# Using the Global Biotic Mercury Synthesis to better understand adverse impacts of methylmercury availability on biodiversity

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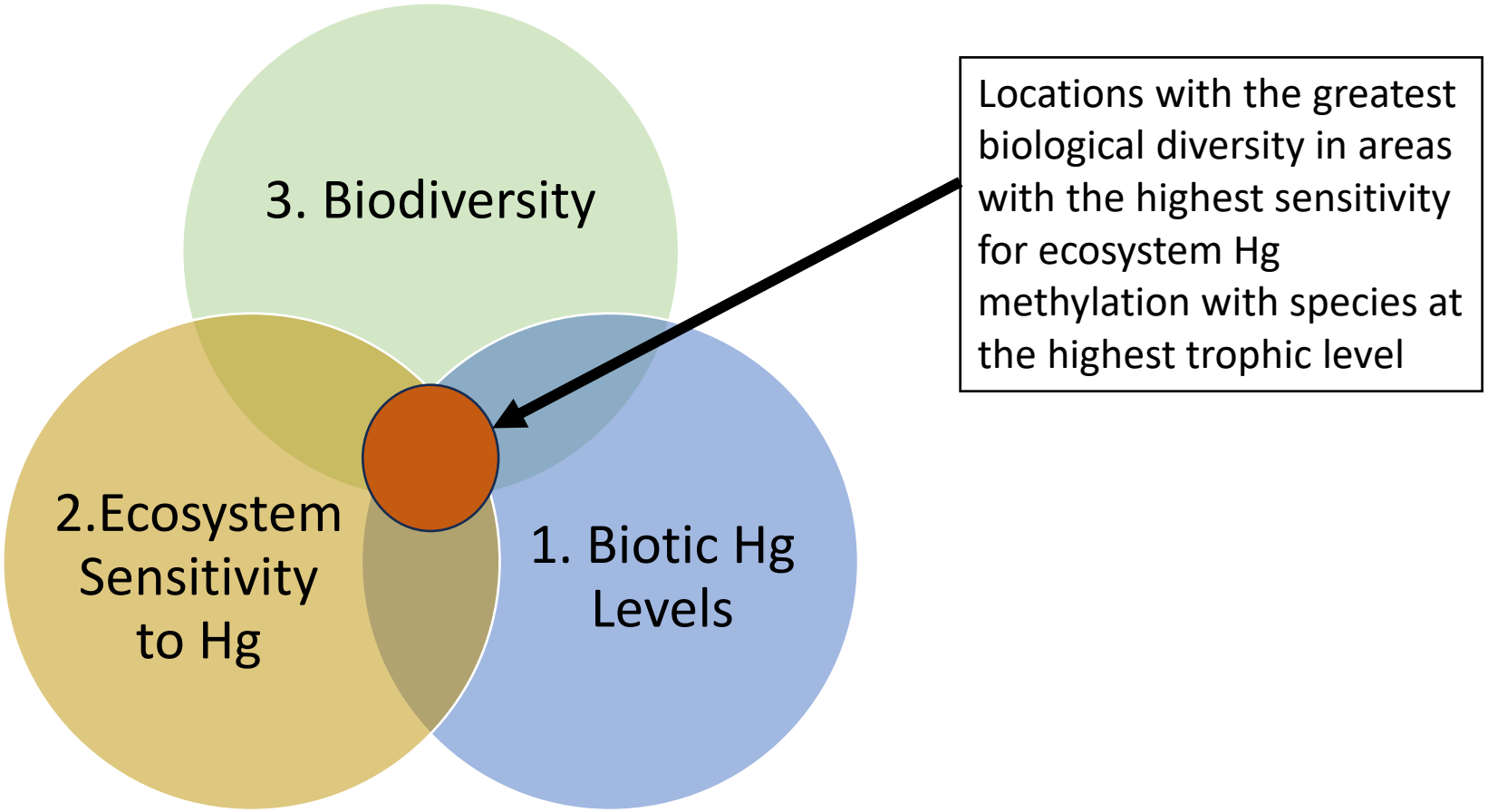
# Important relationships for determining impacts to biological diversity

- New interest and need to explore linkages of the Minamata Convention and the Convention on Biological Diversity



# Part 1: Global Biotic Mercury Synthesis

Developed with UNEP and GEF-STAP since 2014

Based on >1,700 references

Collected over 588,000 biotic Hg data points representing 4,100 unique locations

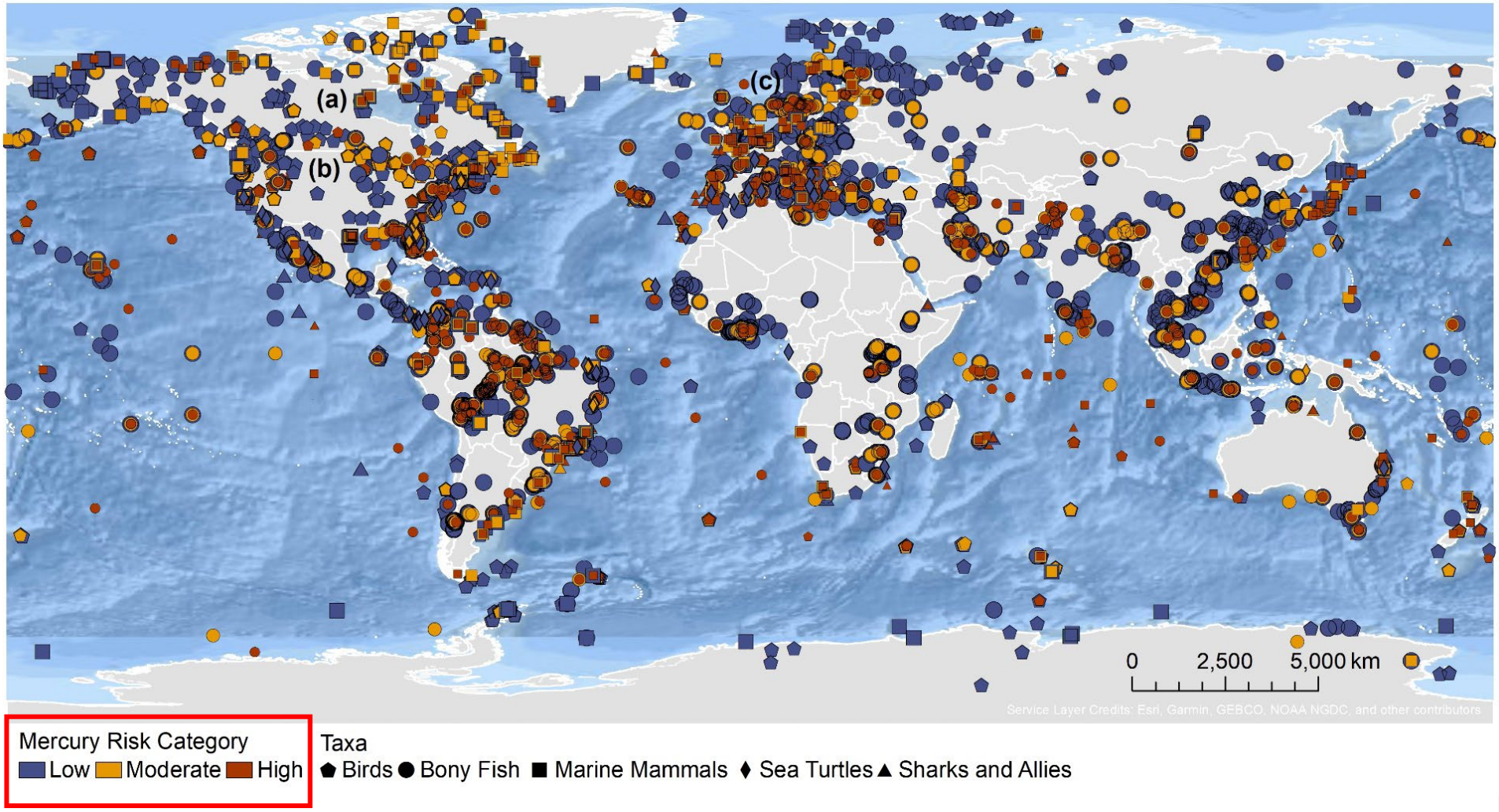
Comprehensive for most high tropic level taxa

32 co-authors with taxa or geographic specific expertise

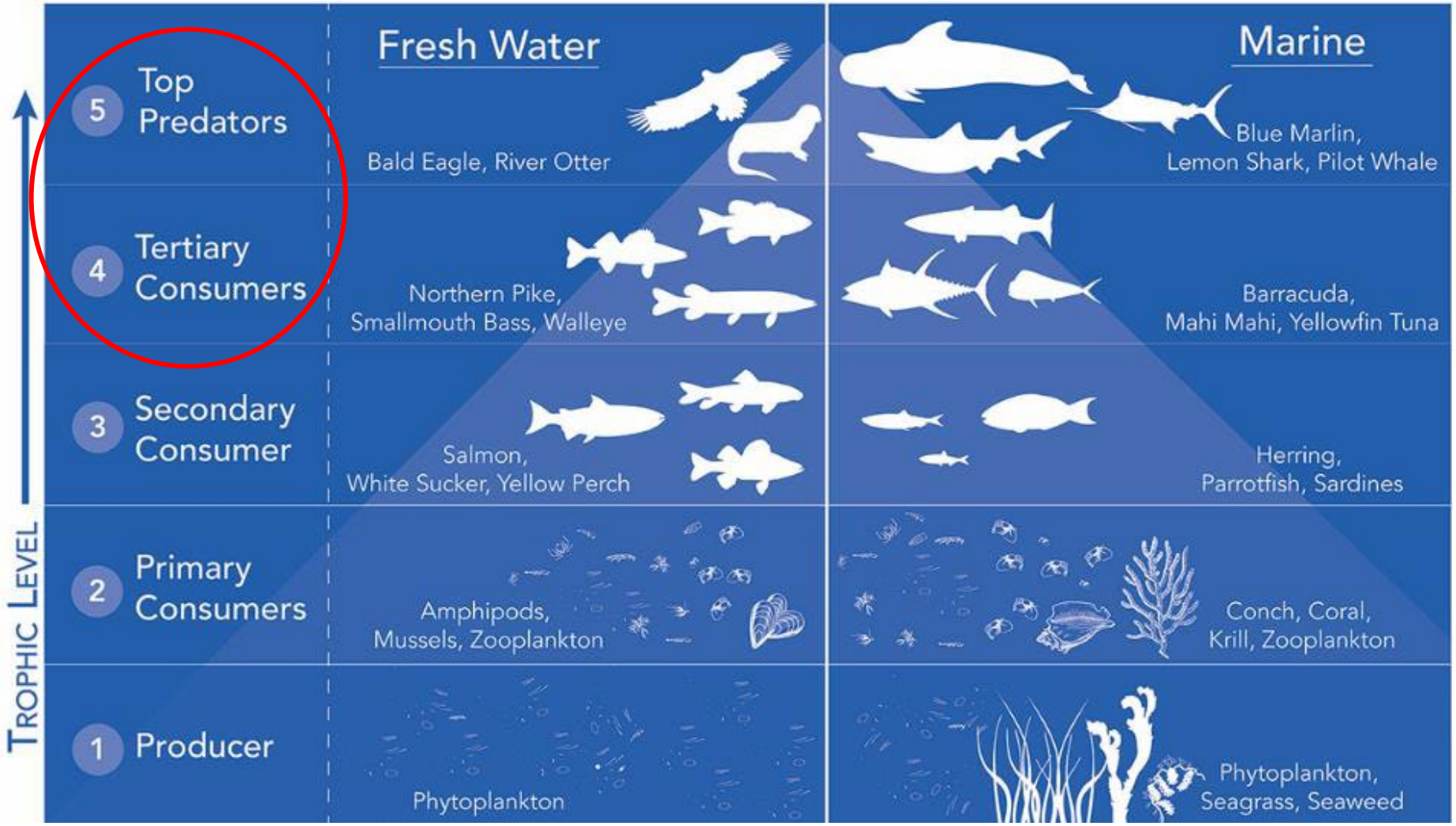
# Global Hg data distribution by major taxa

| | | Fish | Sea Turtles | Birds | Marine Mammals | Subtotal |
|---|---|---|---|---|---|---|
| **Continental** | | | | | | |
| | Africa | 6,126 | n/a | 192 | n/a | 6,318 |
| | Antarctica | 0 | n/a | 0 | n/a | 0 |
| | Asia | 14,093 | n/a | 3,794 | 567* | 18,454 |
| | Australia | 323 | n/a | 3 | n/a | 326 |
| | Europe | 62,321 | n/a | 7,712 | 220* | 70,253 |
| | North America | 191,346 | n/a | 50,449 | n/a | 241,795 |
| | South America | 38,126 | n/a | 356 | 95* | 38,577 |
| | **Subtotal** | **312,335** | **n/a** | **62,506** | **882** | **375,723** |
| **Oceanic** | | | | | | |
| | Antarctic | 1,228 | n/a | 6,305 | 1,738 | 9,271 |
| | Arctic | 1,808 | n/a | 7,498 | 8,730 | 18,036 |
| | Gulf of Mexico-Caribbean | 8,480 | 557 | 467 | 818 | 10,322 |
| | Indian | 9,662 | 397 | 1,851 | 487 | 12,397 |
| | Mediterranean | 13,720 | 773 | 2,054 | 2,600 | 19,147 |
| | North Atlantic | 26,504 | 1,438 | 13,951 | 6,698 | 48,591 |
| | North Pacific | 24,049 | 1,077 | 33,933 | 6,996 | 66,055 |
| | South Atlantic | 12,428 | 714 | 2,808 | 1,398 | 17,348 |
| | South Pacific | 8,152 | 51 | 3,054 | 351 | 11,608 |
| | **Subtotal** | **106,031** | **5,007** | **71,921** | **29,816** | **212,775** |
| **Total** | | **418,366** | **5,007** | **134,427** | **30,698** | **588,498** |

# Distribution of five major taxa and their total Hg concentrations in three risk categories based on mean data derived from a survey of the available peer-reviewed literature



# Indicators of Hg impacts to biodiversity – high trophic level

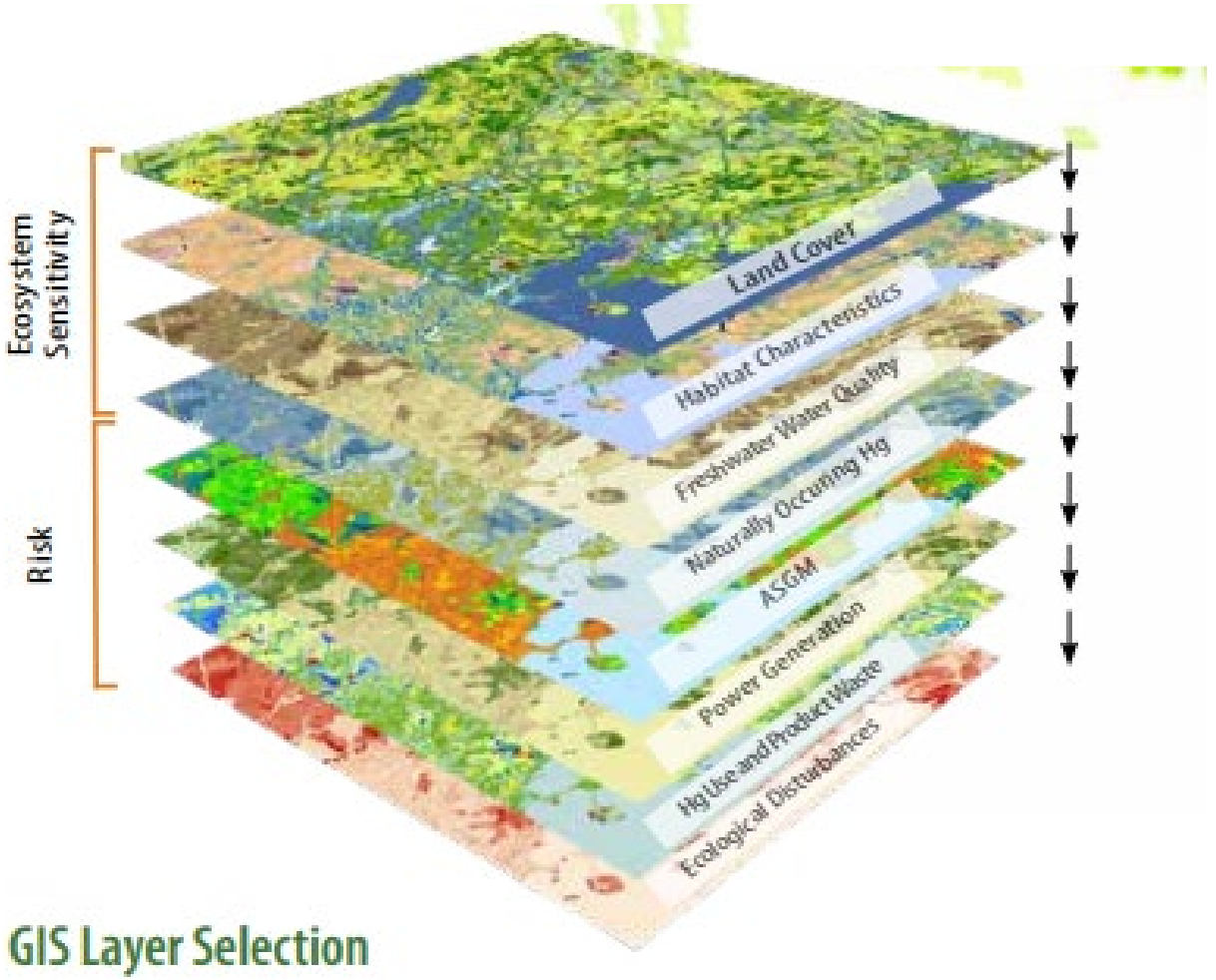


| Terrestrial biomes and associated marine areas | Bioindicators for assessment of potential environmental impact | | | Bioindicators for assessment of potential human exposure (which can also be used for assessing environmental impacts) | | |
|---|---|---|---|---|---|---|
| | Freshwater Birds | Marine Birds | Marine Mammals and other | Freshwater Fish | Marine Fish | Marine Mammals |
| **Arctic Tundra and Arctic Ocean** | Loons, Songbirds | Fulmars, Murres | Polar Bears, Seals | Arctic Char, Arctic Grayling | Arctic Char, Cod, Halibut | Beluga, Narwhal, Seals |
| **Boreal Forest-Taiga and North Pacific and Atlantic Ocean** | Loons, Eagles, Osprey, Songbirds (invertivores only)** | Osprey, Petrels | Otter, Seals | Perch, Pike, Walleye | Bluefish, Cod, Tuna | Pilot Whale |
| **Temperate Mixed Forest and Pacific and Atlantic Ocean** | Loons, Egrets, Herons, Eagles, Osprey, Terns, Songbirds (invertivores only) | Osprey, Terns | Otter, Seals | Perch, Bass, Walleye | Barracuda, Mackerel, Mahi mahi, Sharks, Tuna | Pilot Whale |
| **Tropical Rainforest and South Pacific and Atlantic and Indian Ocean** | Egrets, Herons, Kingfishers, Songbirds (invertivores only) | Albatrosses, Frigatebirds, Shearwaters, Terns, Tropicbirds | Dolphins, Otter, Seals and Sea Turtles | Catfish, Cichlids, Snook | Barracuda, Grouper, Mahi mahi, Sharks, Swordfish, Tuna | Pilot Whale |

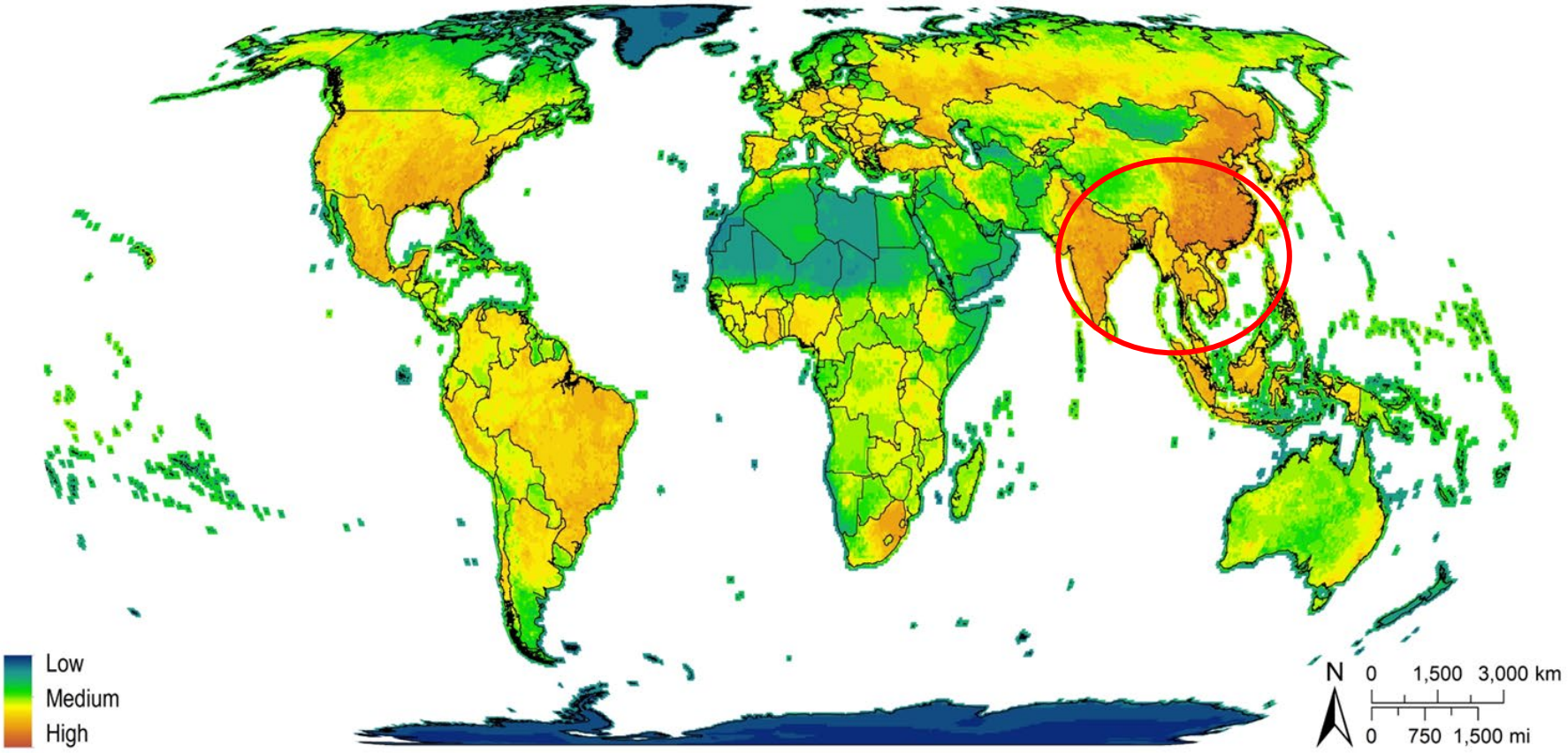
Evers, D.C., S.E. Keane, N. Basu, and D. Buck. 2016. Evaluating the effectiveness of the Minamata Convention on mercury: Principles and Recommendations. Science of the Total Environment 569-570:888-903.

PART 2:

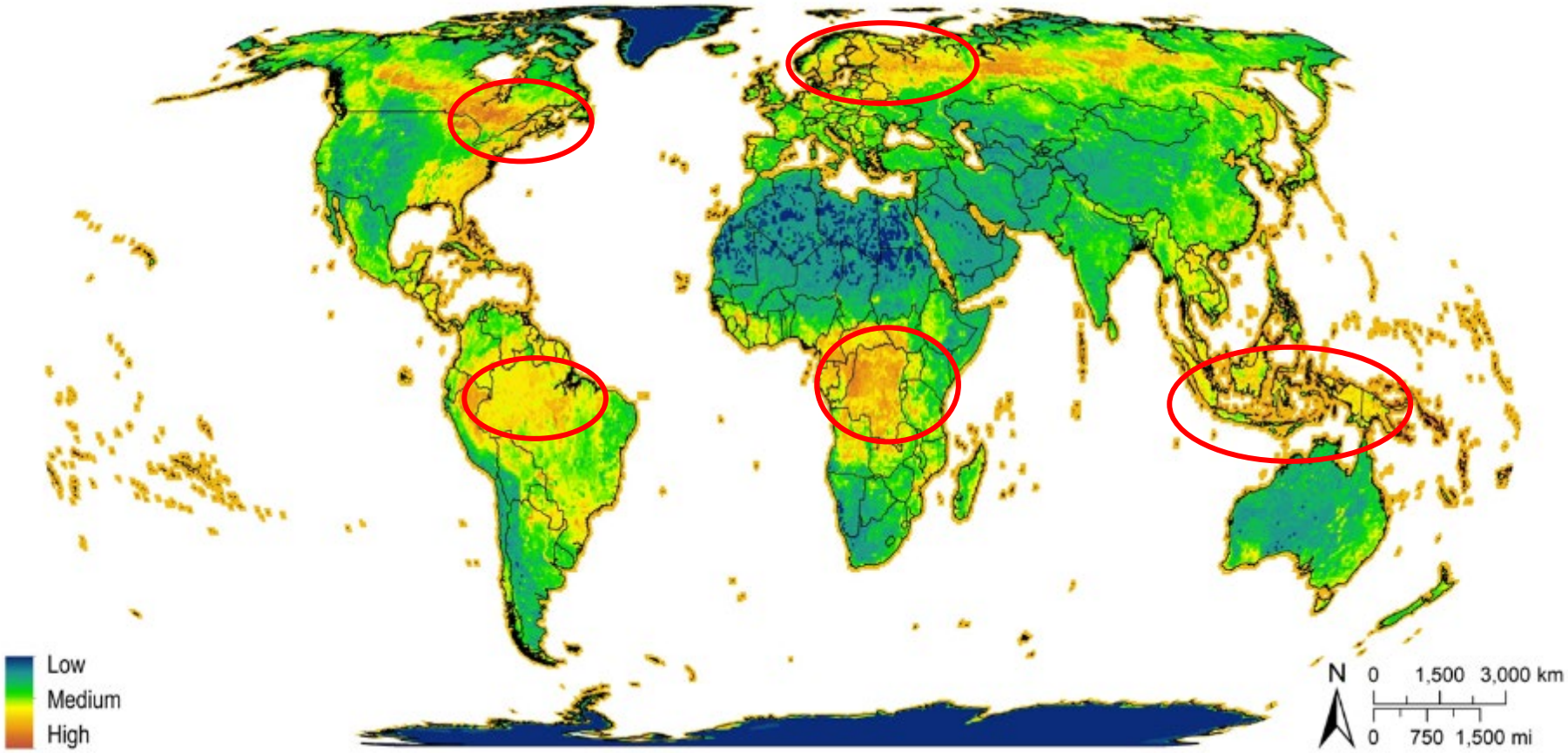
Map Mercury as a **Threat** to human and ecological health by combining **Ecosystem Sensitivity** + **Contamination Risk**



# Anthropogenic Influence/Source (e.g., Risk)

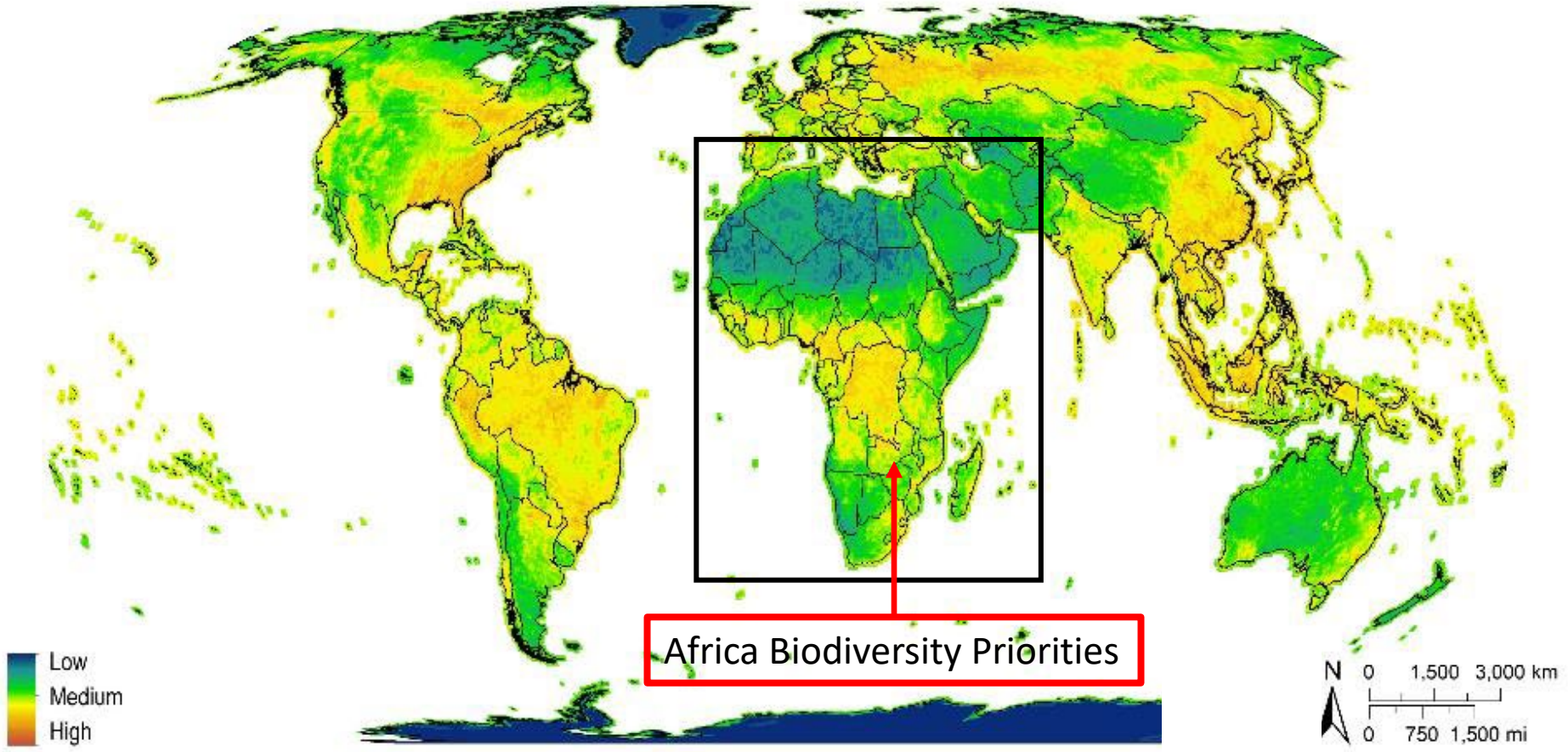


# Ecosystem Sensitivity

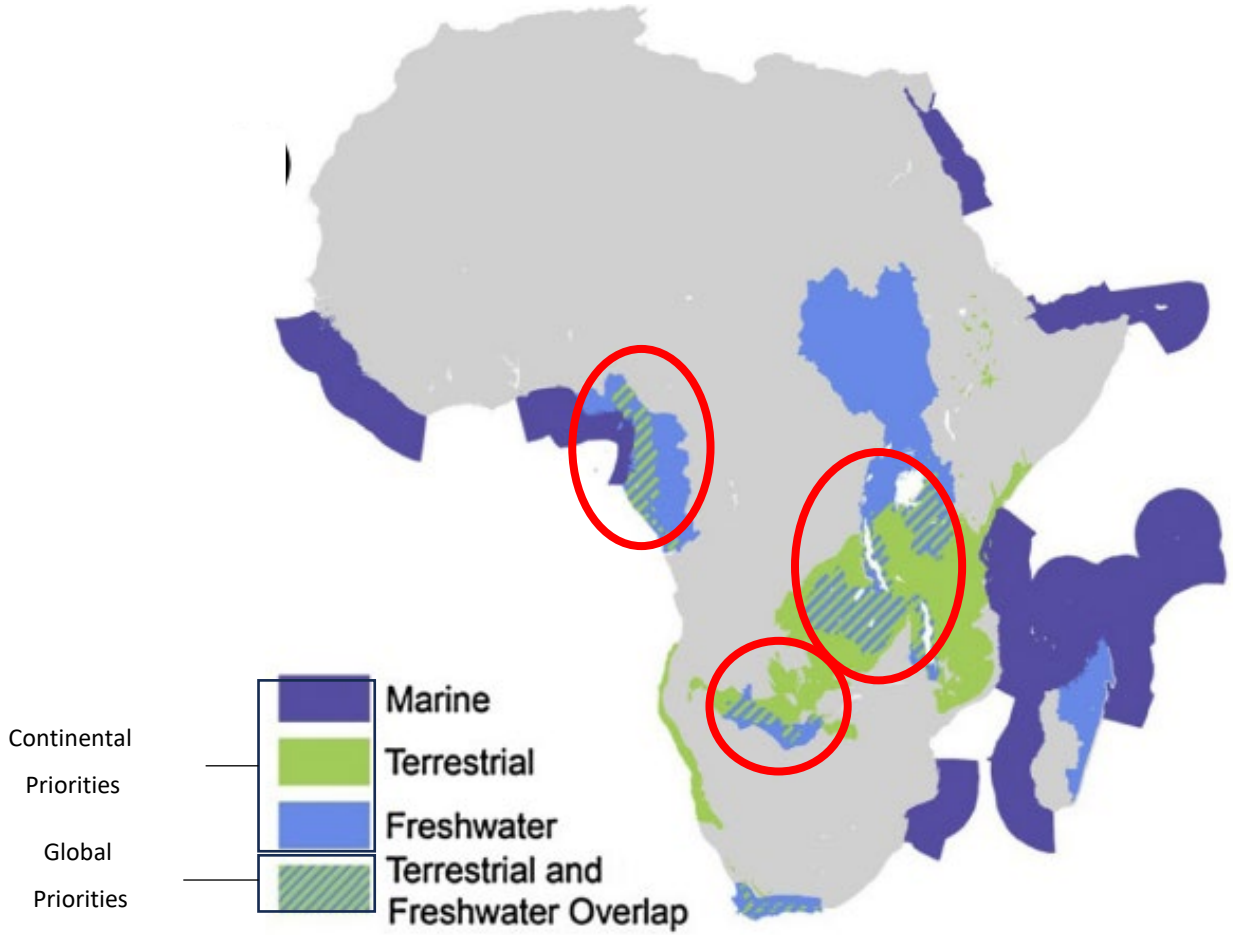


# Mercury Threat

Sensitivity + Risk = Threat

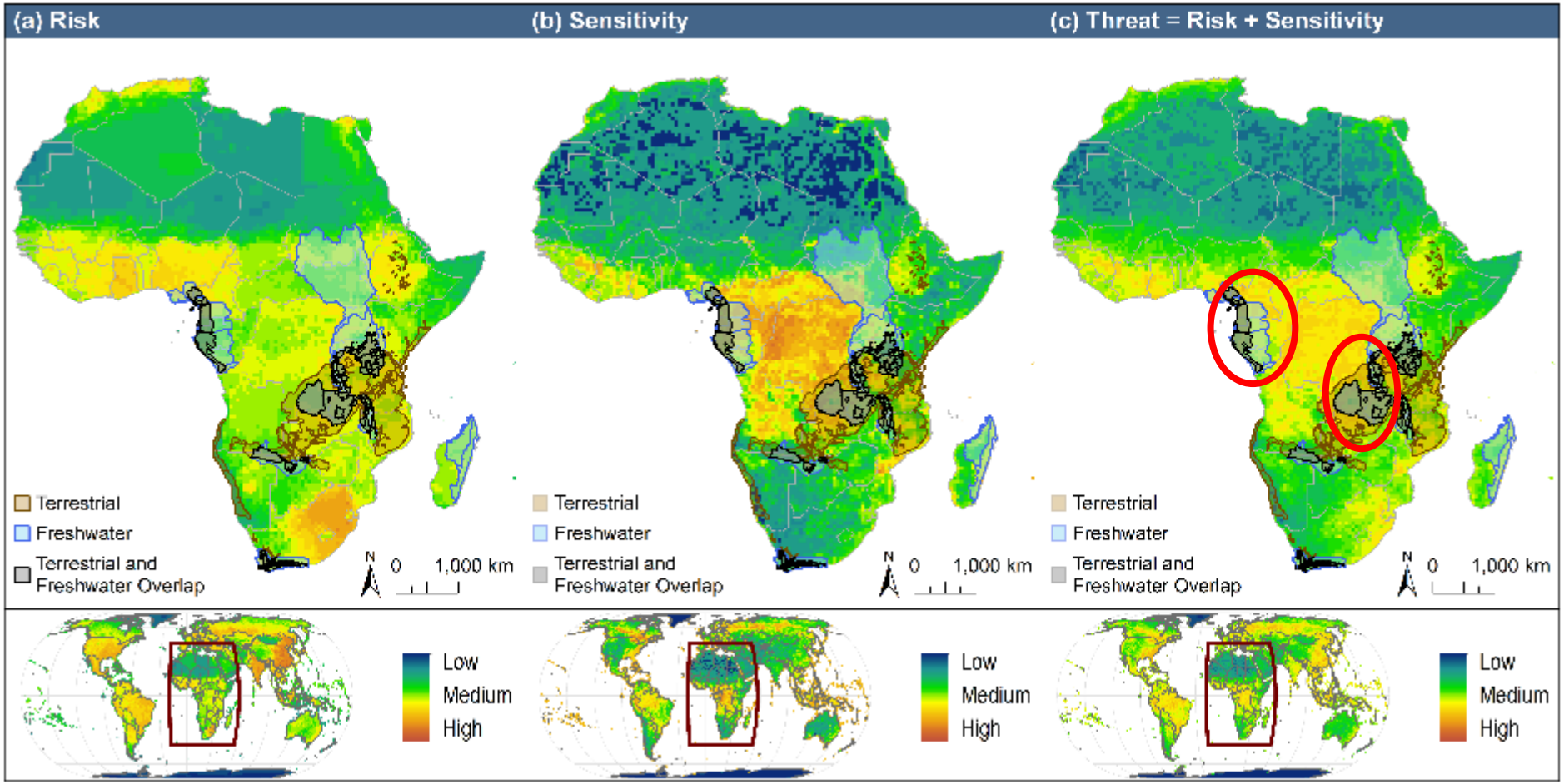


# 3. Biodiversity Priority Areas (e.g., Africa*)

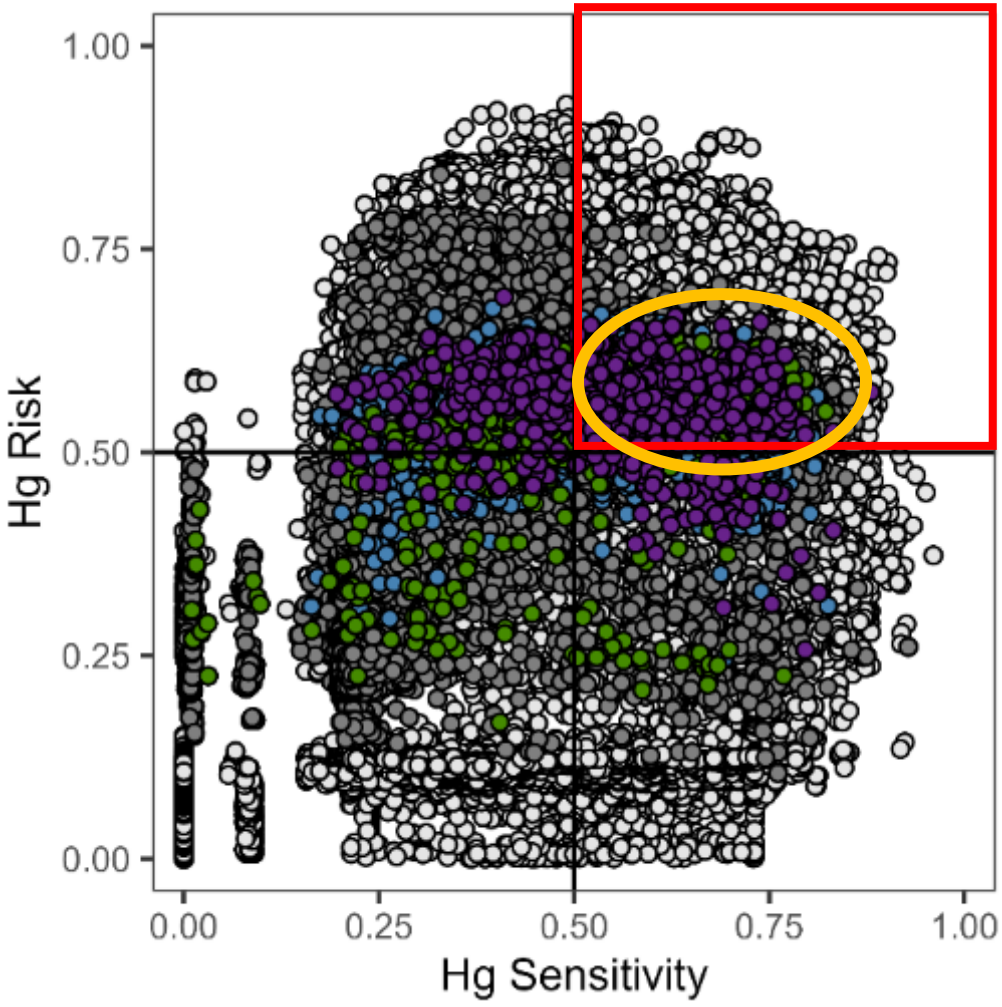



*Tear TH, Stratton BN, Game ET, Brown MA, Apse CD and Shirer RR. 2014. A return-on-investment framework to identify conservation priorities in Africa. *Biological Conservation 173*:42-52.

# Africa Biodiversity Priority Areas



# “Fingerprint” diagram – Africa Biodiversity Priorities




Circles represent scores for each mapping point (pixel) for Hg Threat.

For context, all Africa (dark gray) and global (light gray) scores are shown.

Terrestrial (green)
Freshwater (blue)

Combined (purple)

Meta-analyses of global biotic mercury concentrations. Percentage of species or families that include individuals with muscle tissue Hg concentrations exceeding the U.S. EPA – FDA human health threshold of 0.46 µg/g, ww ("choices to avoid").

| Taxa Group of interest to human health | Taxonomic Unit | Number Over | Percent Over |
|---|---|---|---|
| **Tuna** | Species (commercial) | 6 of 9 | 67% |
| **Billfish** | Species | 5 of 7 | 71% |
| **Sharks** | Genera | 21 of 24 | 88% |
| **Marine Fish – Mediterranean Sea** | Families | 24 of 35 | 69% |
| **Marine Fish – Caribbean Sea** | Families | 25 of 39 | 64% |
| **Freshwater Fish – African** | Families | 3 of 16 | 19% |
| **Freshwater Fish – South America** | Families | 16 of 30 | 53% |
| **Freshwater Fish – Asia** | Families | 21 of 31 | 39% |
| **Freshwater Fish – North America/Europe** | Families | 12 of 25 | 48% |
| **Seabirds – Arctic and subarctic** | Species | 6 of 20 | 30% |
| **Marine Mammals – toothed whales** | Species | 38 of 38 | 100% |

Evers et al. 2024. Global mercury concentrations in biota: Their use as a basis for a global biomonitoring framework. Ecotoxicology 33:325-396.

# Summary

1. A first-time meta-analysis demonstrates that over 50% of tuna, billfish, sharks, and toothed marine mammals and then fish from the Mediterranean and Caribbean Seas and freshwater fish from South America and parts of North America and Europe are over the threshold of fish to avoid to eat

2. Mercury levels of these fish (>0.46 ppm, ww) are **10 to 100x** higher than adverse behavioral effects to fish (0.04 ppm, ww)

3. Global models are now available to identify where the most sensitive ecosystems to Hg overlap with important biodiversity areas.

4. Because of the large number of studies demonstrating how mercury adversely impacts biodiversity at different levels—including individuals, populations, species, and higher taxa—**global biodiversity is likely significantly negatively impacted.**

# Questions?


Evers DC et al. (2024) *Global mercury concentrations in biota: Their use as a basis for a global biomonitoring framework*. Ecotoxicology 33:325-396.

OPEN ACCESS THROUGH JULY 2024


# Global environmental mercury loads in biota and impacts on biodiversity

https://link.springer.com/collections/ifigffgedi

https://briwildlife.org/special-ecotoxicology-mercury-issue/

This special issue will strive to provide further understanding of the science needed for both the Minamata Convention on Mercury and the Convention on Biological Diversity.

**Guest Editors:**

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**Paco Bustamante**, La Rochelle Université
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