# WHAT'S WRONG WITH WORMS?


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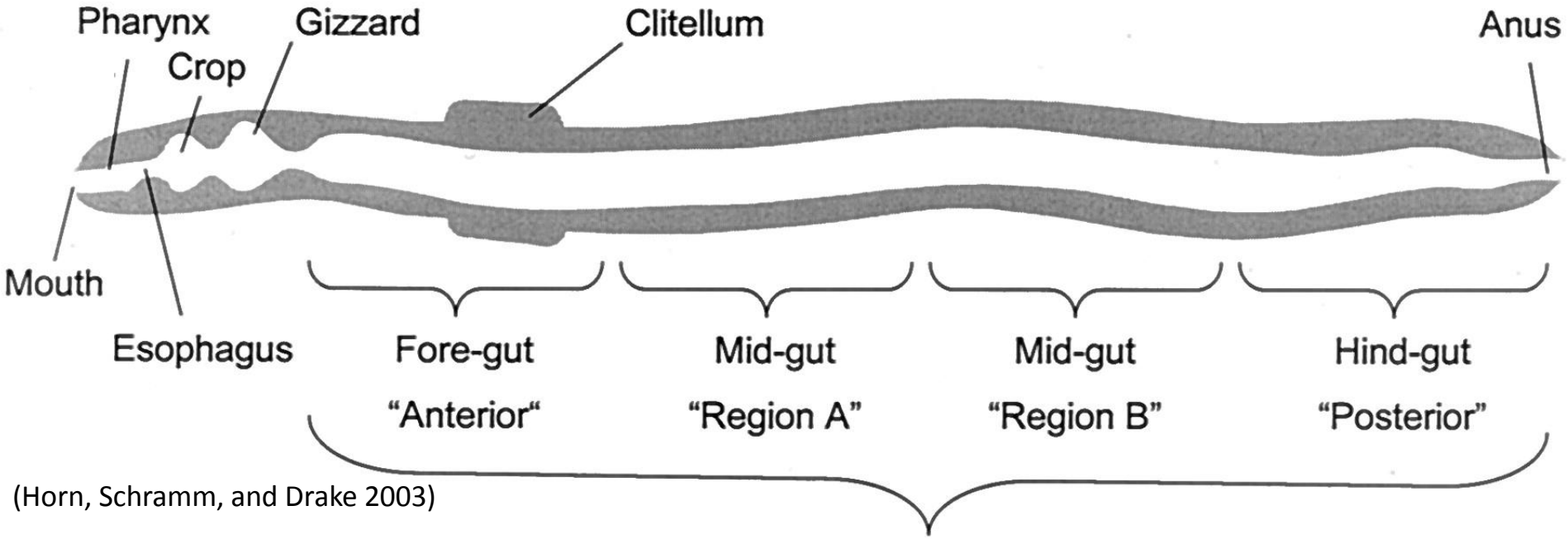
**Environmental Educator**


**Seventh Western Native Plants Conference, December 2016**

# EARTHWORM DIGESTIVE SYSTEM




(Horn, Schramm, and Drake 2003)

- Live 4 to 15+ years
- Eats their weight in soil/organic matter daily
- Food is processed in intestine (alimentary canal)
  - ✓ Muscular mixing with enzymes and microbes in gut (anoxic) to release amino acids, sugars, organic molecules, nitrogen….
  - ✓ Molecules absorbed through intestinal membranes
- Waste Product: ***CASTINGS***

# BENEFITS OF EARTHWORMS (OM/soil digestion and bioturbation)

- Improve soil physical structure
  - ✓ better drainage/infiltration and aeration
  - ✓ reduced stormwater run-off
  - ✓ improved root penetration
- Decompose, Mineralize OM
  - ✓ Concentrate carbon and nutrients
  - ✓ Enhanced soil fertility and tilth for plant growth, seed germination, crop yield.

# NUTRIENT VALUE OF CASTINGS

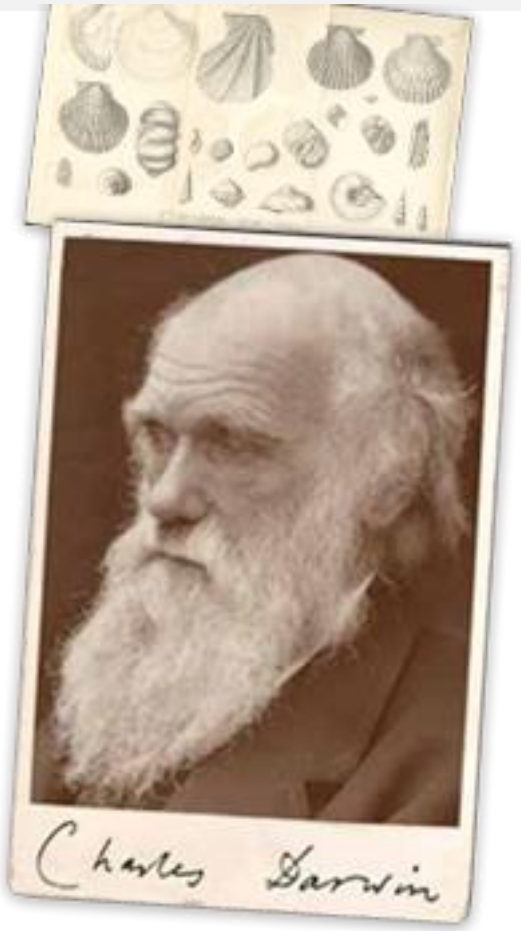
- Nitrogen 1.80–2.05%
- Phosphorus 1.32–1.93%
- Potassium 1.28–1.50%
- Calcium 3.0–4.5%
- Magnesium 0.4–0.7%
- Iron 0.3–0.7%
- Manganese traces–0.40%
- Zinc 0.028–0.036%
- Organic Carbon 20-30%
- pH 6.0–7.0

# Darwin ❤ Earthworms!

*"The plow is one of the most ancient and most valuable of Man's inventions; but long before he existed, the land … was regularly ploughed, and still continues to be ploughed, by earthworms. It may be (doubtful) whether there are many other animals which have played so important a part in the history of the world as these lowly, organized creatures."*

- Charles Darwin (*Earthworms* 1881)

…his last book, published just six months before he died.



# Different earthworms…
# Different functions….

**Compost Dwellers** (Epigeic)

Live in high organic matter environments

- ✓ *Eisenia fetida* (red wriggler; tiger worm)

**Soil Surface Dwellers** (Epigeic)

Feed on decaying roots, shoots, leaves, and dung and live on or near soil surface (0-15 cm depth)

- ✓ *Lumbricus rubellus*

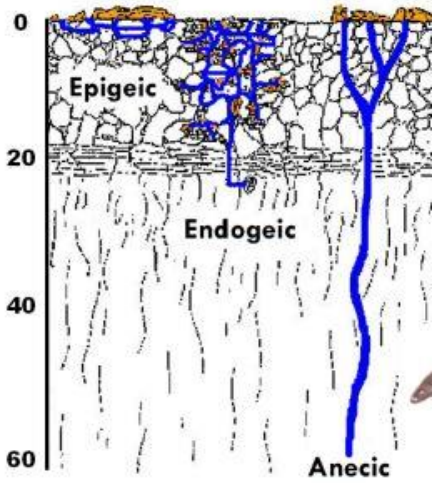
(European earthworm; red wriggler)

**Topsoil Dwellers** (Endogeic)
Live in the top 20-30 cm of soil.
Burrow through soil, eating and excreting it.

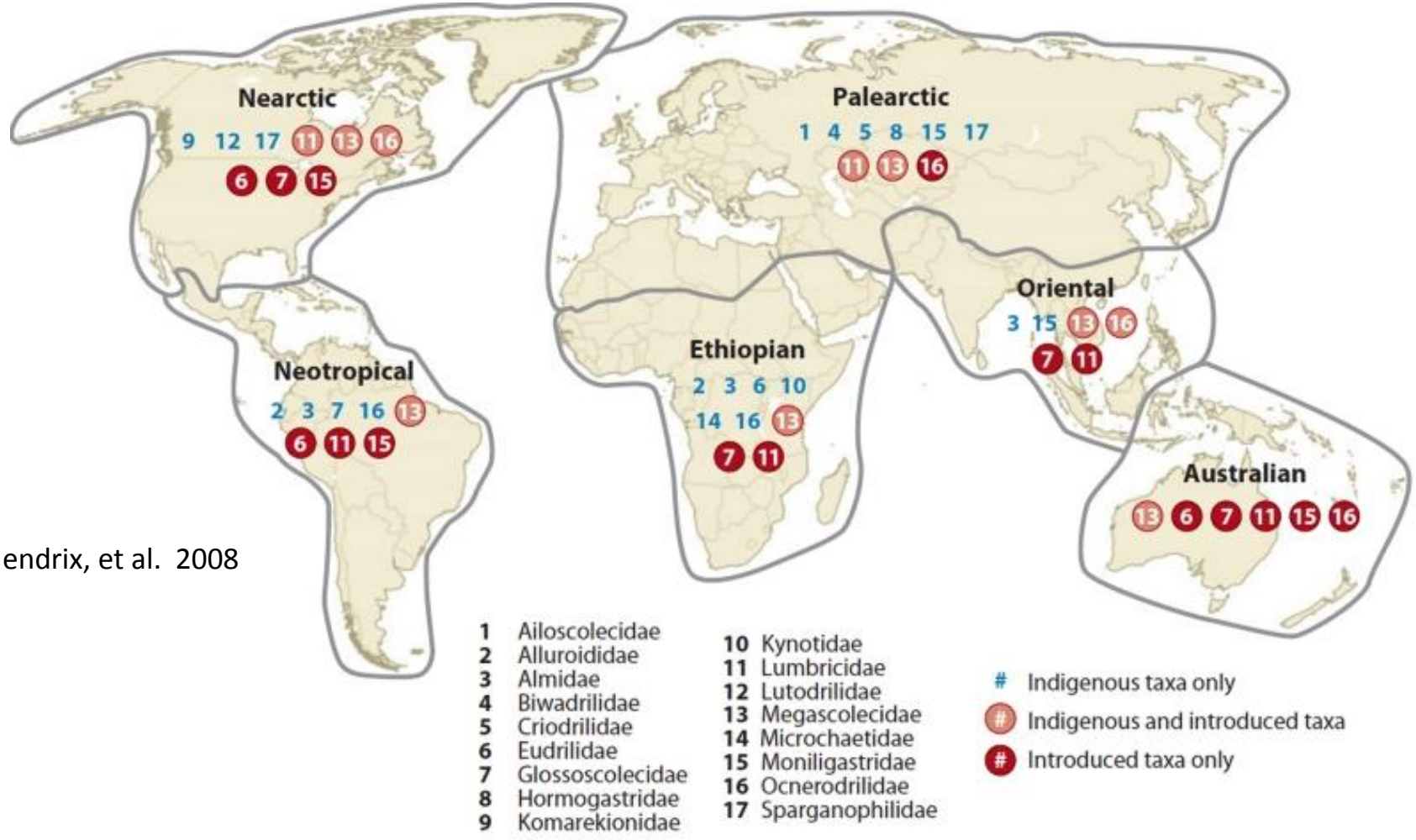
- ✓ *Aporrectodea caliginosa* (grey worm)
- ✓ *Octolasion cyaneum* (blue-grey worm)
- ✓ *Lumbricus terrestris* (nightcrawler)


**Subsoil Dwellers** (Anecic)
Tend to live in permanent burrows as deep as 4 ft below soil surface.

- ✓ *Aporrectodea longa*

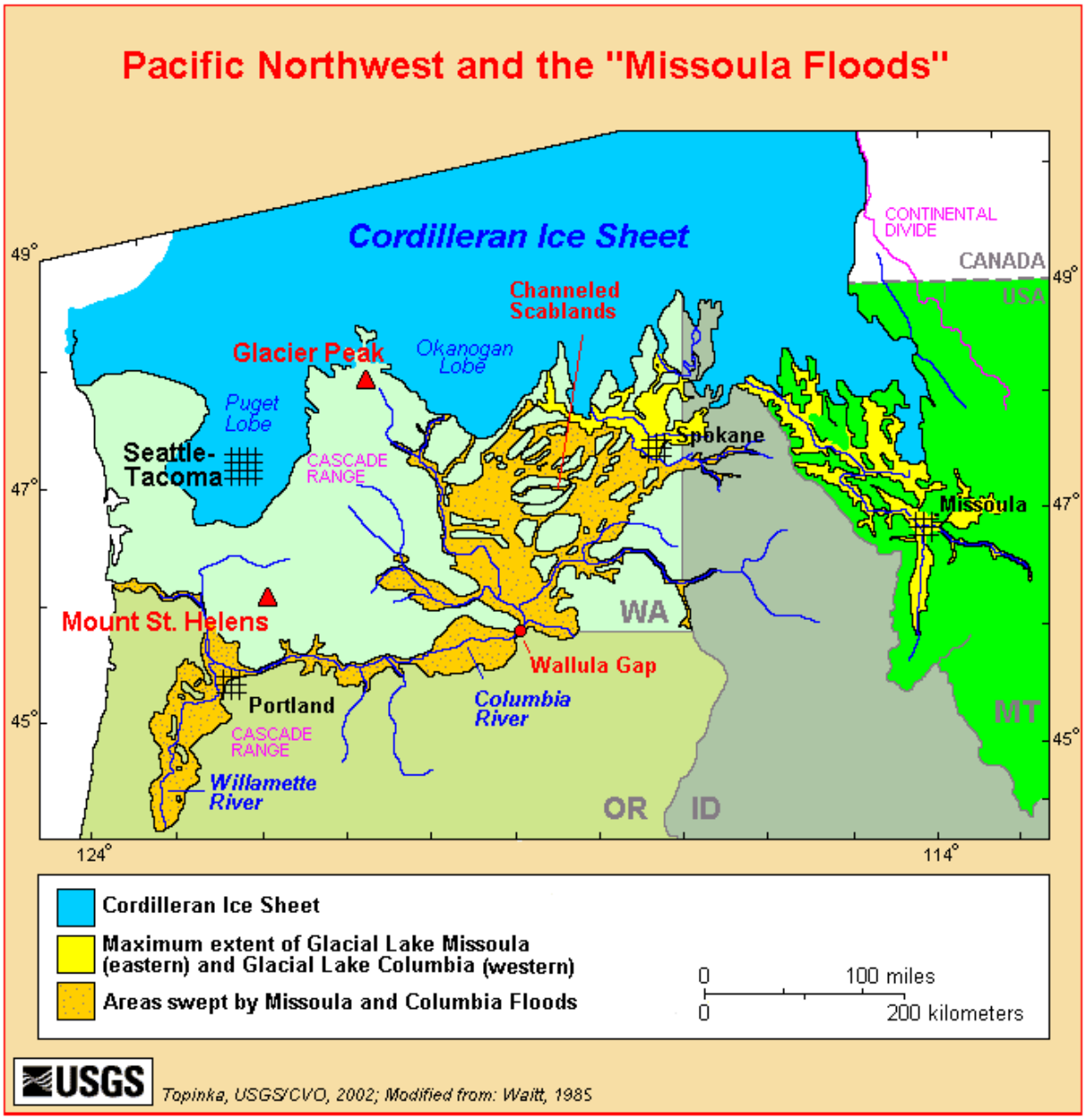


# EARTHWORM DIVERSITY



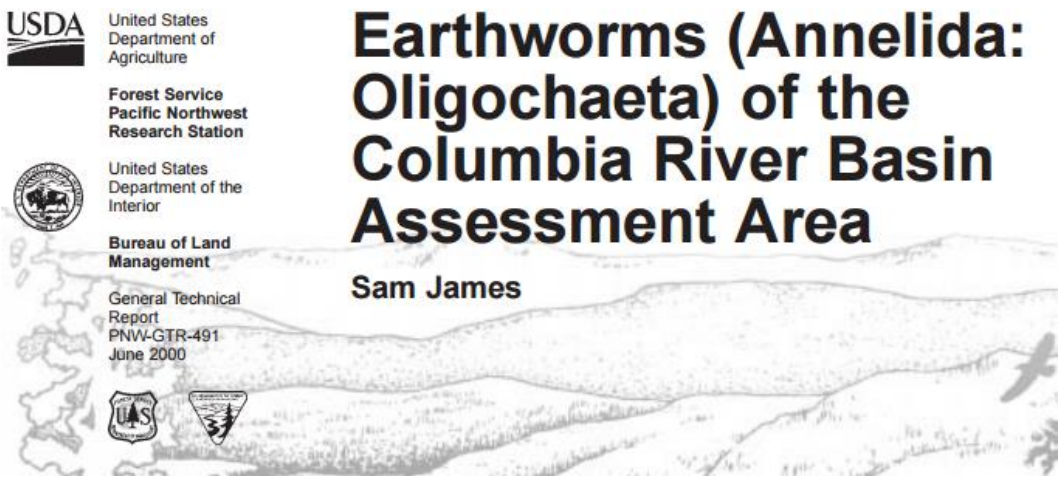

Hendrix, et al. 2008

- 3,700?? species world-wide; 17 families
- Native North American earthworms are diverse (~100-110 species)
- They're only indigenous to previously unglaciated an un-permafrosted areas
- Present-day ecosystems can develop fine without presence of earthworms




If you live in the Puget Sound region, every earthworm you've ever seen in your garden or elsewhere here is a non-native (introduced) species; (migration rate is ~5 ft/year)

Yaniria Sanchez-de Leon; 2005 (Univ. of Idaho)





**GIANT PALOUSE EARTHWORM (*Driloleirus americanus*)**

# EARTHWORMS AS INVASIVE SPECIES

- Introduced earthworms now occur in every biogeographic region (except the driest and coldest habitats)
- ~ 120 species are recognized to be widespread from regional to global scales.
- Principal widespread, invasive species are adapted to human transport and to colonization of disturbed habitats.
- Humans are primary vectors: ship ballast, nursery trade, soil movement, fishing bait, vermiculture, off-road recreation….

**Ecological Risk Assessment of Non-indigenous Earthworm Species**

Prepared for U.S. Fish and Wildlife Service
International Affairs
Division of Scientific Authority

Final Draft
Submitted on March 4, 2003

Nick Proulx
Minnesota Department of Natural Resources
Division of Ecological Services
500 Lafayette Road, Box 25
Saint Paul, MN 55155

Pandora's Box Contained Bait: The Global Problem of Introduced Earthworms*

Paul F. Hendrix,[1,2] Mac A. Callaham, Jr.,[3] John M. Drake,[1] Ching-Yu Huang,[1] Sam W. James,[4] Bruce A. Snyder,[1] and Weixin Zhang[5,6]

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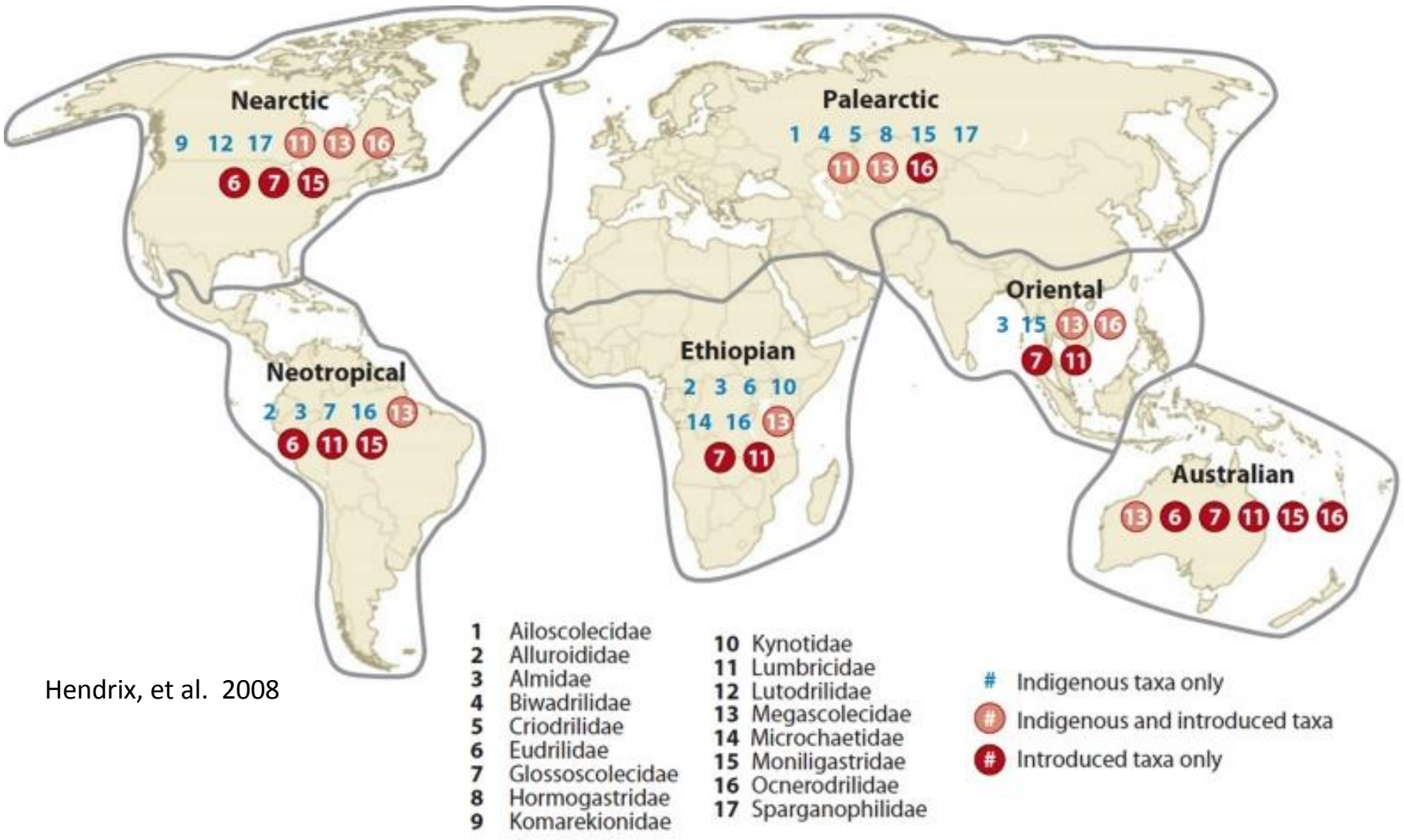
# EARTHWORMS AS INVASIVE SPECIES

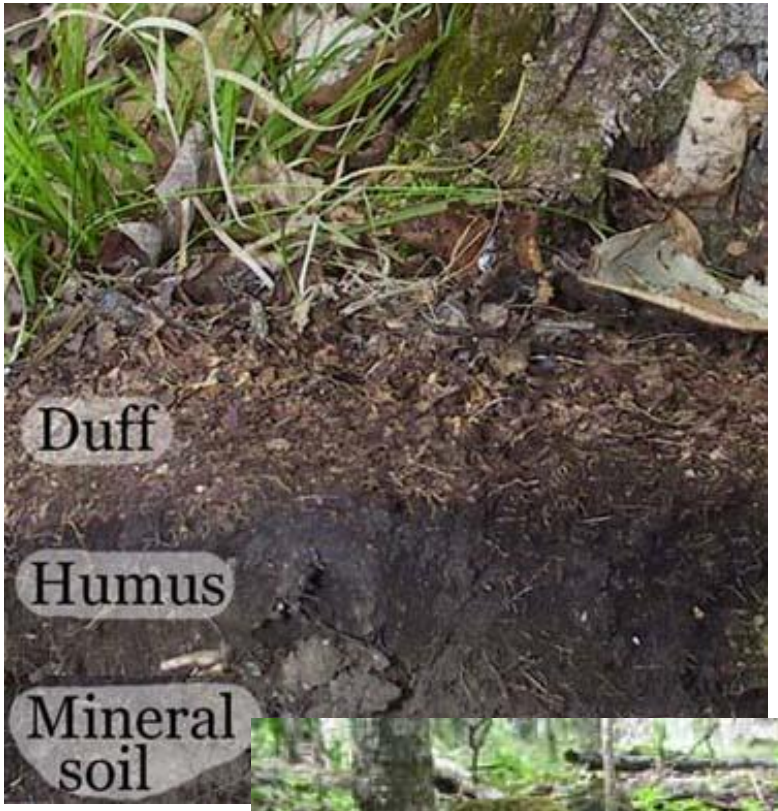



Hendrix, et al. 2008

Eurasian earthworms (Lumbricidae) are primary culprits in northern forests of North America, but Asian, African, and South American species have all found their way there. At least 15 non-native Eurasian species have been identified in Canadian soils.

# EARTHWORMS AS INVASIVE SPECIES

- Earthworms rapidly consume, mix, and decompose organic material.
- Naturally earthworm-free ecosystems have soil processes (nutrient and organic matter cycling) that are controlled by fungi and bacteria—resulting in very slow cycling and accumulation of a forest “floor” (mor duff).
- Where invasions occur in occupied soils (or heavily disturbed soils where native worms have been negatively impacted), soil processes may not be so drastically altered, although it’s still possible to have major physical, biological, and chemical changes.




# EARTHWORM EFFECTS IN TEMPERATE DECIDUOUS FORESTS


NO EARTHWORMS


HEAVY EARTHWORM INVASION

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# EARTHWORMS AS INVASIVE SPECIES

**In cold-temperate forests of North America invasive worms threaten forest ecosystems by:**

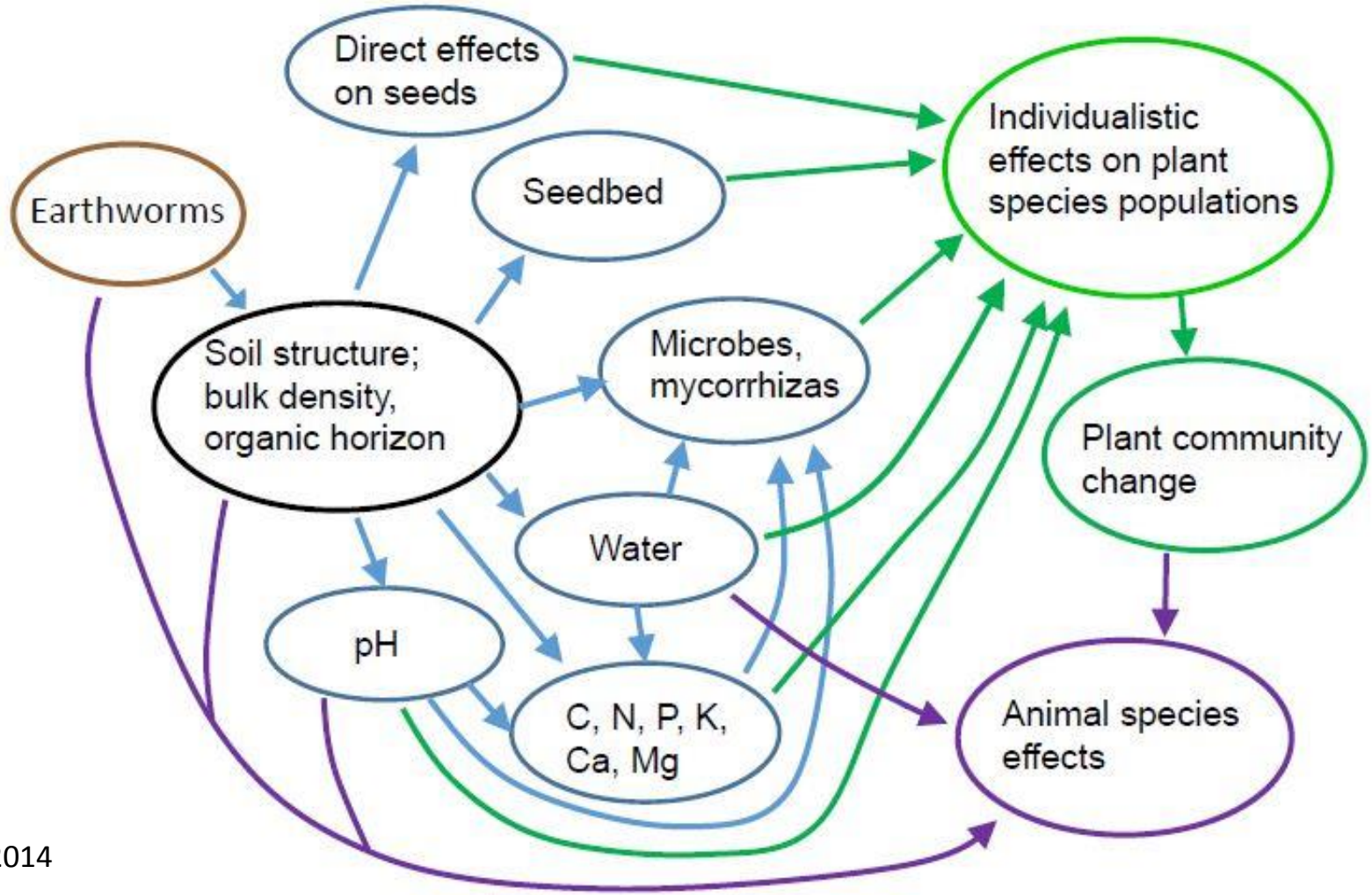
- decreasing soil C:N ratios (changes in type of humus content (mor into mull)
- decreasing or eliminating leaf litter (soil duff layers)
- disrupting soil seed bank
- altering soil temperature and structure, including increased heating and compaction
- altering nutrient cycling and dynamics
- altering water movement/retention
- changing soilfoodweb biota

**….which adversely affect forest ecosystem processes by:**

- encouraging growth of other invasive non-native species (buckthorn; garlic-mustard, stiltgrass, barberry…)
- inhibiting germination, establishment, growth of native trees and undergrowth
- altering patterns of forest succession, favoring shifts to grasses/graminoids
- decreasing plant/animal biodiversity [mammal, bird, reptile, amphibians, micro- and macro-arthropods (insects, crustaceans, spiders, mites, fungi, etc.)]
- negatively affecting species sensitive to change (e.g *Botrychium*, orchids…)
- increasing soil-sealing and subsequent runoff and soil erosion (castings)

# ECOSYSTEM MELTDOWN (CASCADE EFFECTS)

The complex of micro cascades leading to fundamental effects on soils (blue arrows), and secondary/tertiary effects on plants (green arrows), and animals (purple arrows)




Frelich 2014

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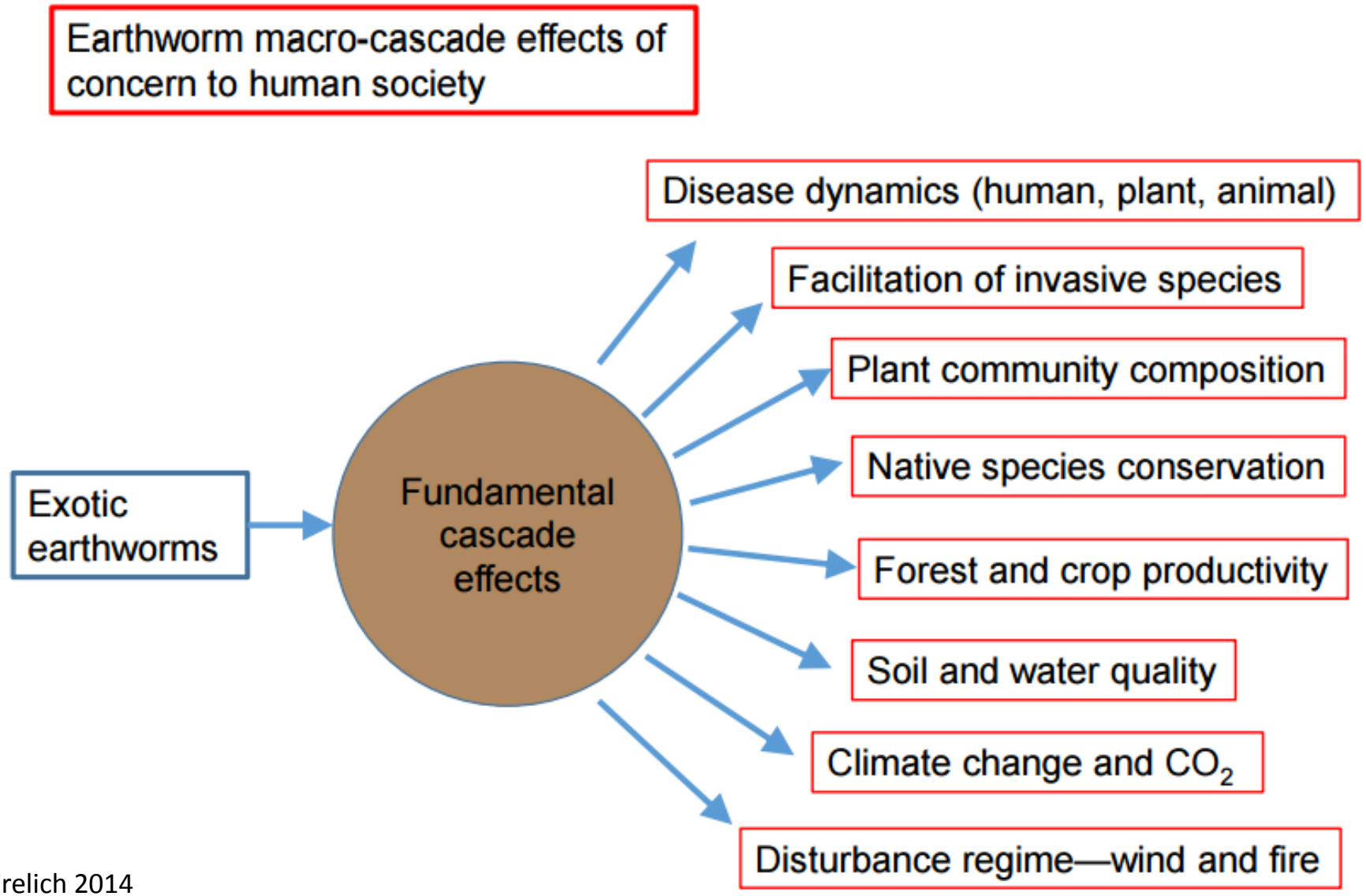


Frelich 2014

# TAKE-AWAYS

- Earthworms have large fundamental effects on soil physical environment (organic matter, temperature, moisture, nutrient content, structure) that ultimately effect many links in the foodweb. No known control measures.
- Profound implications for conservation of natural areas, especially forested ecosystems. "Keystone species" like beavers, wolves, sea urchins…??
- Much uncertainty remains regarding distributions, ecology, the invasive biology, and impacts of introduced earthworms around the world.
- Essentially no attention to earthworms in previously glaciated landscapes of Washington and British Columbia (coniferous forested ecosystems).
- Essentially no public policy has dealt with issue of earthworm invasion; most efforts focus on prevention and education.
- Large potential for many other species of earthworms to become invasive in the future, especially among tropical species. Positive attitudes towards earthworms and their ecological effects lead to casual disposal/use. Earthworm use is a strong cultural practice and the risk of their continued introduction is high.
- **Global Worming??**

# ADDITIONAL INFO

Hendrix, et al. 2008. Pandora's Box Contained Bait: The Global Problem of Introduced Earthworms. Annual Review of Ecology, Evolution, and Systematics Vol. 39: 593-613 (December).

http://naldc.nal.usda.gov/download/26847/PDF

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