

Marine Pollution:

The Toxic Legacy of Our Consumer Culture



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GEO Blue Planet Symposium
College Park, MD May 31-June 2, 2017

Greenhouse Gases

Convergence of Stress

- Alteration of climate & ocean chemistry
- Oceans warming (store 9/10 of heat trapped by greenhouse gases), melting ice at poles
- Acidification (CO₂) = loss of corals by 2050
- Toxicity increasing – increasing pollutant distribution, potency (metabolism)
- Species extinctions
- Sea level rise, extreme weather, human displacement

“Living Better With Chemistry.”

DDT c. 1949

Petrochemicals and plastics post WWII





Dilution Is The Solution









An aerial photograph showing a coastline with green land on the left and a deep blue ocean on the right. The text is overlaid on the ocean area.

The Plastic Sea

By 2050 the oceans could contain more plastic than fish by weight

**8 billion pieces of plastic enter
the oceans every year**



The Problem of Plastics

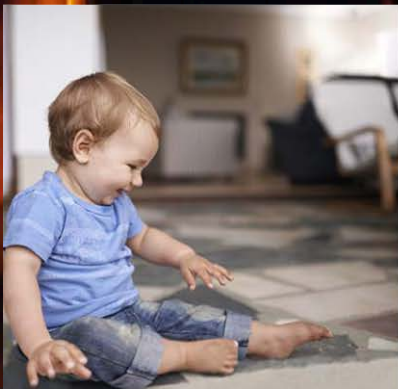
- 46,000 pieces per sq mile of ocean
- Degrade to microplastics, last 100+ years
- Contain and adsorb toxic chemicals (PCBs, phthalates, flame retardants)
- Eaten by fish, then people, effects uncertain





Entanglement in Plastic

Flame Retardants (PBDEs, polybrominated diphenyl ethers)



Clothing, textiles, mattresses, upholstery, TVs, computers, plastics, electronics, building materials, house dust and food
Endocrine disruptors, IQ loss in children, cancer

Perfluorinated Chemicals (PFCs)



Stain-and water resistant coatings on food wrappers, outdoor wear, non-stick pans, also in fire-fighting foams

Endocrine disruptors, cancer



Newly discovered flame retardants in Mariana Trench amphipods

Flame Retardants 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*)

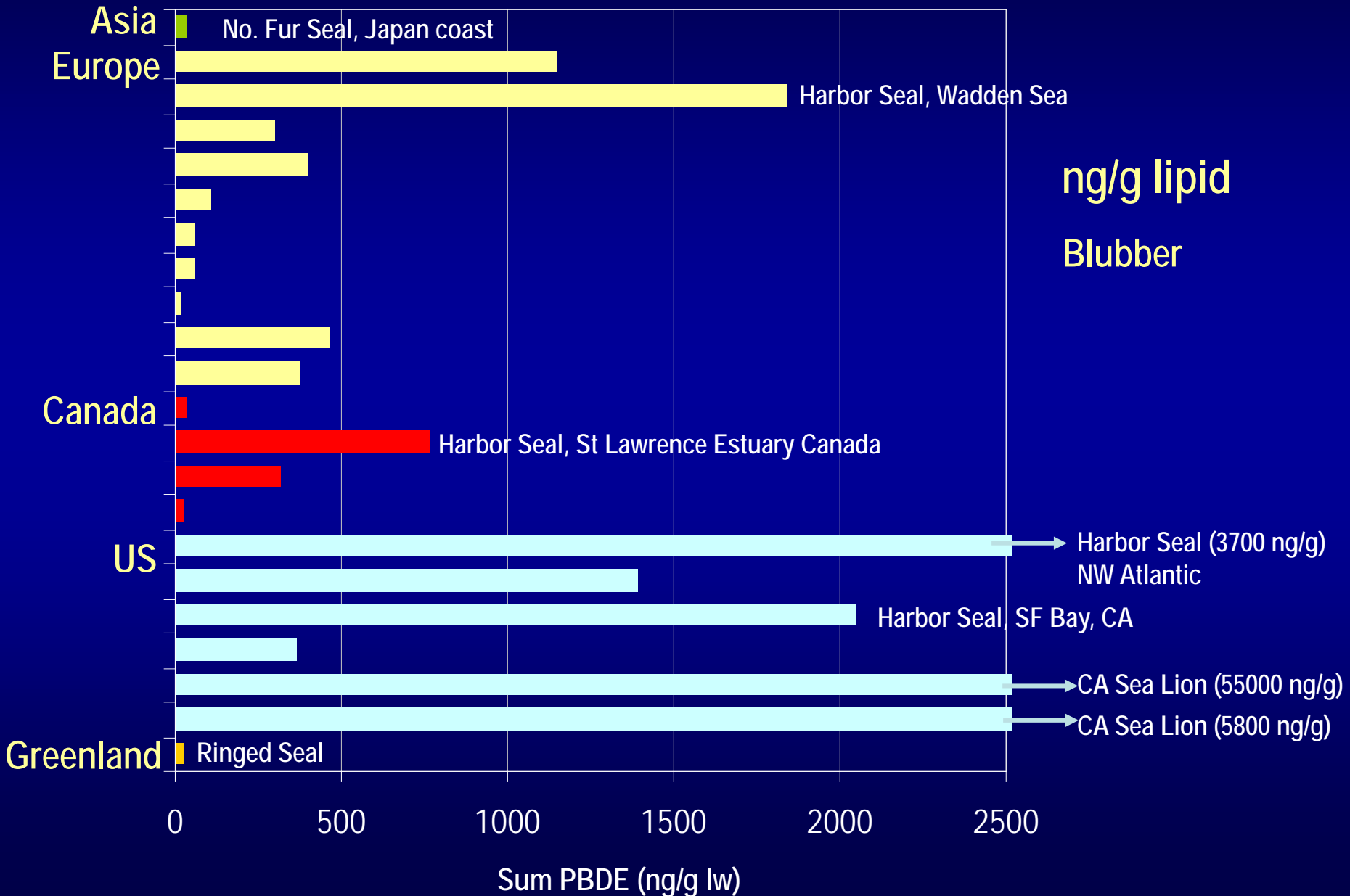
Meng et al. 2009



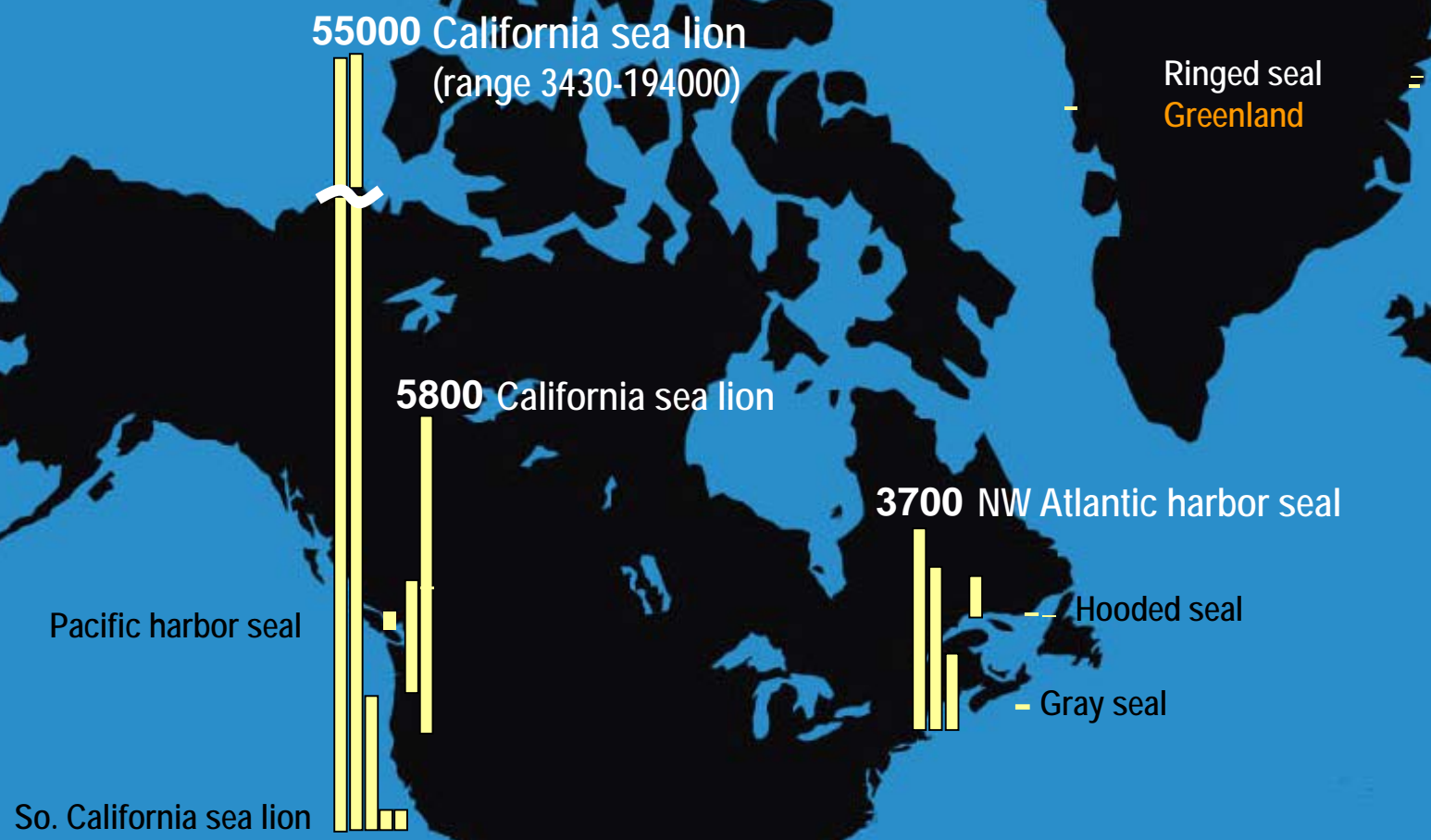
Harp seal (*P. groenlandica*)

Johansen et al. 2004

PBDE Levels in Pinnipeds



PBDEs in North American Pinnipeds



PBDE levels in California sea lions (max 194000 ng/g lw) highest reported in wildlife to date

Flame Retardants 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

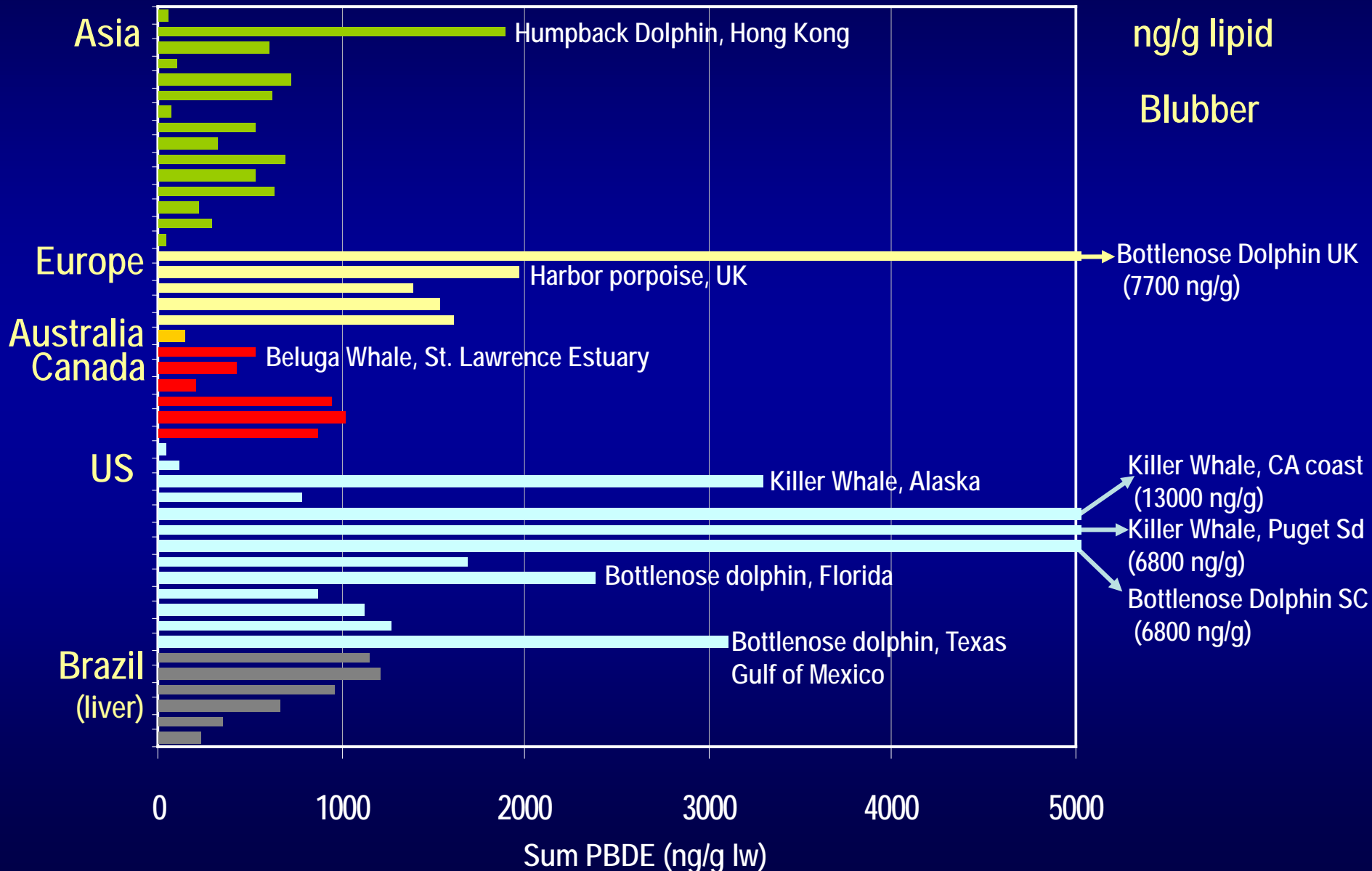


White-sided dolphin (*L. obliquidens*)
Tuerk et al. 2005

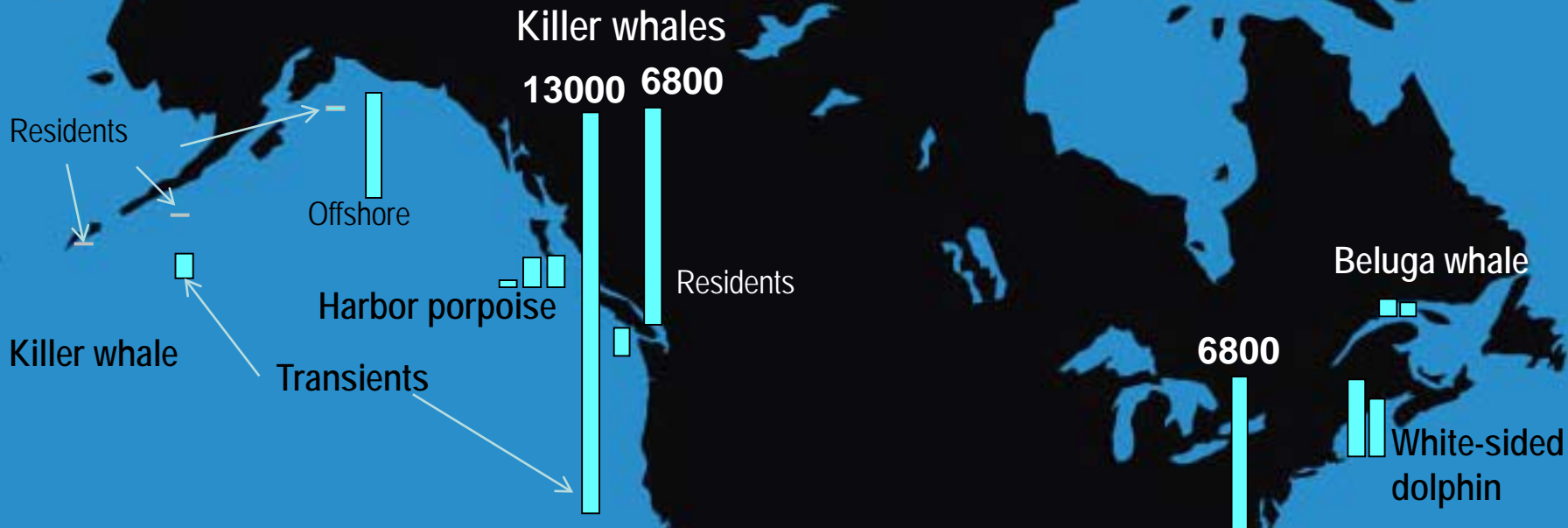


Striped dolphin (*S. coeruleoalba*)
Isobe et al. 2009

PBDE Levels in Cetaceans

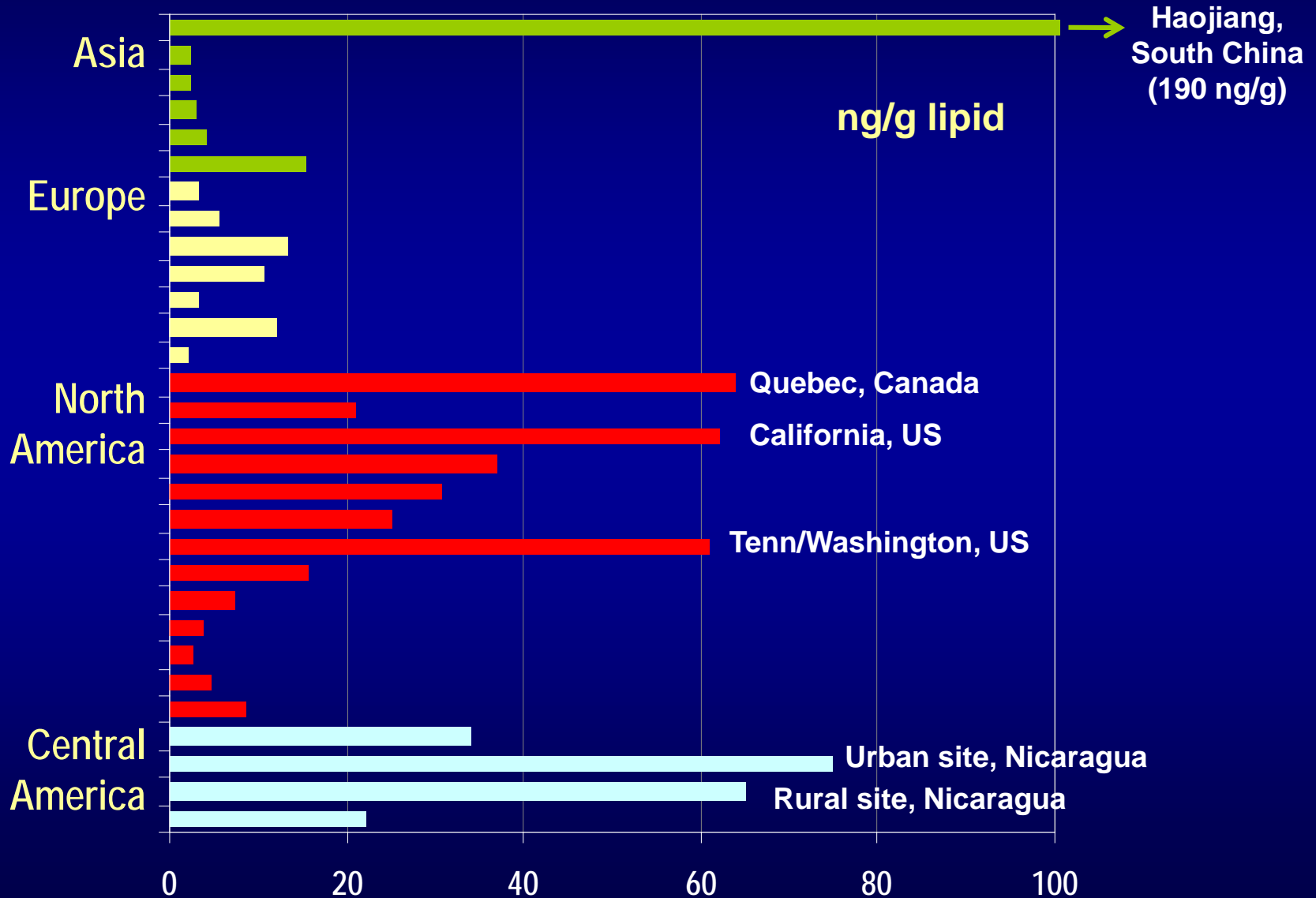


PBDE Levels in North American Cetaceans



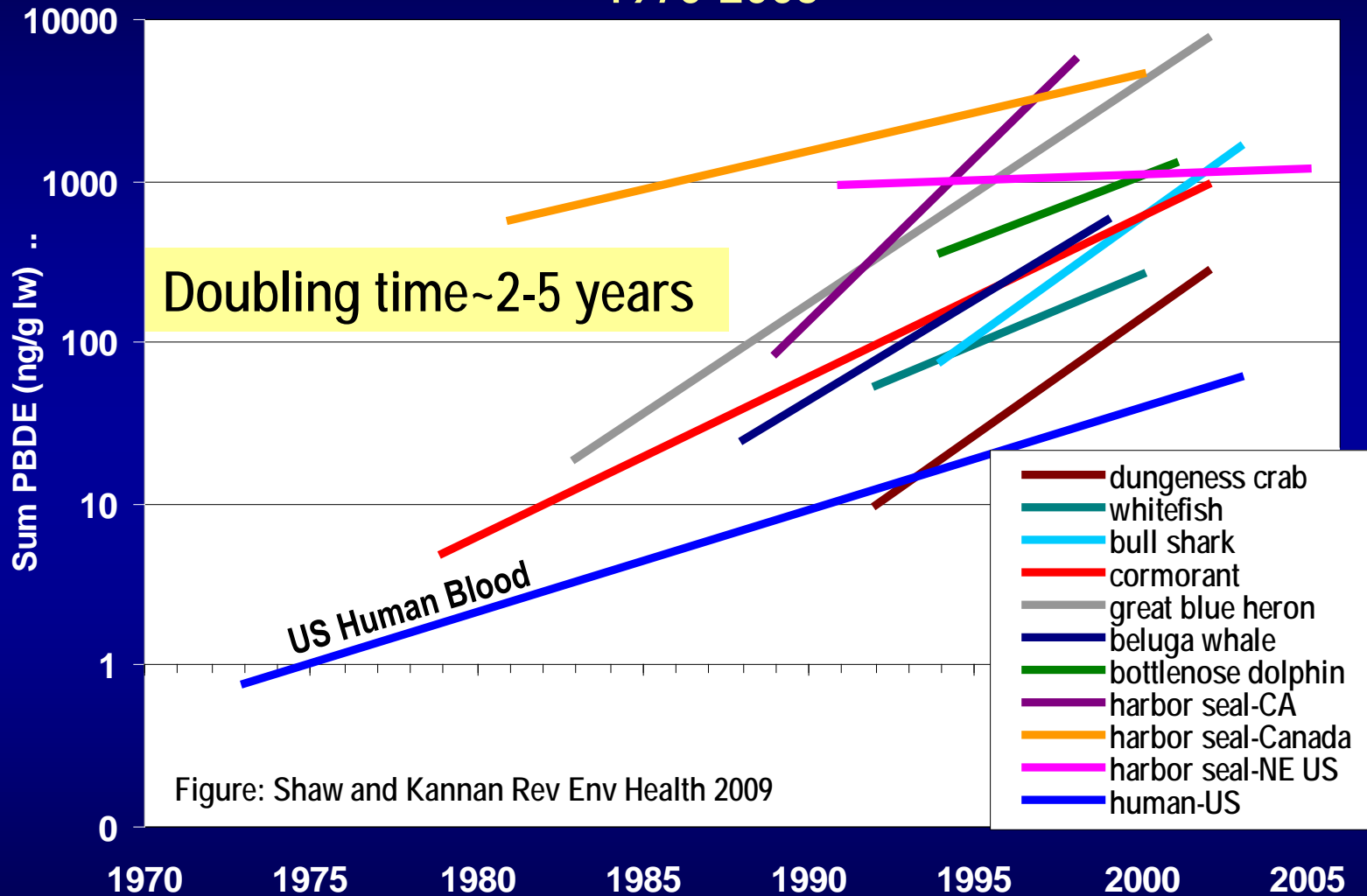
High PBDE levels in transient killer whales (CA coast) due to consumption of contaminated marine mammals (sea lions)

PBDE Levels in Human Blood



PBDEs Increasing in North America

1970-2005



Data: Schechter et al. 2005, Ikonomou 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

Biomagnification of PCBs

Seawater
2 ng/kg (ppt)


Plankton
3,000 ng/kg



Cod
300,000 ng/kg



Seals
3,000,000 ng/kg



Polar Bears
10,000,000 ng/kg



Humans
??? ng/kg



Since 1930, there have been 196 marine mammal mortality events worldwide

Marine Mammal Die Offs Since 1980



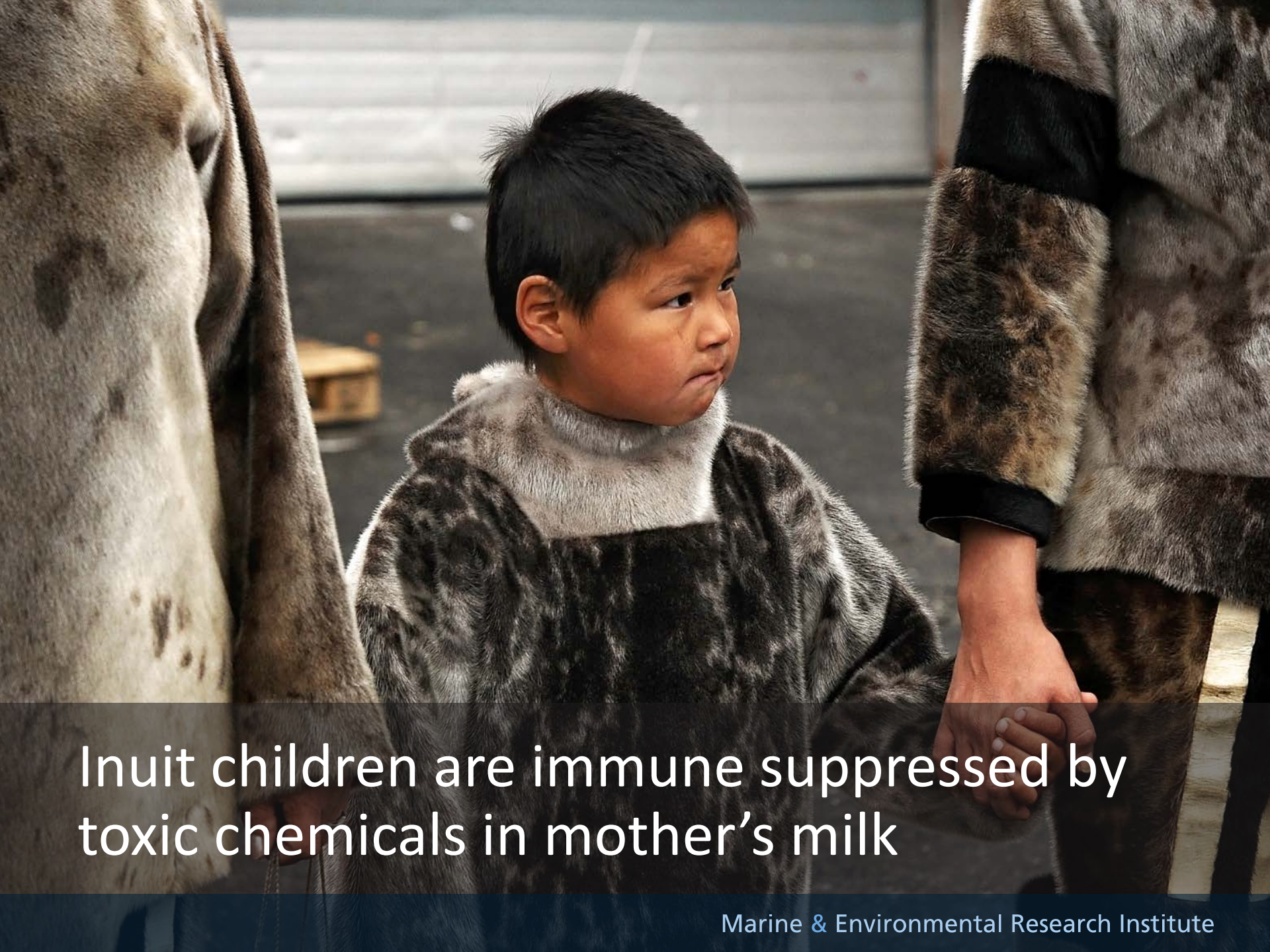
Toxic Legacy

An aerial photograph of a beach with a large number of seals resting on the sand. The ocean is visible in the foreground and background, with a curved shoreline separating the water from the beach.

Like marine mammals, we all carry hundreds of toxic chemicals in our bodies that are linked with endocrine disruption, cancer, birth defects, immune suppression and reduced IQ in children.

Extreme Exposure



A young Inuit child with dark hair, wearing a thick, dark fur parka with a white fur collar, stands in the center. The child is holding the hand of an adult whose arm and hand are visible on the right, also wearing a fur garment. To the left, the head and neck of a reindeer are visible. The background is a blurred outdoor setting, possibly a stable or a farm. The overall tone is somber and documentary.

Inuit children are immune suppressed by
toxic chemicals in mother's milk

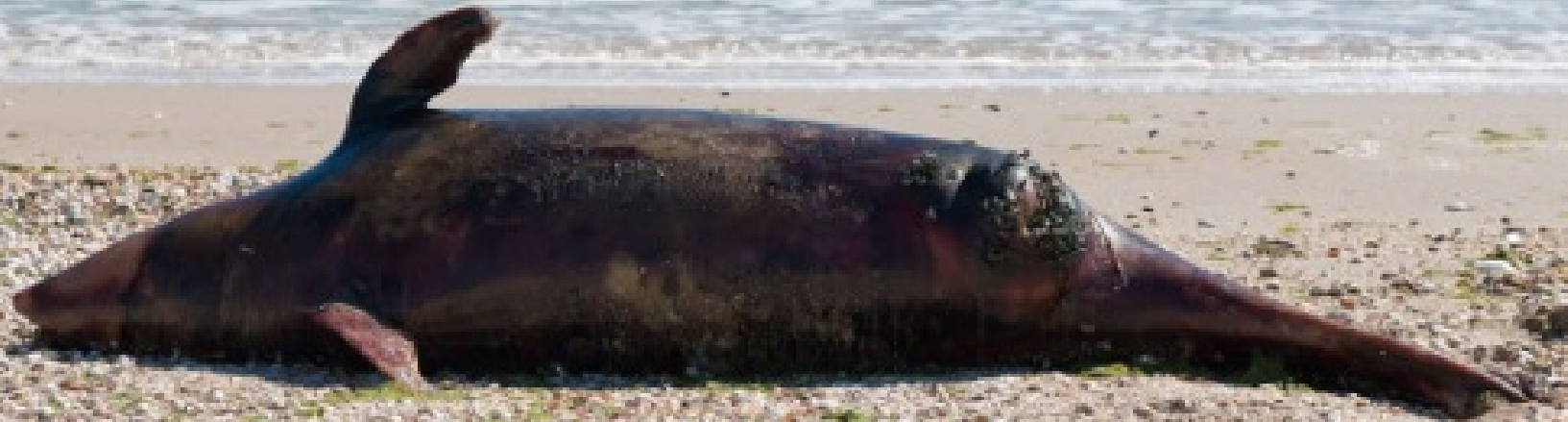
Offshore Drilling: Risky Business





Chemical dispersants + oil = toxic mixture

Decimation of Gulf of Mexico Dolphins



Chemical pneumonia, liver damage,
sterility, skin lesions

Public Health Crisis

Chemical pneumonia

multiple chemical sensitivities

respiratory system damage

migraines

skin lesions

liver damage

temporary paralysis

seizures

heart palpitations

rapid weight loss

burning and lesions

kidney damage

blood in urine

memory loss

nervous system damage

Climate Change Fast-Tracking, Adding to Pollution Stress

- Marine species moving toward the poles
- Decimation of corals, marine nurseries
- Habitat & food web displacement
- Pollution spreading, released from ice melt
- Species extinctions
- Sea level rise, extreme weather, widespread starvation, disease



Melting Ice Releasing Stored Pollutants (PCBs, PBDEs)

A photograph showing a large, white ice shelf melting into the ocean. A dark, greenish-brown stream of water flows from the edge of the ice shelf into the sea, indicating the release of pollutants. The sky is a pale blue, and the overall scene is a stark representation of climate change and environmental impact.





Marine Mammals Facing Extinction

Critically Endangered:

Yantze river dolphin
Vaquita, or Gulf of
California harbor porpoise

Endangered:


Galapagos fur seal
Australian sea lion
New Zealand sea lion
Galapagos sea lion
Mediterranean Monk Seal
Hawaiian monk seal
Caspian seal
Sea otter
Marine otter
North Atlantic right whale
North Pacific right whale
Sei whale
Blue whale
Fin whale
South Asian river dolphin
Hector's dolphin

Vulnerable:

Northern fur seal
Walrus
Hooded seal
Polar bear
Sperm whale
Francicana
Irrawaddy dolphin
Atlantic humpback dolphin
Indo-Pacific finless porpoise
Narrow ridged finless porpoise
Amazonian manatee
American manatee
West African manatee
Dugong

“We are the asteroid now.”

– Elizabeth Kolbert, *The Sixth Extinction, An Unnatural History*

A man with a beard and glasses, wearing a blue shirt, is speaking and gesturing with his hands. He is looking upwards and to the right. The background is a blurred blue and white light pattern.

“It is mind-boggling to me that this insignificant speck of humanity, all 7 billion of us,... have managed to take a precious resource, our life blood, and bring it to the edge of doom.”

– Dave Gallo, Oceanographer, Explorer, Robotics Pioneer

Earth at a crossroads



Technology = transparency (better information, we see the changes)

Ocean governance still challenging

- mining, fishing, vessel tracking


Private sector incentives

- overfishing
- incentive for plastic removal?

Paris Climate Agreement ??

Will we take the necessary actions in time to sustain marine mammals – and ourselves?



A polar bear is seen walking across a vast expanse of broken ice floes in the Arctic. The ice floes are scattered and small, creating a fragmented path for the bear. The water between the floes is a deep blue, and the sky above is a clear, pale blue. The bear is positioned in the lower center of the frame, moving towards the right. The overall scene conveys a sense of isolation and the impact of climate change on the Arctic environment.

Humans have caused this impending demise of species and we are the only species with the capacity to fix it.

A polar bear is standing on a small, white ice floe in the middle of a sea of broken ice. The bear is looking directly at the camera with its mouth open, as if it is speaking or roaring. The background is filled with numerous other ice floes of various sizes, scattered across a dark blue-grey sea. The overall scene conveys a sense of isolation and the harsh, cold environment of the Arctic.

Thank you for your attention!