GLOBAL MERCURY MONITORING IN BIOTA

DAVID EVERS, PHD
BIODIVERSITY RESEARCH INSTITUTE
PORTLAND, MAINE, USA

CO-LEAD FOR FATE AND TRANSPORT
GLOBAL MERCURY PARTNERSHIP AREA

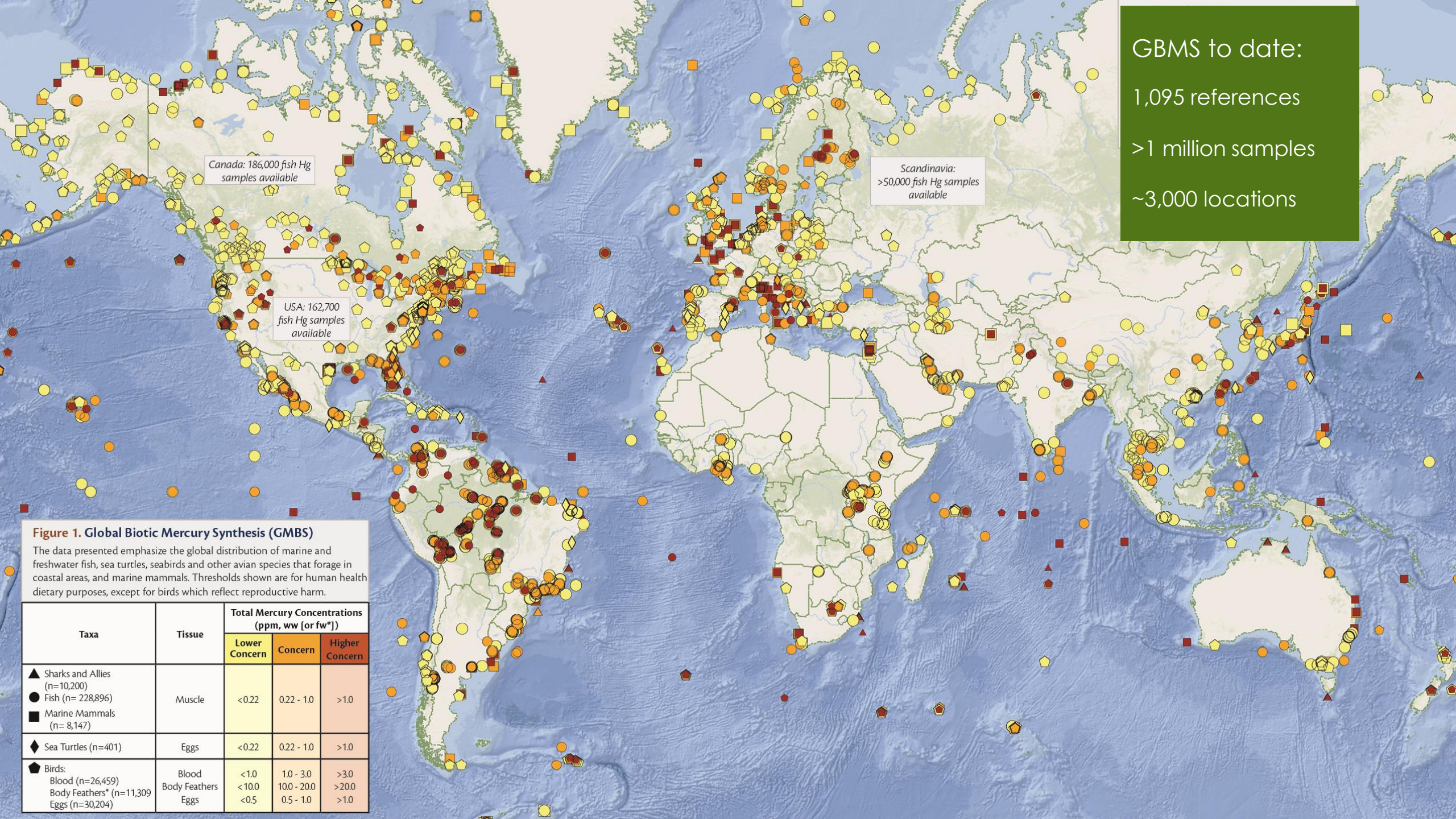
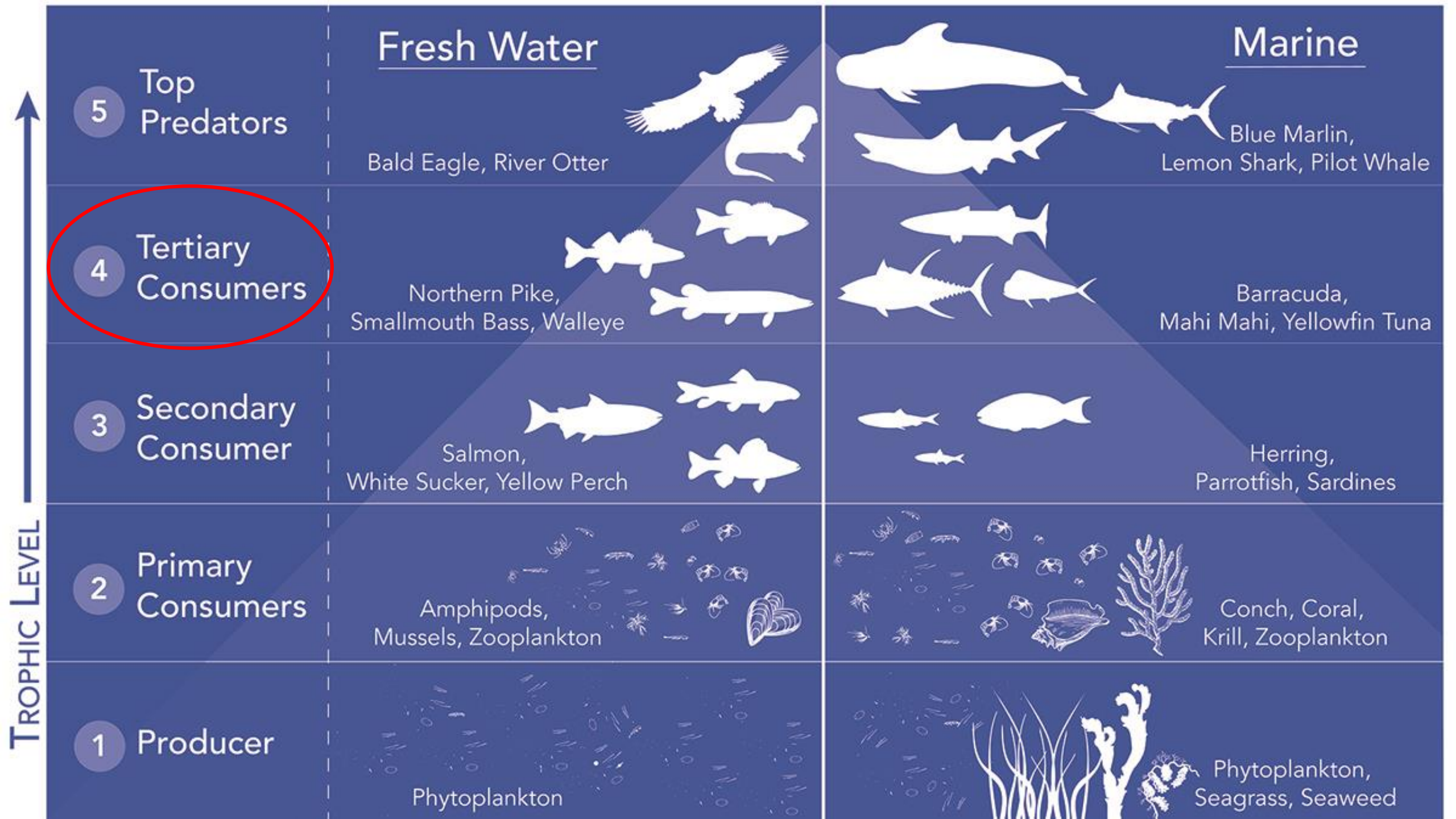


Figure 1. Global Biotic Mercury Synthesis (GMBS)

The data presented emphasize the global distribution of marine and freshwater fish, sea turtles, seabirds and other avian species that forage in coastal areas, and marine mammals. Thresholds shown are for human health dietary purposes, except for birds which reflect reproductive harm.

Taxa	Tissue	Total Mercury Concentrations (ppm, ww [or fw*])		
		Lower Concern	Concern	Higher Concern
▲ Sharks and Allies (n=10,200) ● Fish (n= 228,896) ■ Marine Mammals (n= 8,147)	Muscle	<0.22	0.22 - 1.0	>1.0
♦ Sea Turtles (n=401)	Eggs	<0.22	0.22 - 1.0	>1.0
⬟ Birds: Blood (n=26,459) Body Feathers* (n=11,309 Eggs (n=30,204)	Blood Body Feathers Eggs	<1.0 <10.0 <0.5	1.0 - 3.0 10.0 - 20.0 0.5 - 1.0	>3.0 >20.0 >1.0


Trophic Level
Fresh Water
Marine
5 Top Predators
Bald Eagle, River Otter
Blue Marlin, Lemon Shark, Pilot Whale
4 Tertiary Consumers
Northern Pike, Smallmouth Bass, Walleye
Barracuda, Mahi Mahi, Yellowfin Tuna
3 Secondary Consumer
Salmon, White Sucker, Yellow Perch
Herring, Parrotfish, Sardines
2 Primary Consumers
Amphipods, Mussels, Zooplankton
Conch, Coral, Krill, Zooplankton
1 Producer
Phytoplankton
Phytoplankton, Seagrass, Seaweed

A provisional slate of potential bioindicators for evaluating and monitoring environmental Hg loads (Evers et al. 2016 Sci. Total Environ. 569-570:888-903.)

Target Terrestrial Biomes	Associated Aquatic Ecosystems	Human and Ecological Health Bioindicators		
		Freshwater Fish	Marine Fish	Marine Mammals
Arctic Tundra	Arctic Ocean and associated estuaries, lakes, rivers	Arctic Char, Arctic Grayling	Halibut, Cod	Beluga, Narwhal
Boreal Forest and Taiga	North Pacific and Atlantic Oceans and associated estuaries, lakes, rivers	Catfish, Pike, Sauger, Walleye	Flounder, Snapper, Tuna	Pilot Whale
Temperate Broadleaf and Mixed Forest	North Pacific and Atlantic Oceans, Mediterranean and Caribbean Seas, and associated estuaries, lakes rivers	Bass, Bream, Mullet, Walleye	Barracuda, Mackerel, Mullet, Scabbard-fish, Sharks, Tuna	
Tropical Rainforest	South Pacific and South Atlantic and Indian Oceans and associated estuaries, lakes, rivers	Catfish, Snakehead	Barracuda, Grouper, Sharks, Snapper, Swordfish, Tuna	

PROPOSED 3-STEP OVERARCHING FRAMEWORK FOR MONITORING MERCURY IN BIOTA ACROSS CONTINENTS AND OCEANS.

Step 1

Map ecosystem sensitivity spots for methylmercury availability

Step 2

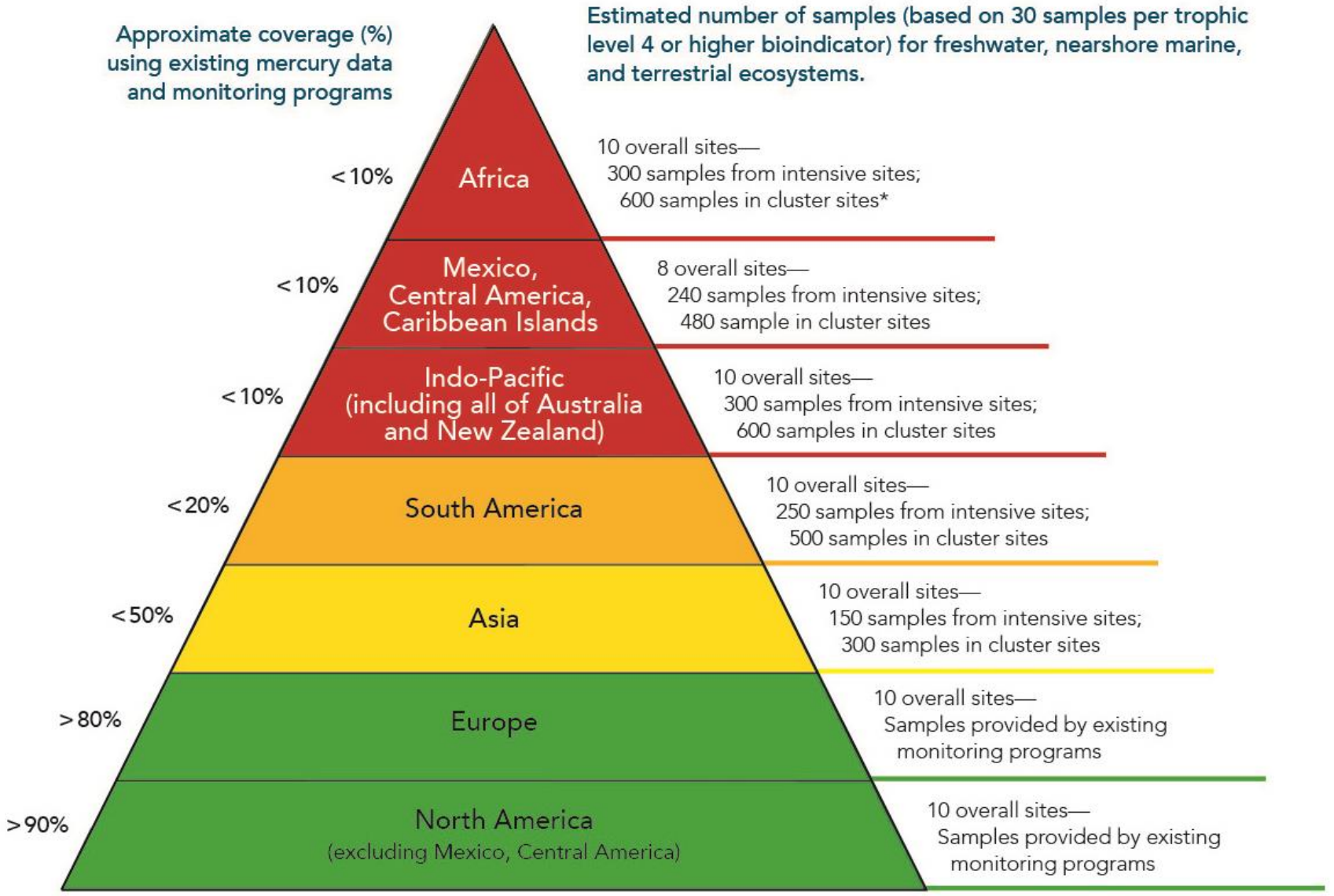
Identify sensitive and at-risk trophic level 4 or higher species

Step 3

Select species and ecosystems to model and monitor globally

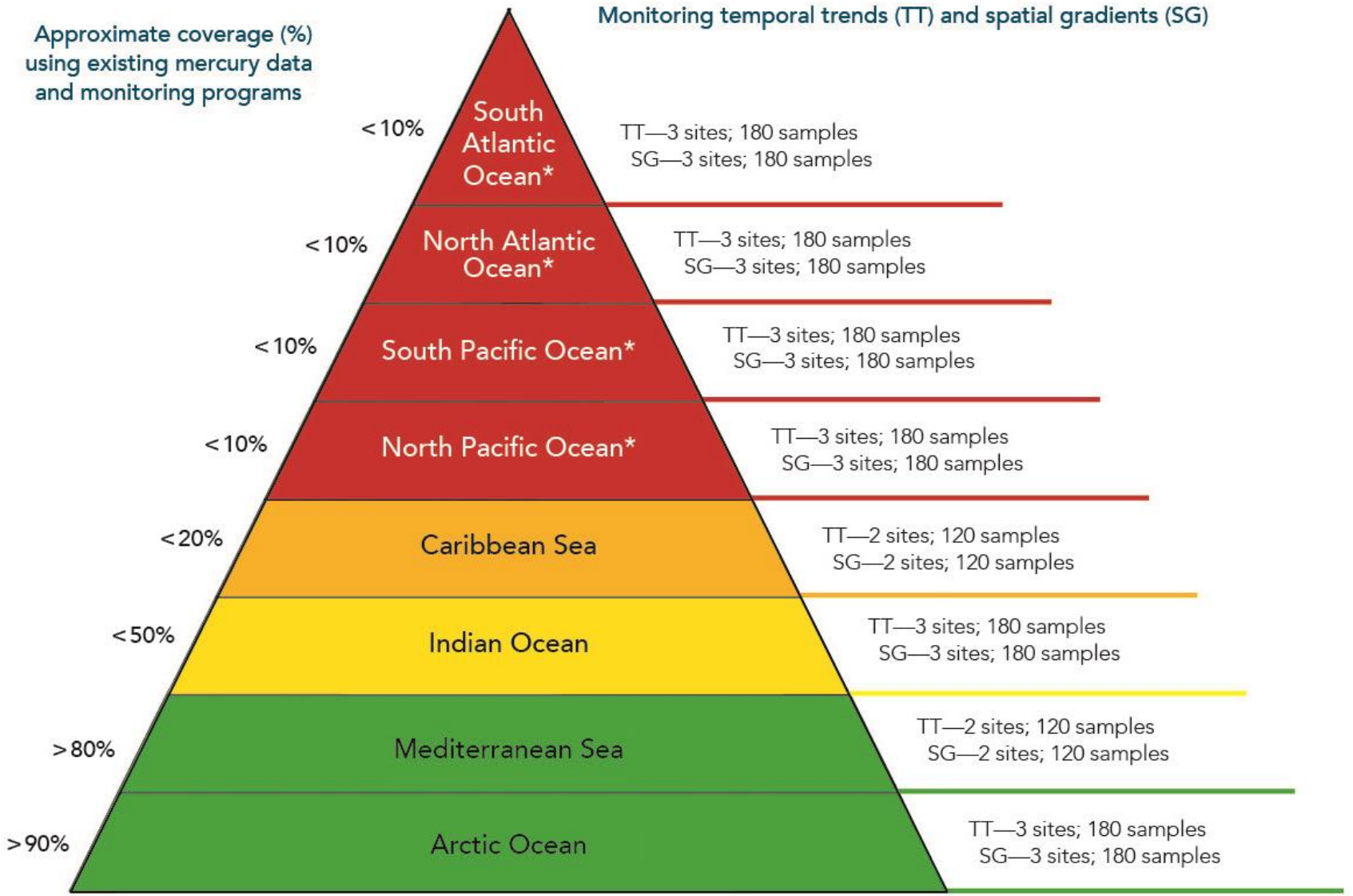
CONTINENTAL Sampling Framework for Integrated Mercury Monitoring

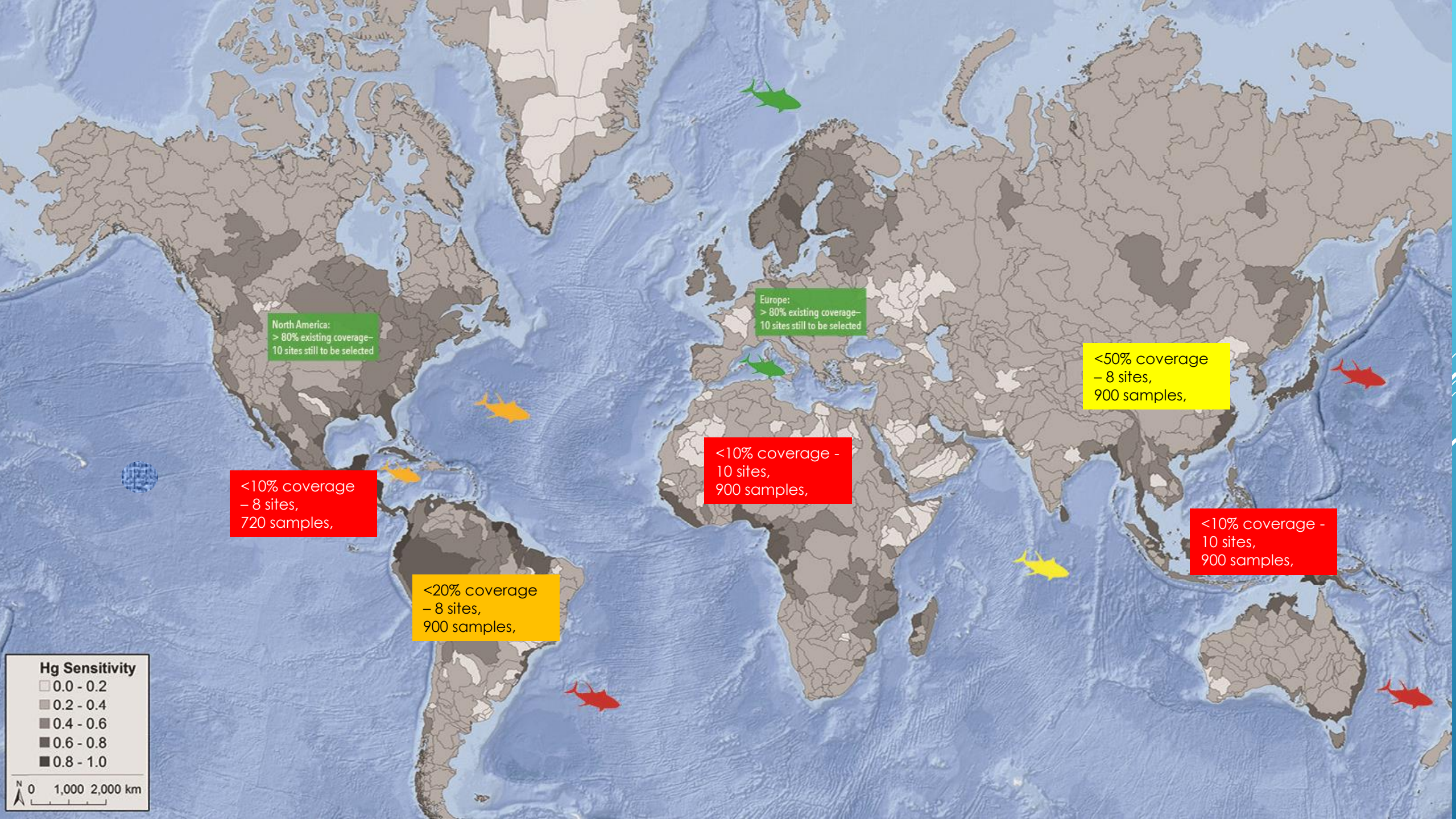
Figure 3. Sampling strategy for trophic level 4 or higher biota for the Continental Sampling Framework. Listed are the number of intensive sites (with a sample size of 30 at each site); each which should include another three cluster sites (with a sample size of 20 at each site) to account for local variability.

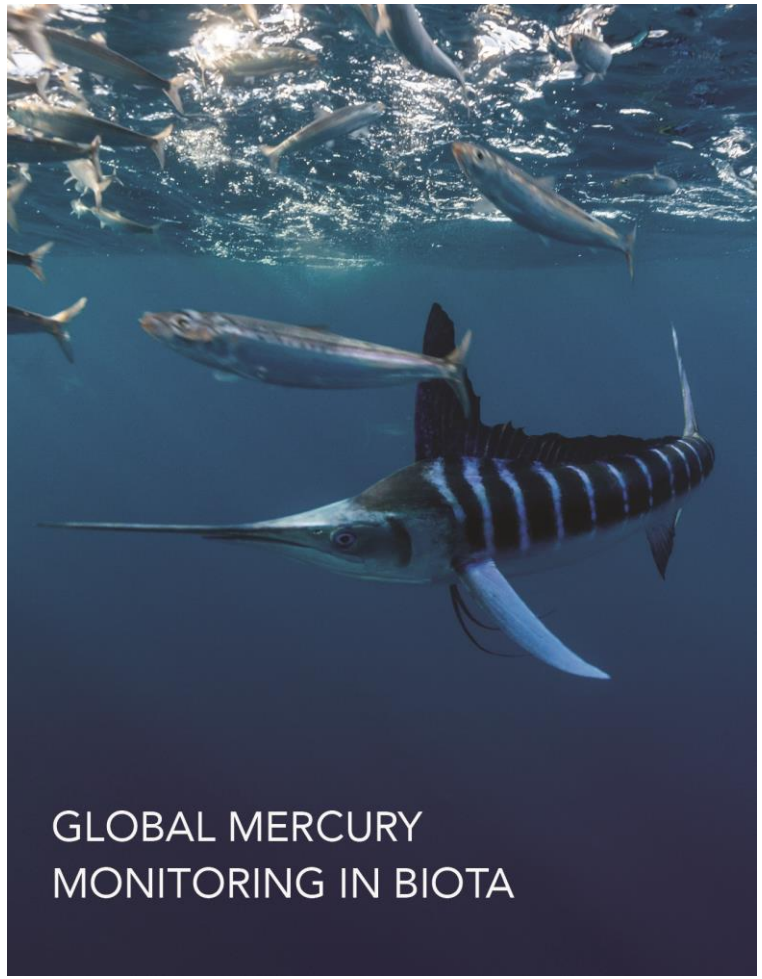


OCEANIC Sampling Framework for Integrated Mercury Monitoring

Figure 4. Sampling strategy for trophic level 4 or greater biota for the Oceanic Sampling Framework. Listed are the number of sites (with an initial sample size of 30 fish at each site) for both objectives of monitoring temporal trends and spatial gradients of mercury.




North America:
> 80% existing coverage–
10 sites still to be selected
Europe:
> 80% existing coverage–
10 sites still to be selected
<50% coverage
– 8 sites,
900 samples,
<10% coverage
– 8 sites,
720 samples,
<10% coverage -
10 sites,
900 samples,
<10% coverage -
10 sites,
900 samples,
<20% coverage
– 8 sites,
900 samples,
Hg Sensitivity
0.0 - 0.2
0.2 - 0.4
0.4 - 0.6
0.6 - 0.8
0.8 - 1.0
N
0
1,000
2,000 km



TECHNICAL INFORMATION REPORT ON MERCURY MONITORING IN BIOTA

November 2019

Proposed components towards a strategic long-term plan for monitoring mercury in fish and wildlife globally.

Hg

bri
Biodiversity Research Institute

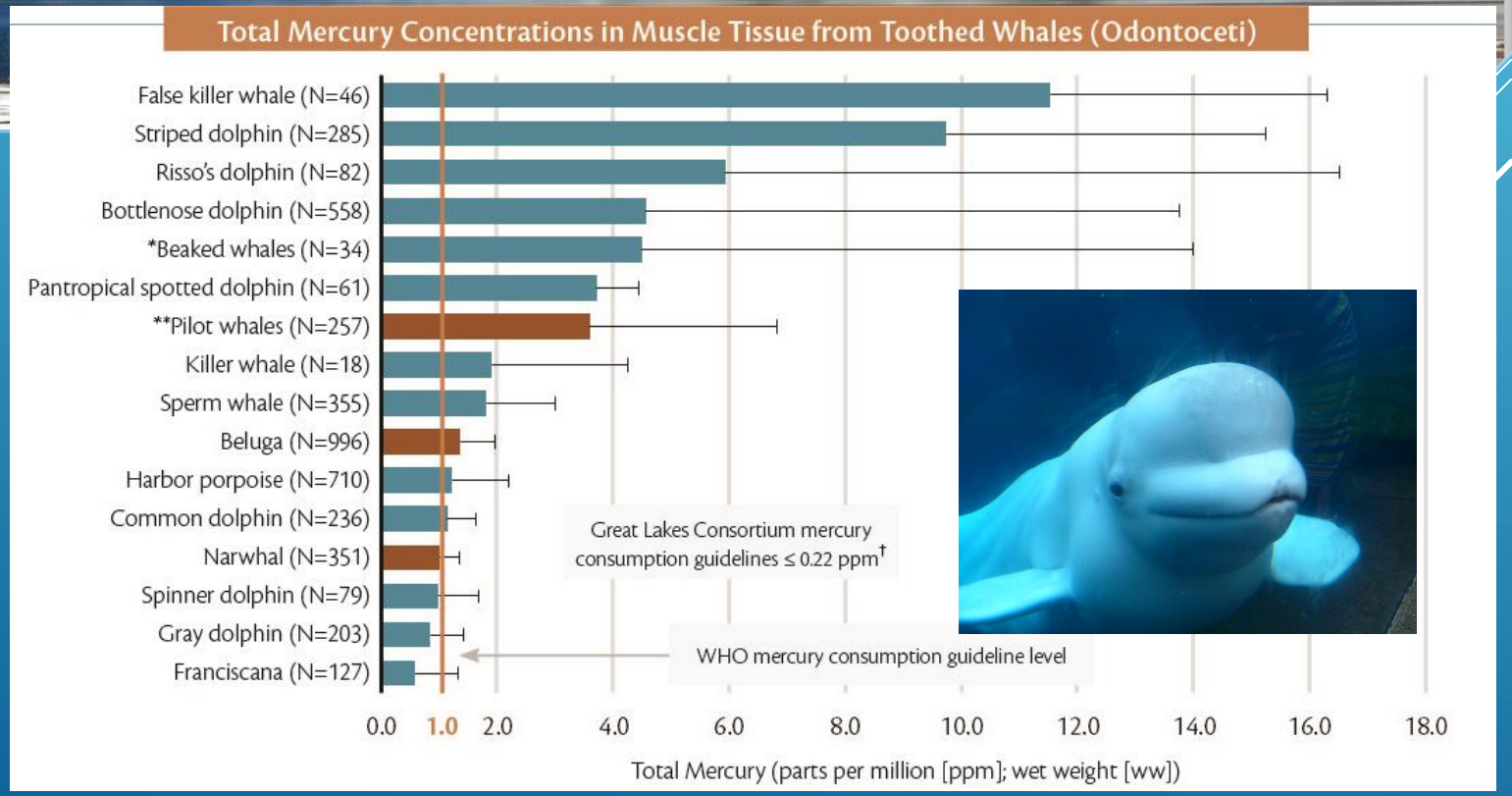
gef

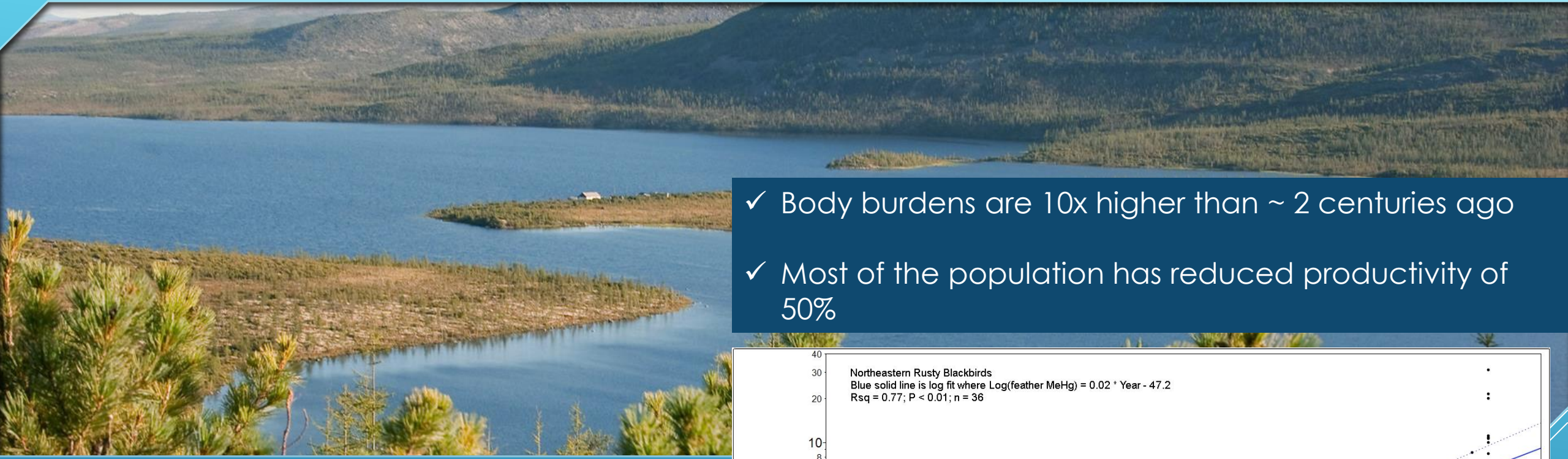
UN environment programme

- ✓ Body burdens exceed thresholds for 13 of 16 toothed whales
- ✓ Some species average 10x above thresholds

ARCTIC TUNDRA AND ARCTIC OCEAN BIOME

- ARCTIC CHAR, YELLOW-BILLED LOONS AND IVORY GULL, BELUGA WHALES AND NARWALS

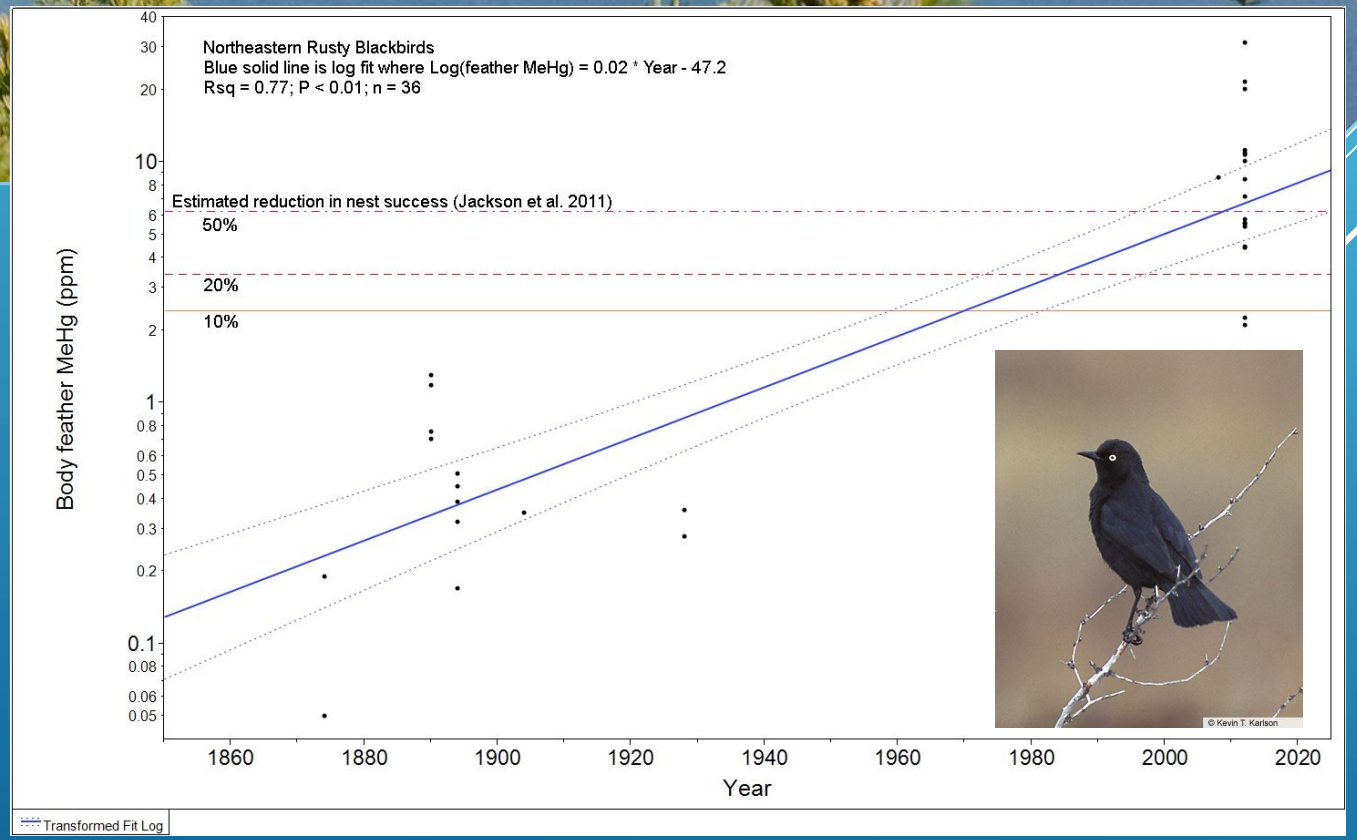


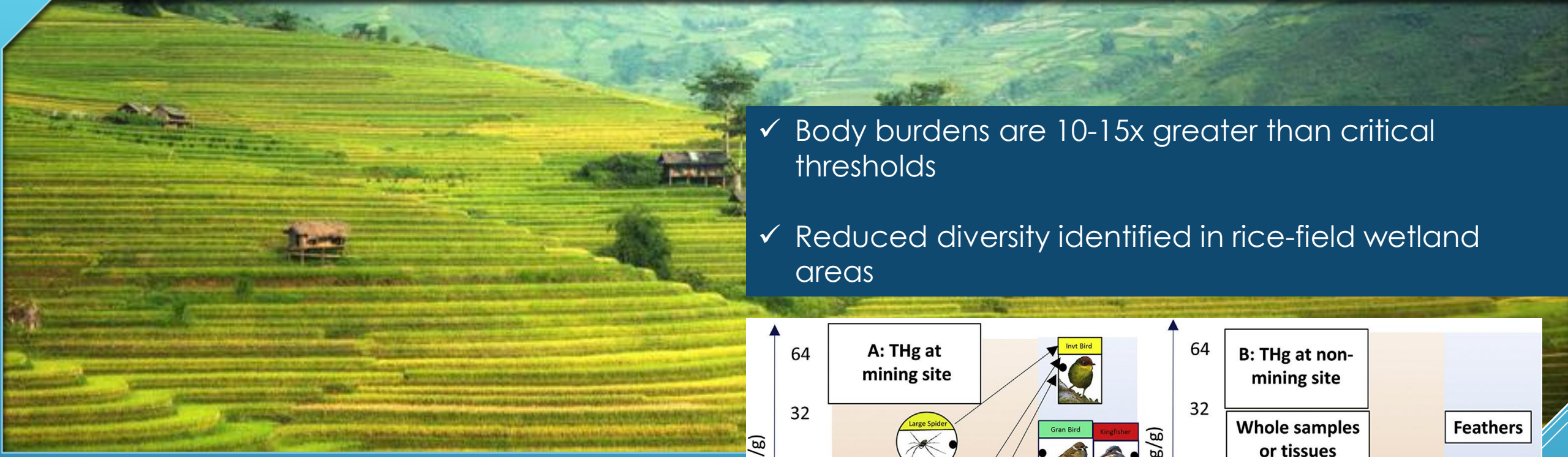


- ✓ Body burdens are 10x higher than ~ 2 centuries ago
- ✓ Most of the population has reduced productivity of 50%

BOREAL FOREST AND TAIGA AND NORTH ATLANTIC/PACIFIC BIOME

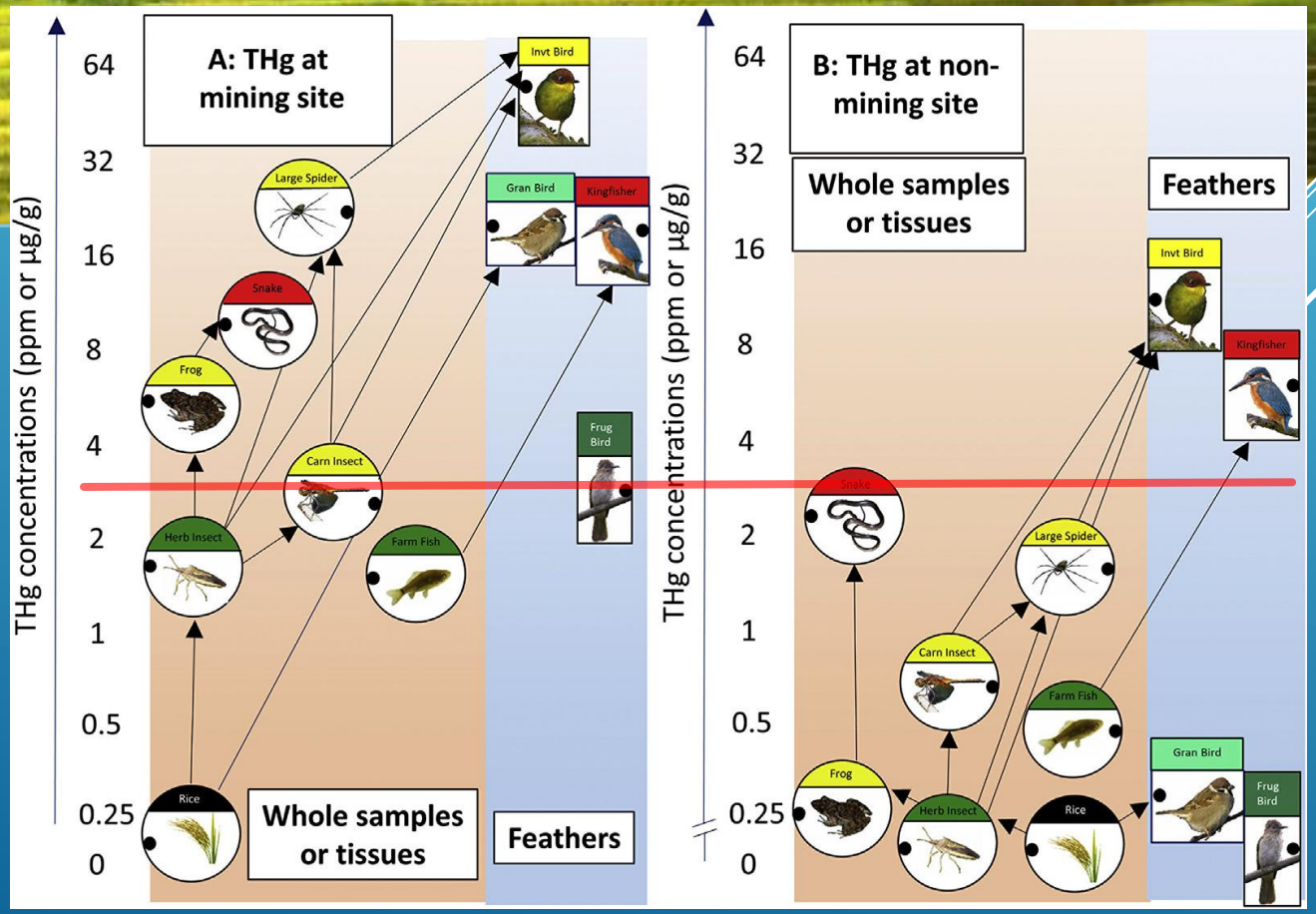
– PILOT WHALE, COMMON LOON, RUSTY BLACKBIRD, NORTHERN PIKE



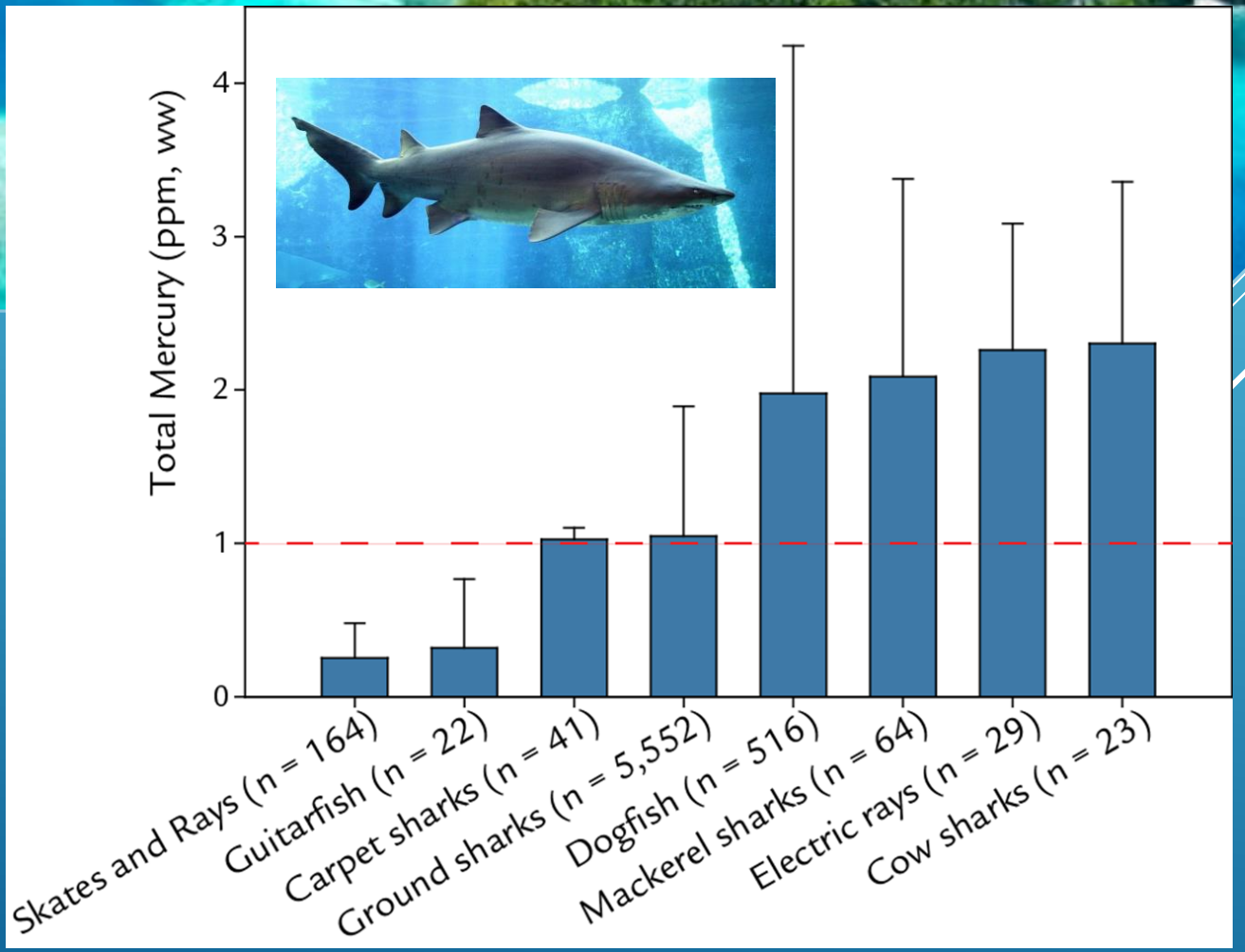


- ✓ Body burdens are 10-15x greater than critical thresholds
- ✓ Reduced diversity identified in rice-field wetland areas

TEMPERATE BROADLEAF AND CENTRAL OCEAN BASINS BIOME – LEMON SHARK, BARRACUDA, OSPREY, SALTMARSH SPARROW



- ✓ Body burdens average higher than threshold levels for 6 shark families
- ✓ Effects from mercury are still relatively unknown



TROPICAL RAINFOREST/SOUTH PACIFIC-ATLANTIC BIOME –

TIGER SHARK, GOLIATH GROUPER, RINGED KINGFISHER, WANDERING ALBATROSS

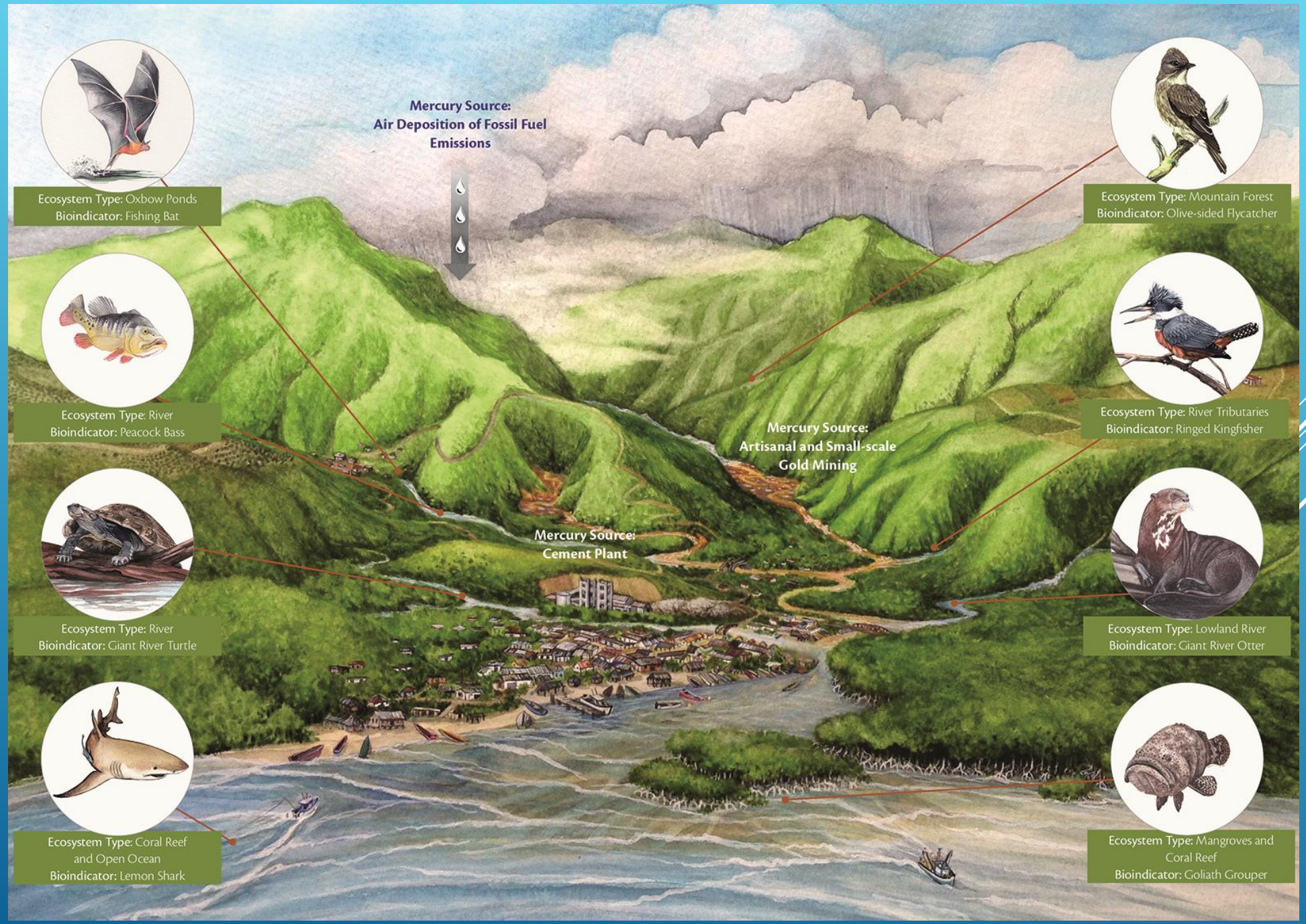
SUMMARY

1. Fish and Wildlife Populations are adversely impacted by Hg

2. Many species are likely declining because of Hg

3. Biodiversity is likely suffering in many biomes for high trophic level species

4. Particular concern is in areas most sensitive to Hg input



MERCURY IN 9 SPECIES OF TUNA (N=6,222)

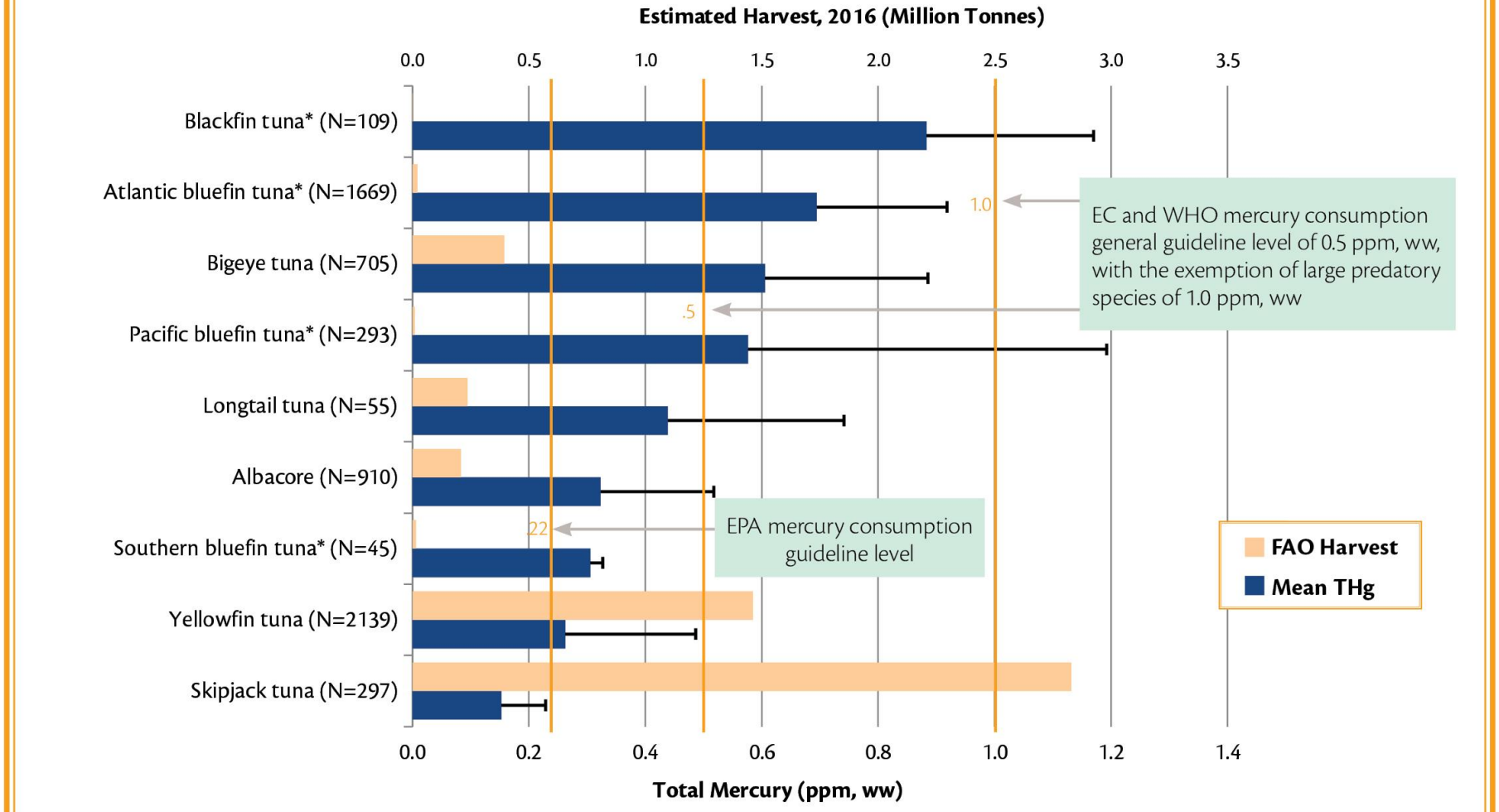


Figure 2. Average (+/– SD; N=sample size) THg concentration in muscle tissue of nine tuna species compared with the FAO harvest estimate in tonnes. See above for mercury consumption guidelines. *FAO harvest is less than 15,000 tonnes.