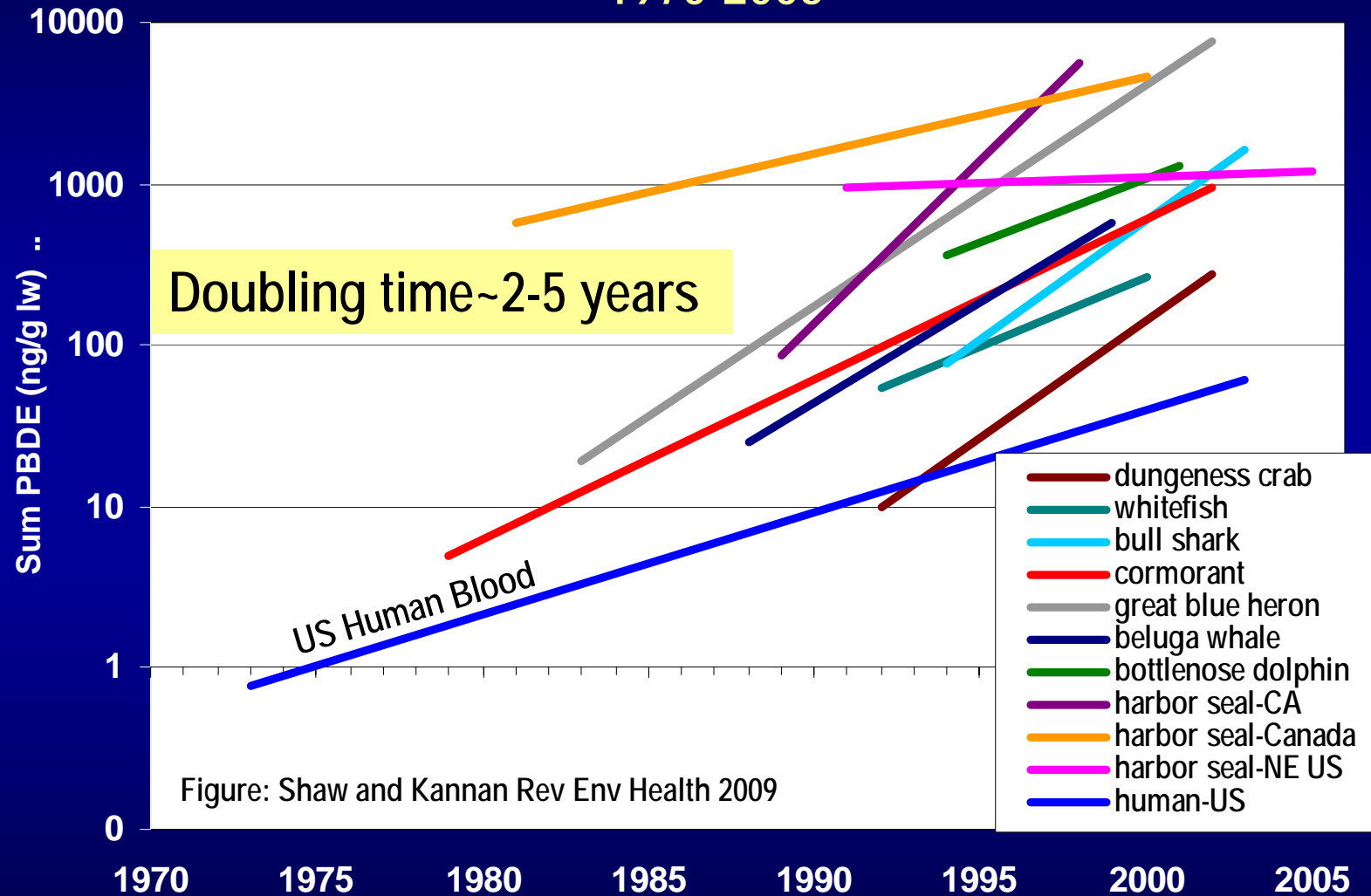
Temporal Trends



Northern Fur Seal

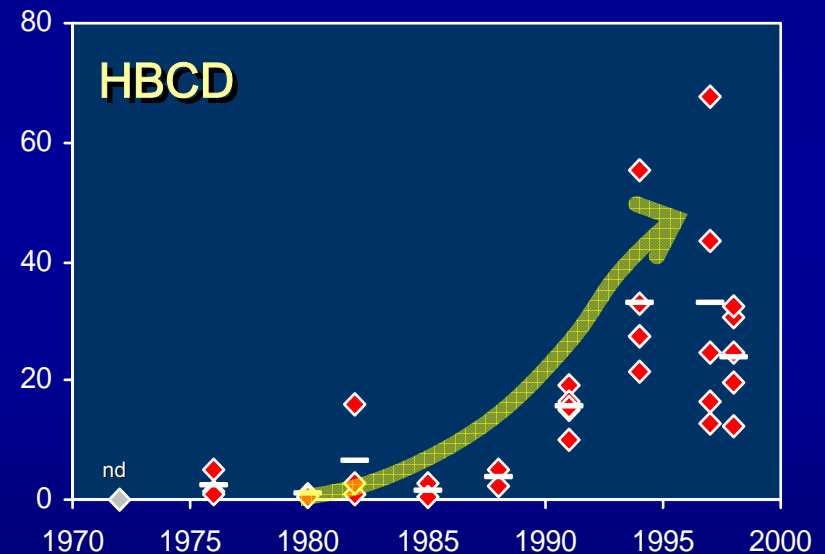
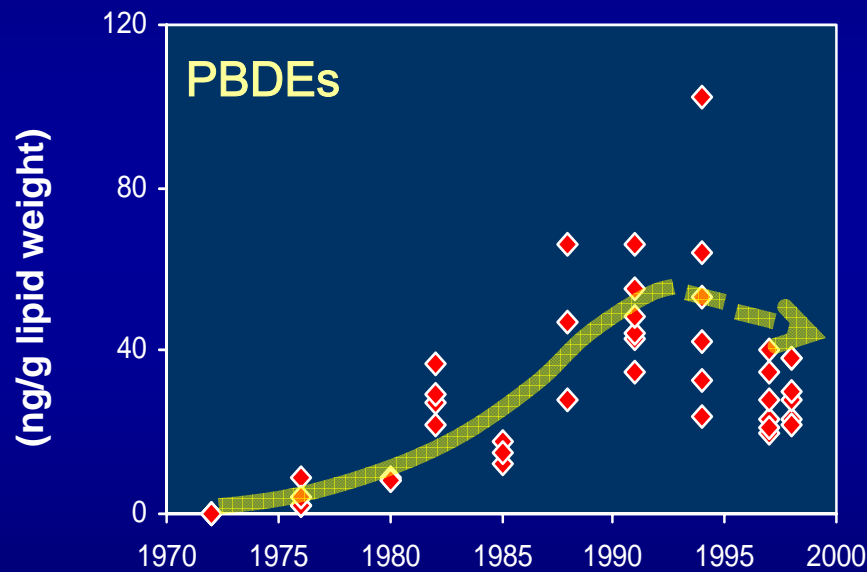
PBDEs Increasing in North America

1970-2005



Data: Schechter et al. 2005, Ikonomidou et al 2002, 2006, Rayne et al 2003, Johnson-Restrepo et al 2005, Elliott et al 2005, Lebeuf et al 2004, She et al 2002, Shaw et al 2008

PBDEs Constant, HBCDs Increasing in Northern Fur Seals, Japan 1970 - 2000



Data: Kajiwara et al. 2004, 2006

Toxic Effects of Penta-BDE in Wildlife

- Complete reproductive failure in mink
- Eggshell thinning, infertility in kestrels, peregrine falcons, osprey
- Altered thyroid hormones, low survival in seals



Data: Zhang et al. *Env Tox Chem* 2008, Martin et al. *Env Tox Chem* 2007, Fernie et al. *ES&T* 2009, McKernan et al. *Env Toxicol Chem* 2009, Johnansson et al. *Environ Toxicol Chem* 2009, Hall et al. *Env Poll* 2003, Hall and Thomas *Env Tox Chem* 2007, Hall et al. *Env Sci Technol* 2009

"New BFRs" - Potentially Persistent, Bioaccumulative, Toxic PBDE Alternatives

Chemical	Primary Uses
Hexabromocyclododecane (HBCD)	insulation, textiles, thermoplastics
Tetrabromobisphenol-A (TBBPA)	printed circuit boards, thermoplastics
Decabromodiphenylethane (DBDPE)	thermoplastics
1,2-Bis(2,4,6 tribromophenoxy) ethane (BTBPE)	thermoplastics
Pentabromoethylbenzene (PBEB)	textiles, adhesives, coatings, polyurethane foam
Hexabromobenzene (HBB)	thermoplastics?
Dechlorane Plus [®]	electrical wires/cables, computer connectors, plastic roofing materials
Firemaster 550 [®]	polyurethane foam

“新的溴化阻燃剂” – 潜在持久性, 生物蓄积性, 有毒PBDE的替代物

Chemical	Primary Uses
六溴环十二烷(HBCD)	绝缘, 纺织材料, 热塑性塑料
四溴双酚A (TBBPA)	印制电路底板, 热塑性塑料
十溴二苯乙烷(DBDPE)	热塑性塑料
1,2-二(2,4,6-三溴苯氧基)乙烷 (BTBPE)	热塑性塑料
Pentabromoethylbenzene (PBEB)	纺织材料, 粘合剂, 涂料, 聚氨酯泡沫
六溴苯 (HBB)	热塑性塑料?
得克隆, 双(六氯环戊二烯)环辛烷 (DRCP) [Dechlorane Plus®]	电线, 电缆, 电子连接插件, 塑料屋面材料
聚氨酯软泡沫(FPF)阻燃剂[Firemaster 550®]	聚氨酯泡沫

致谢...

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---and my colleagues worldwide