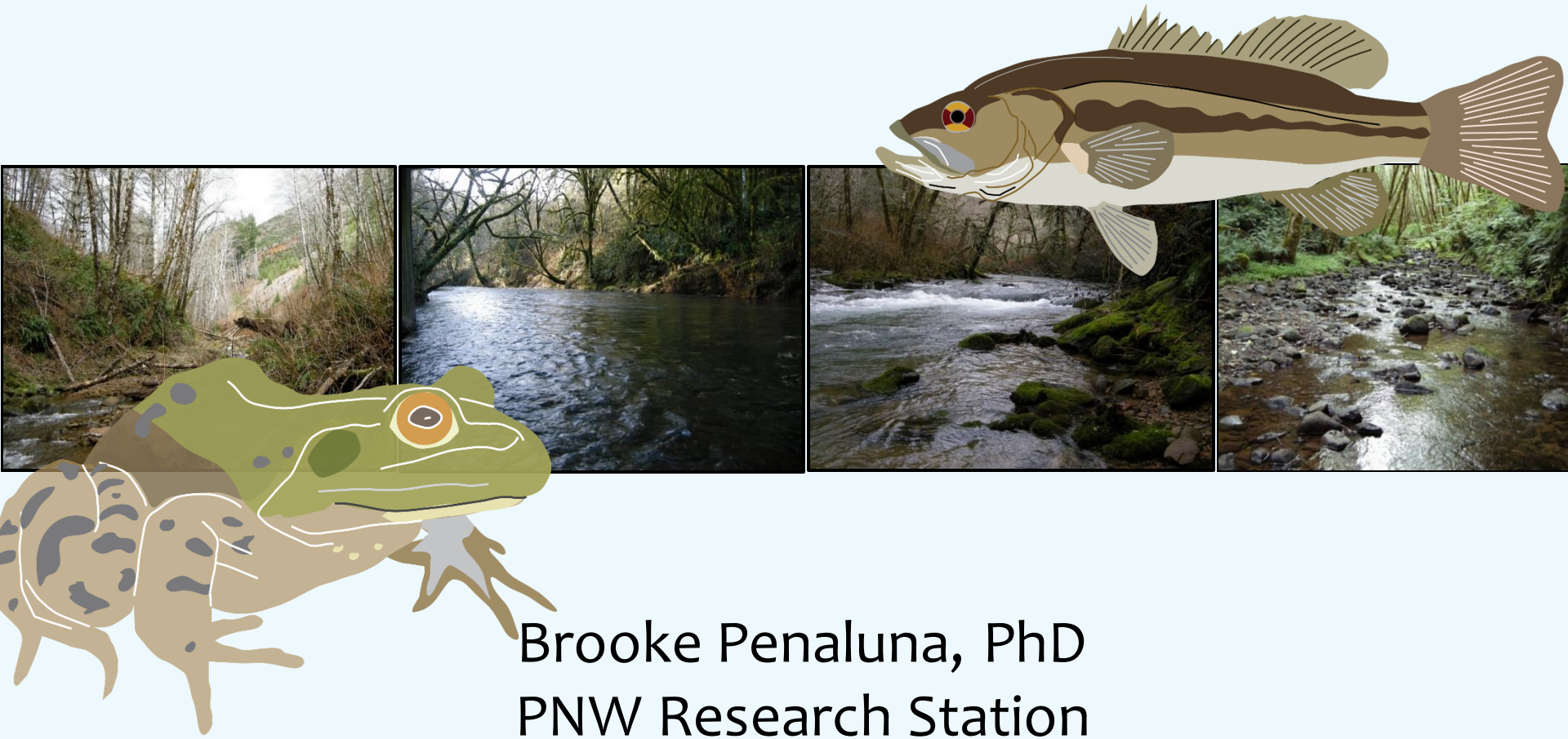
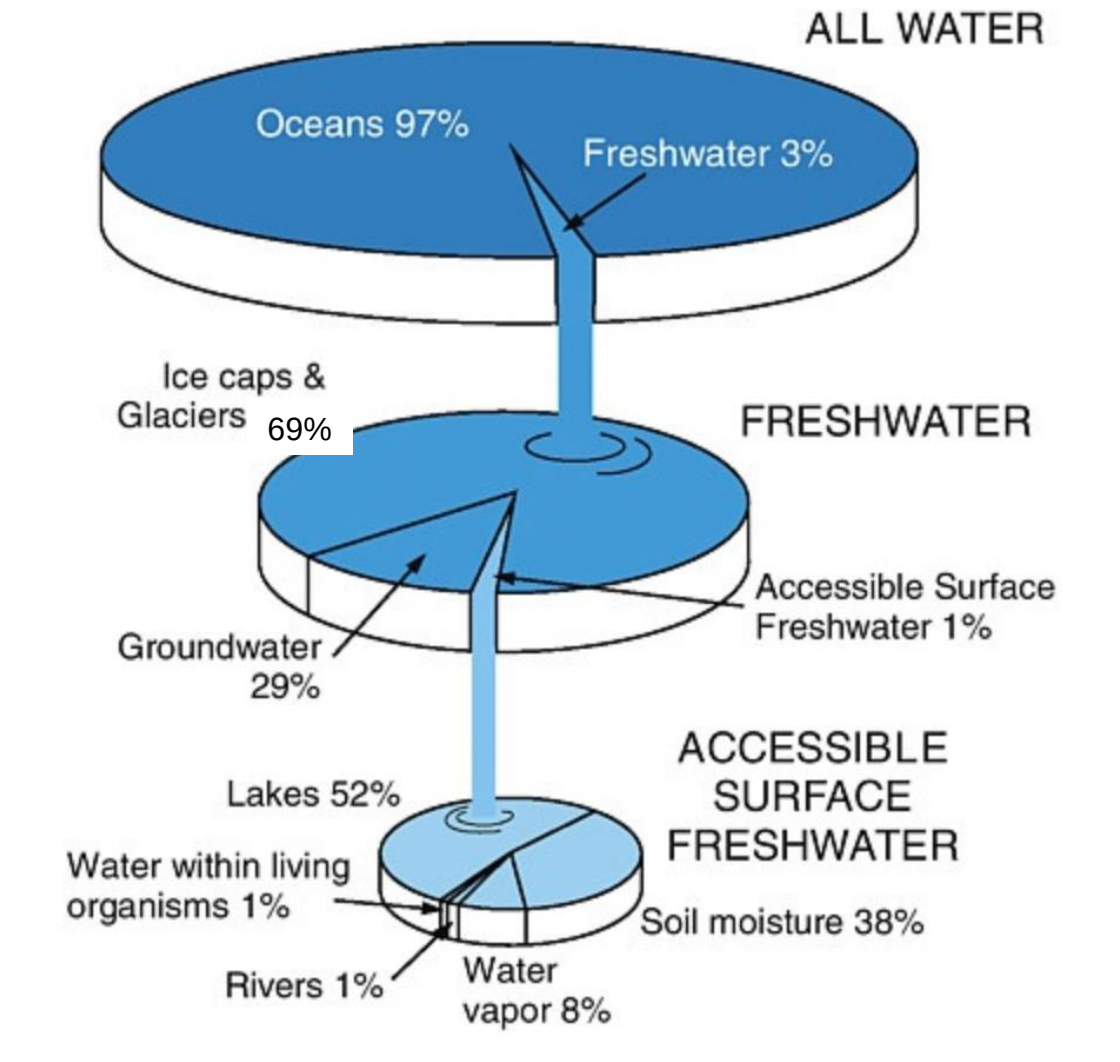
Detecting Aquatic Invaders with eDNA: Challenges and Opportunities



Brooke Penaluna, PhD
PNW Research Station
US Forest Service

Despite covering less than 1% of the Earth's surface, freshwaters support 1/3 of all vertebrates



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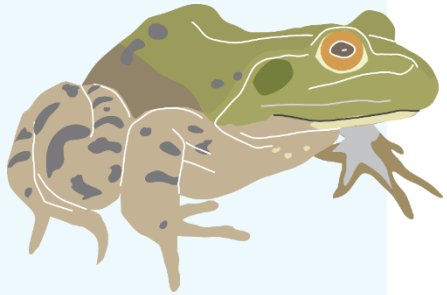
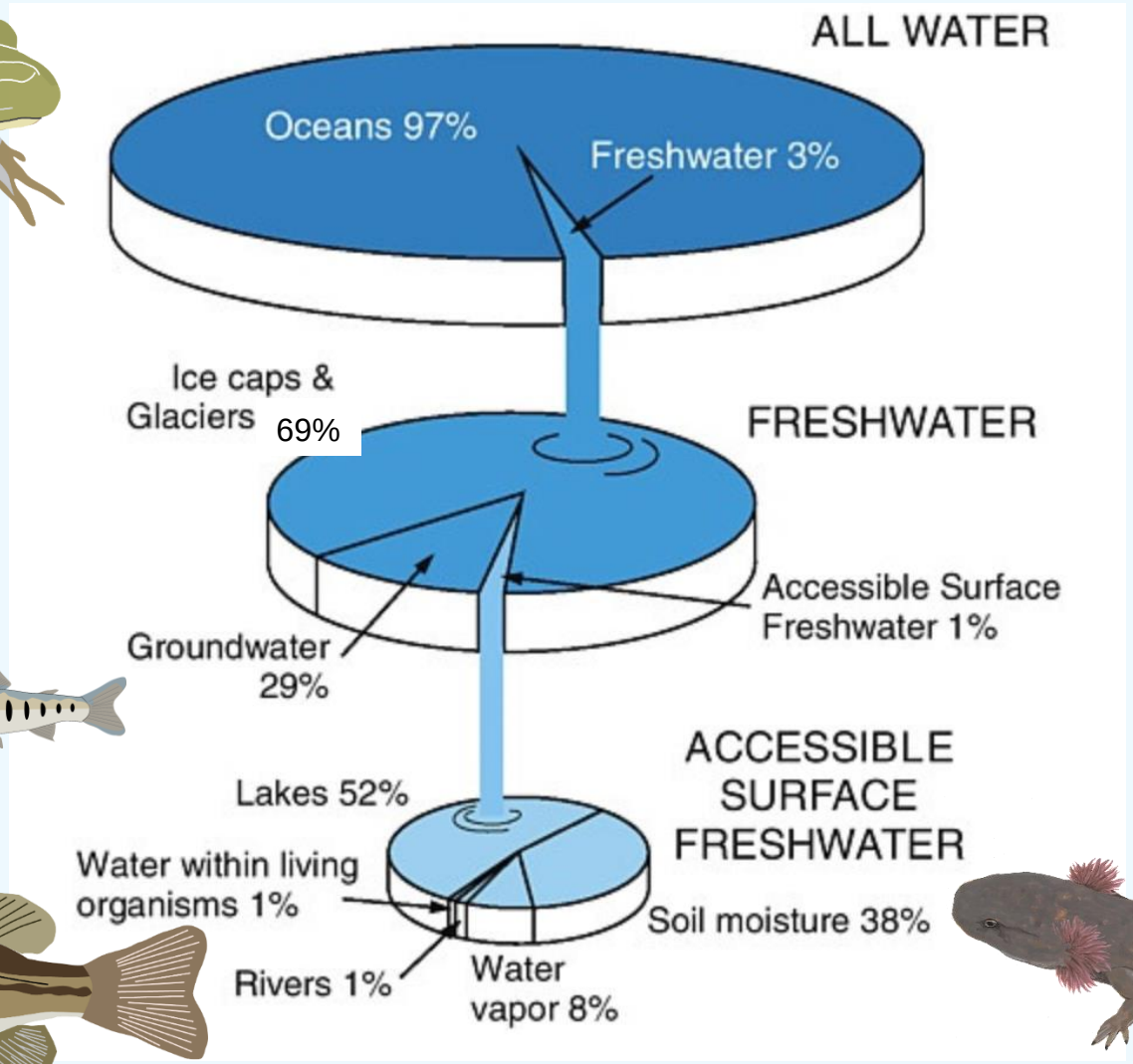
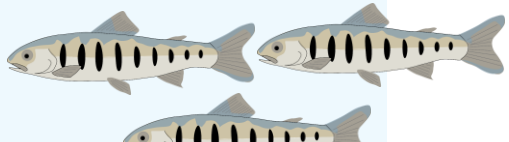
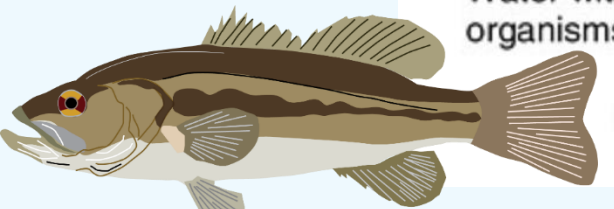
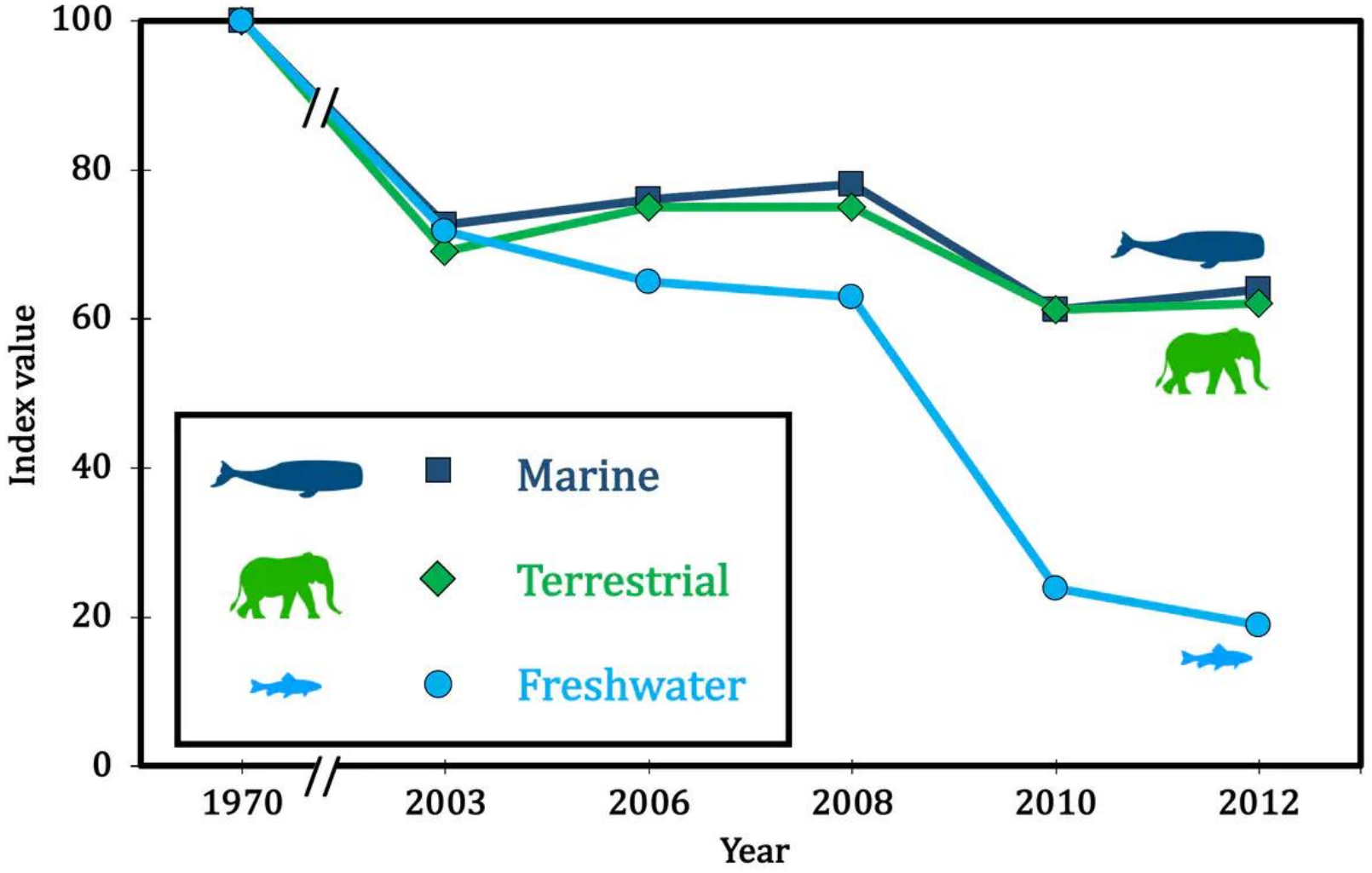




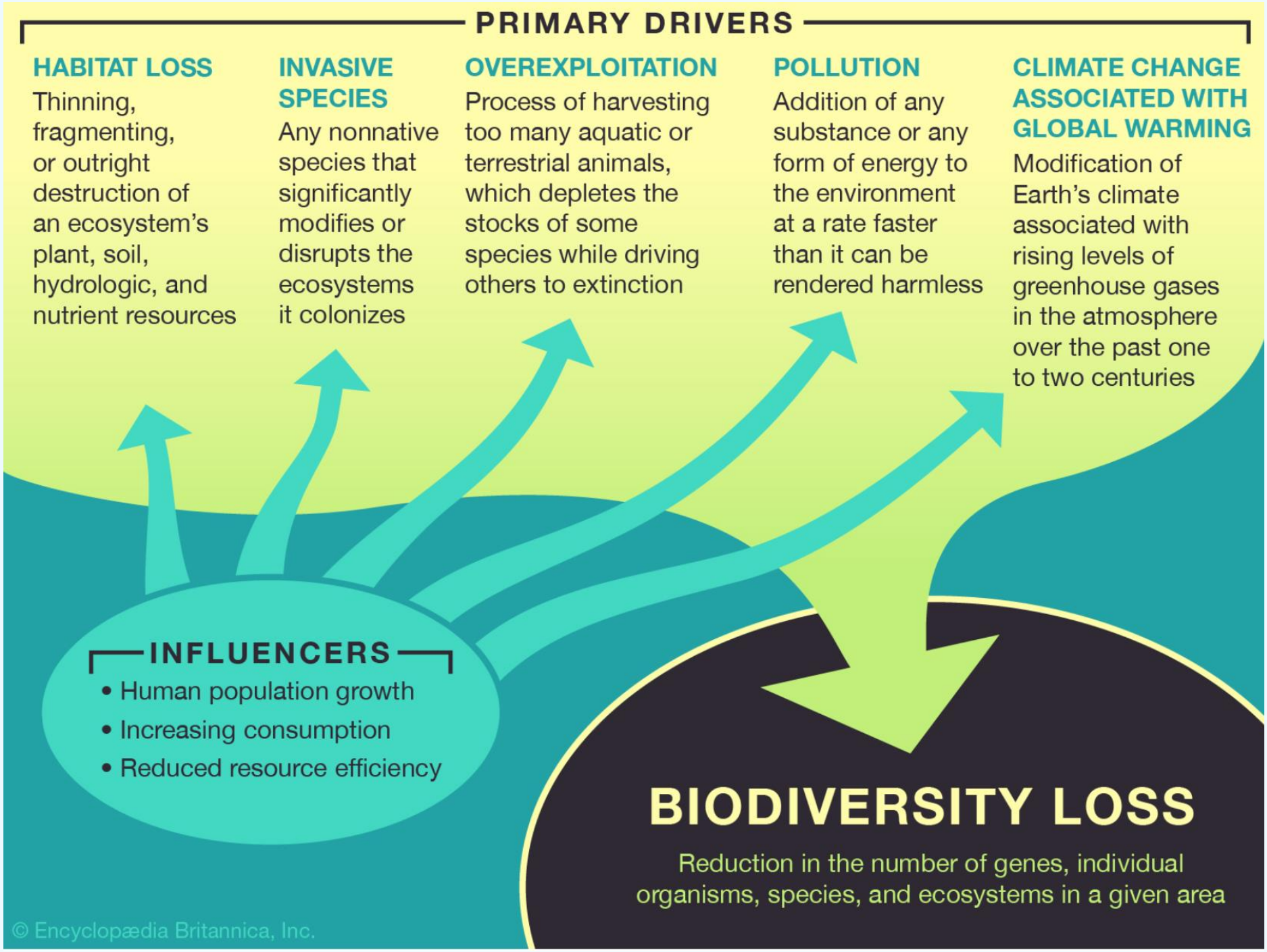




Worldwide freshwater biodiversity is among the most imperiled



Modified from Reid et al. 2018 for 2018 WWF world's living planet report


PRIMARY DRIVERS
HABITAT LOSS
Thinning, fragmenting, or outright destruction of an ecosystem's plant, soil, hydrologic, and nutrient resources
INVASIVE SPECIES
Any nonnative species that significantly modifies or disrupts the ecosystems it colonizes
OVEREXPLOITATION
Process of harvesting too many aquatic or terrestrial animals, which depletes the stocks of some species while driving others to extinction
POLLUTION
Addition of any substance or any form of energy to the environment at a rate faster than it can be rendered harmless
CLIMATE CHANGE ASSOCIATED WITH GLOBAL WARMING
Modification of Earth's climate associated with rising levels of greenhouse gases in the atmosphere over the past one to two centuries
INFLUENCERS
• Human population growth
• Increasing consumption
• Reduced resource efficiency
BIODIVERSITY LOSS
Reduction in the number of genes, individual organisms, species, and ecosystems in a given area
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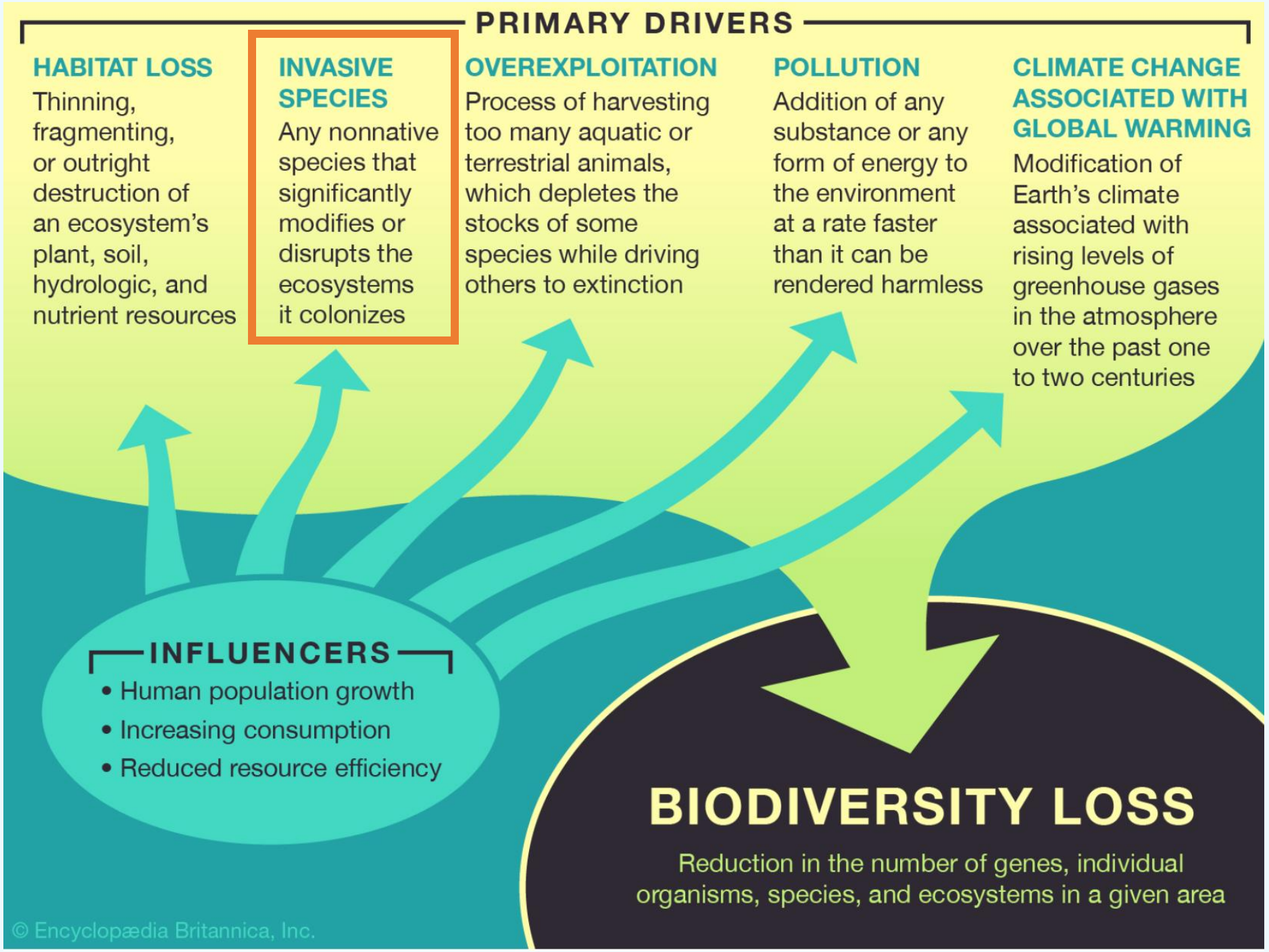
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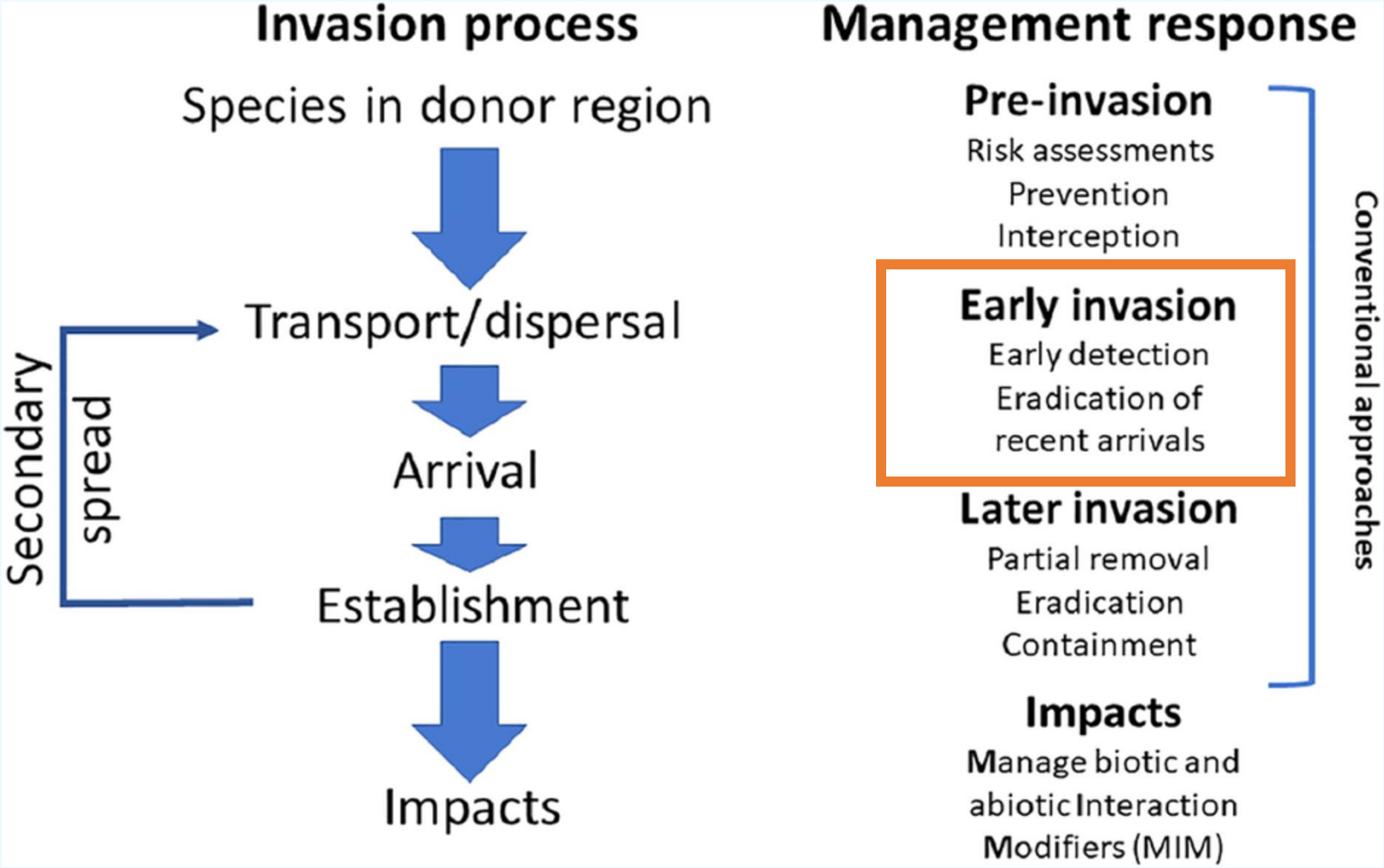
Detecting an invader when there are few greatly improves the success of eradication, decreases costs and impact



Dunham et al. 2020

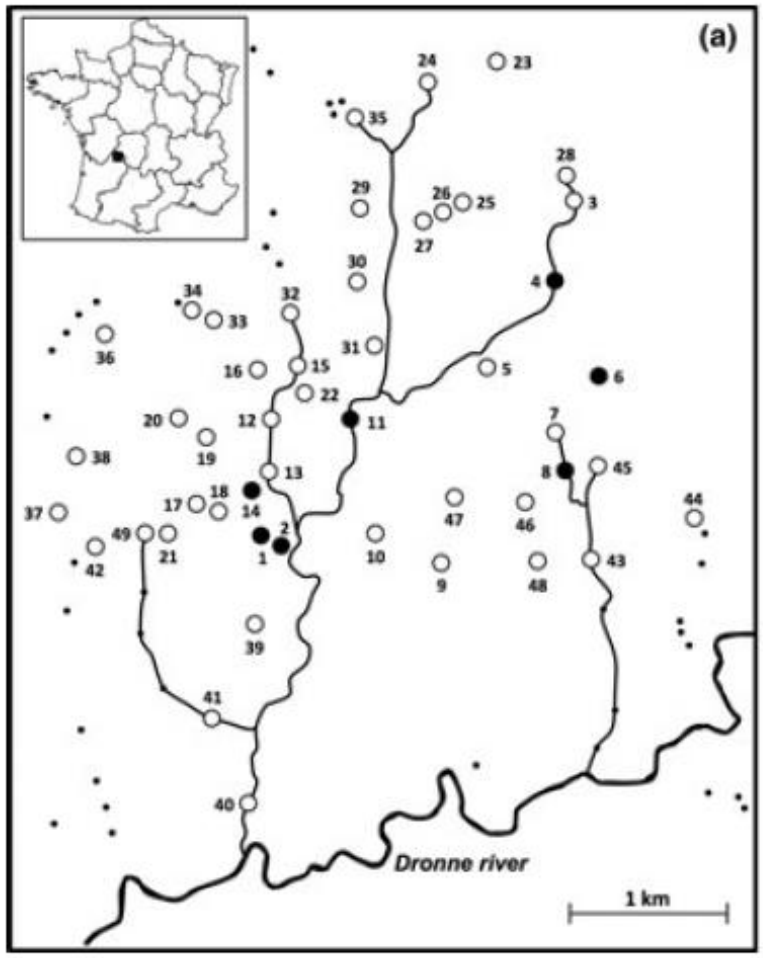

environmental DNA


environmental DNA

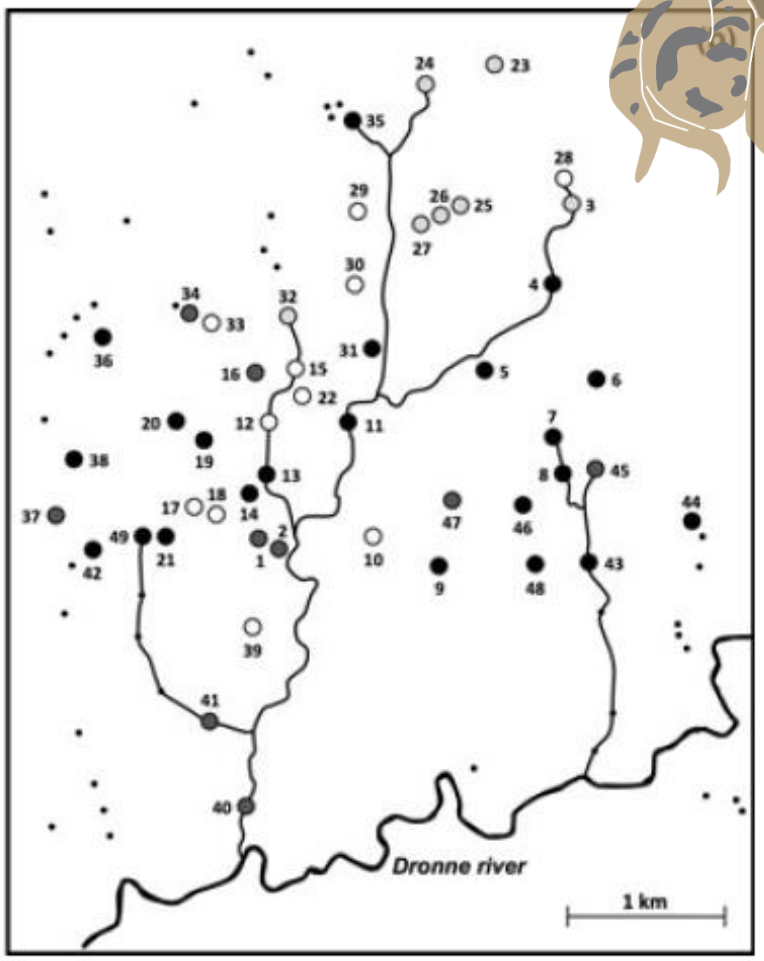

environmental DNA

eDNA improves detection of invasive American Bullfrogs over traditional surveys

Auditory/visual pond surveys



eDNA surveys



eDNA detected bullfrogs in 38/49 ponds suggesting ability to identify early detection of invasive species

● **Bullfrog detections**

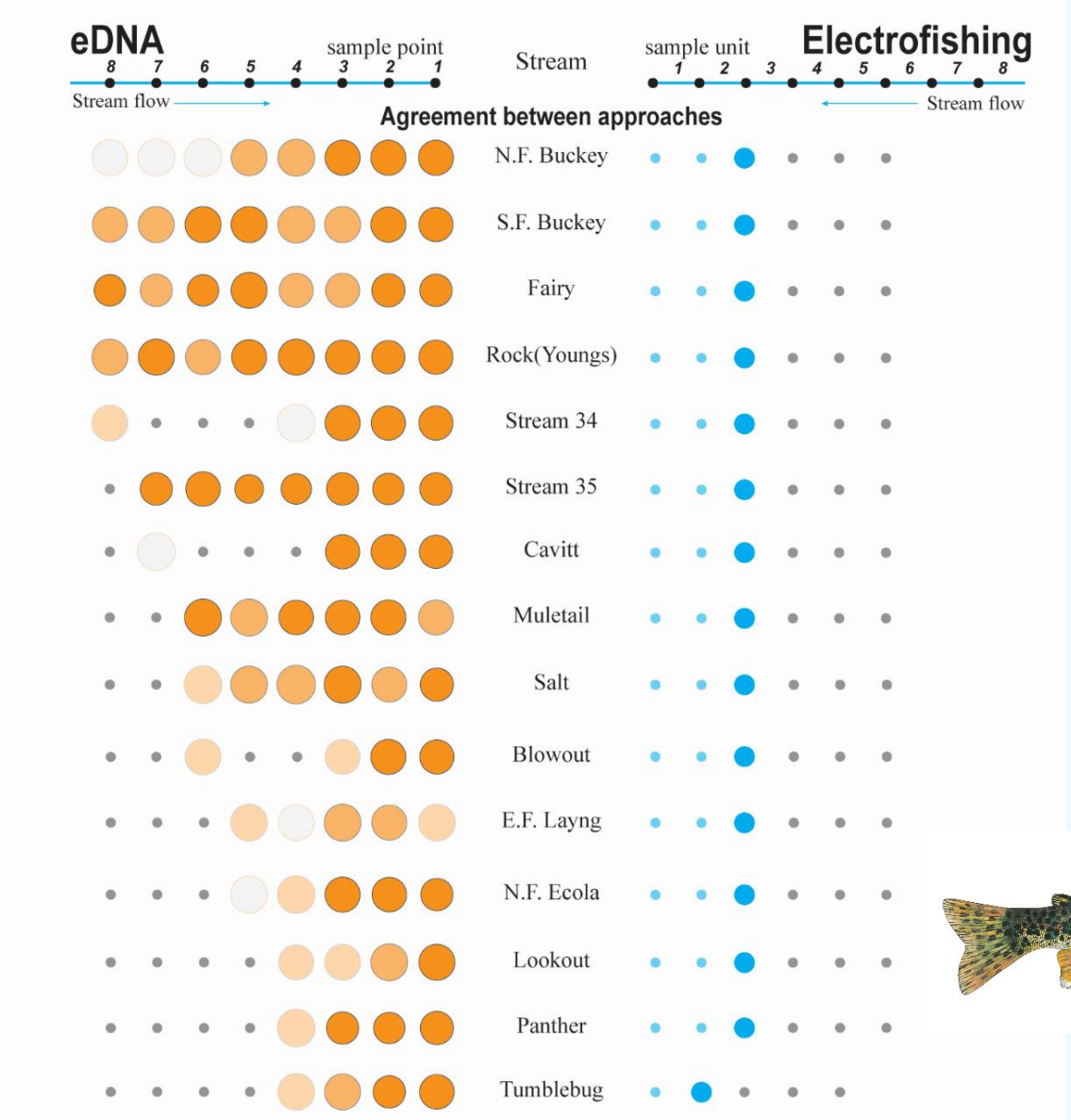
○ **No bullfrog detections**

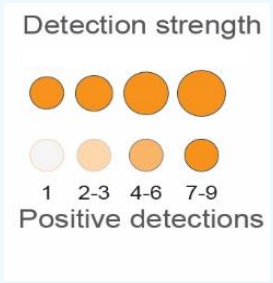
Dejean et al. 2012

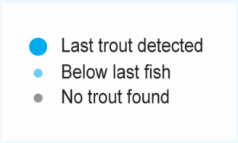
eDNA allows for early detection of rare species

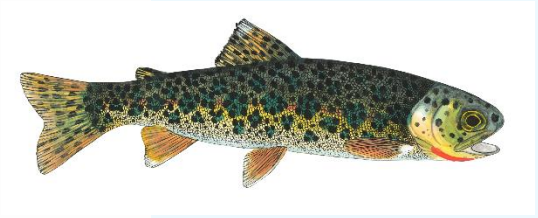
Ardura et al. 2015

eDNA suggests distribution extension of upper-most fish by 50-250m





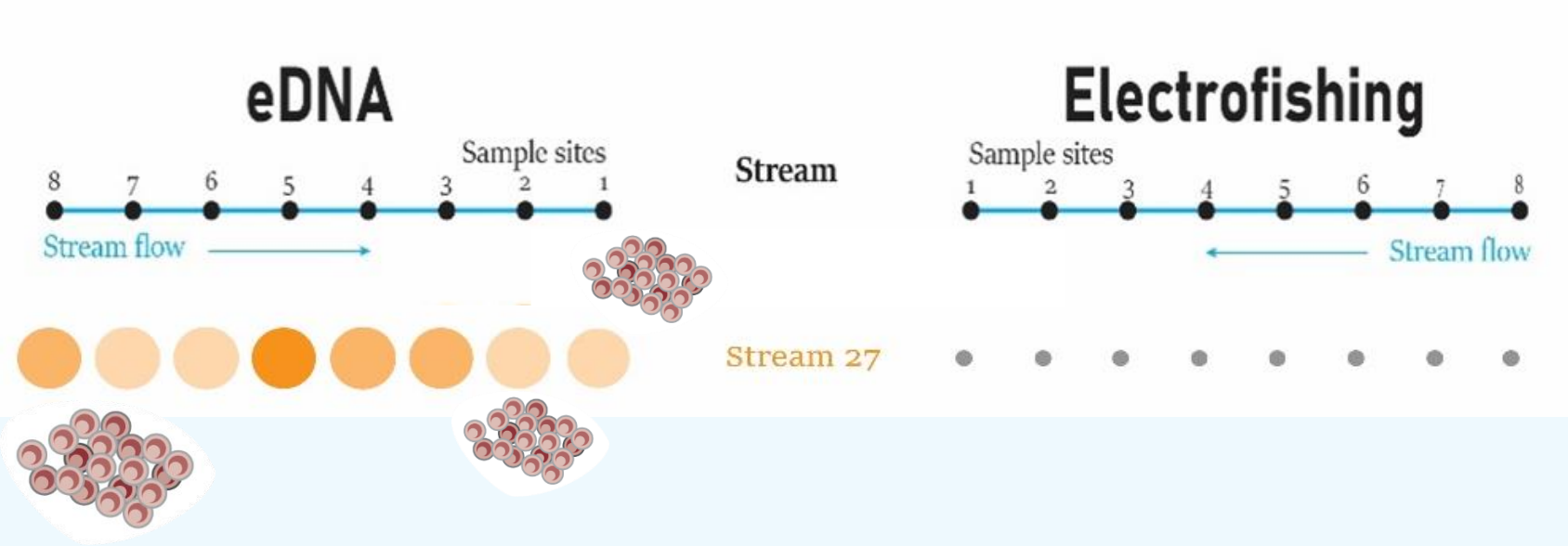




Penaluna et al. 2021

eDNA may detect fish eggs in redds

consistent signal across sites during spawning season with no indication of trout by electrofishing



Penaluna et al. 2021

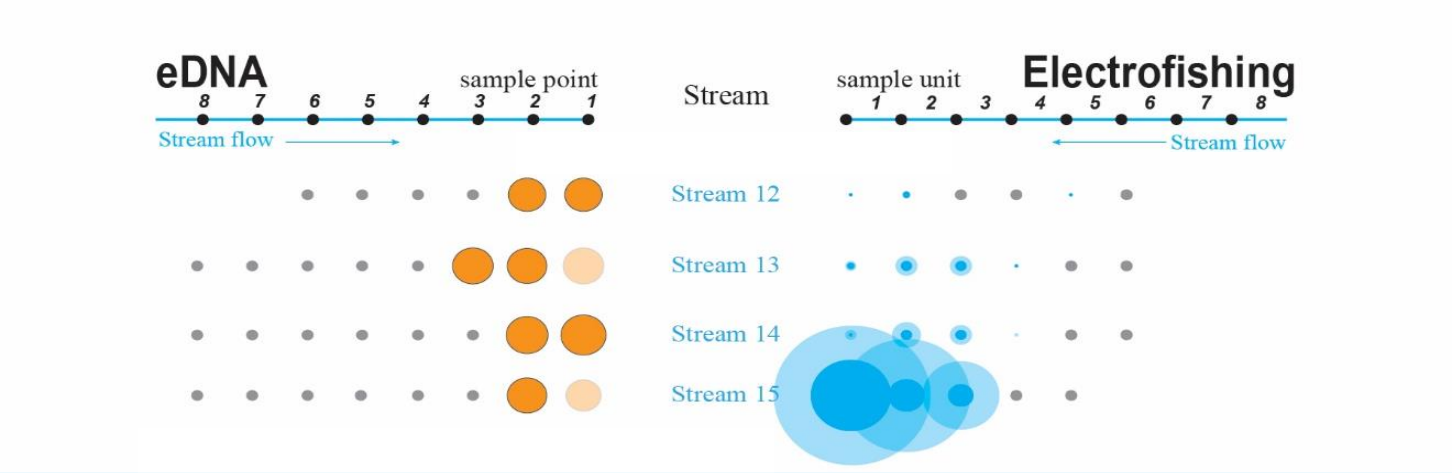
eDNA allows for early detection of elusive species

eDNA improves occurrence of semi-aquatic invasive reptile Burmese Python in Florida, USA

Piaggio et al. 2014,
Hunter et al. 2015

But there are challenges…

Is no detection a true absence of the species?



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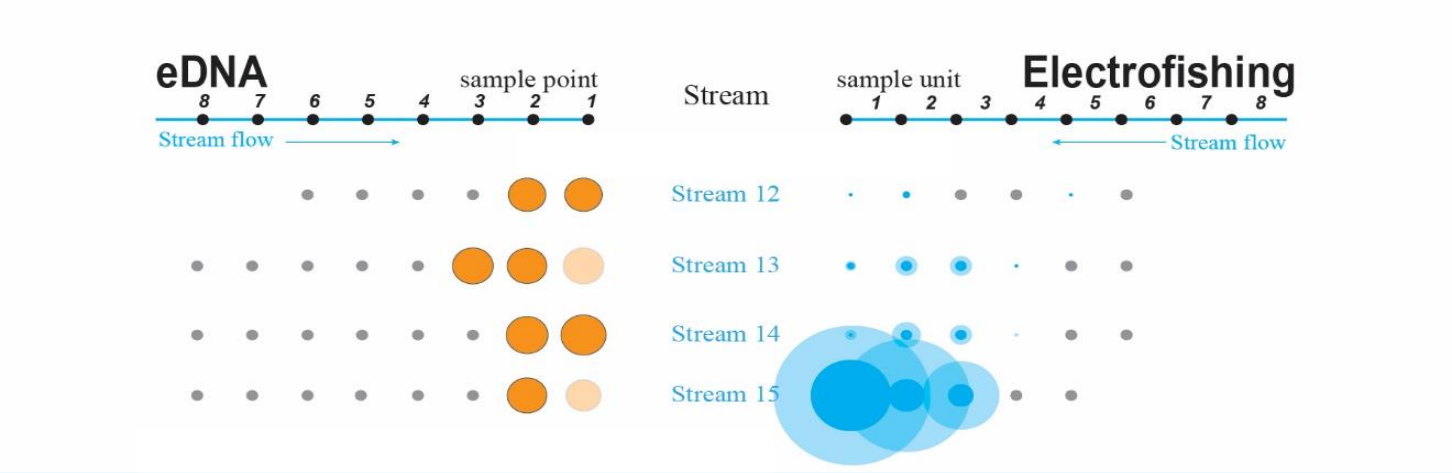
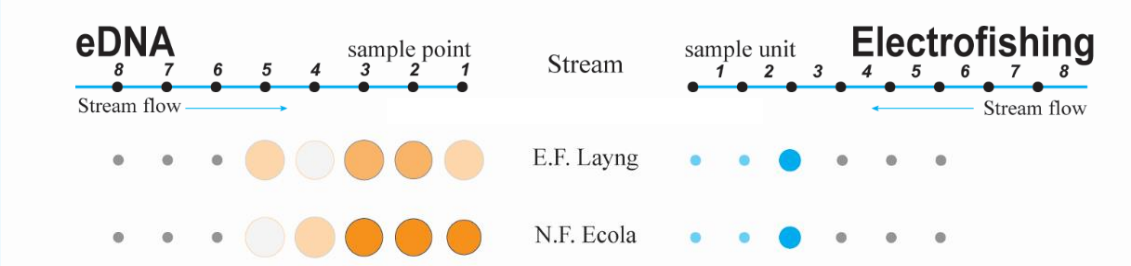
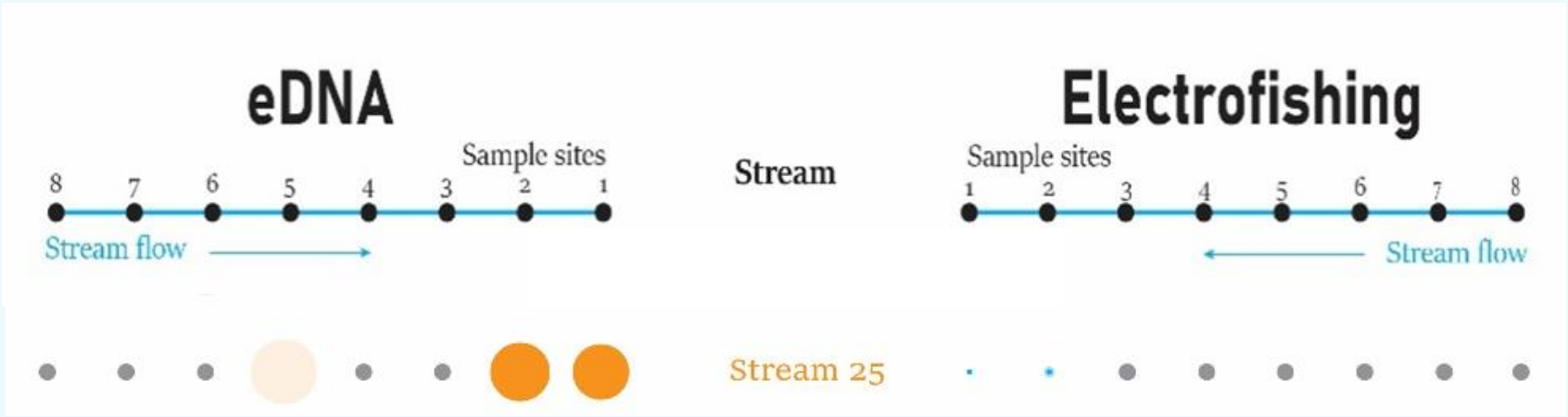


Is one positive detection a true presence of the species?



eDNA may amplify in a sample, even when focal fish is not actually present



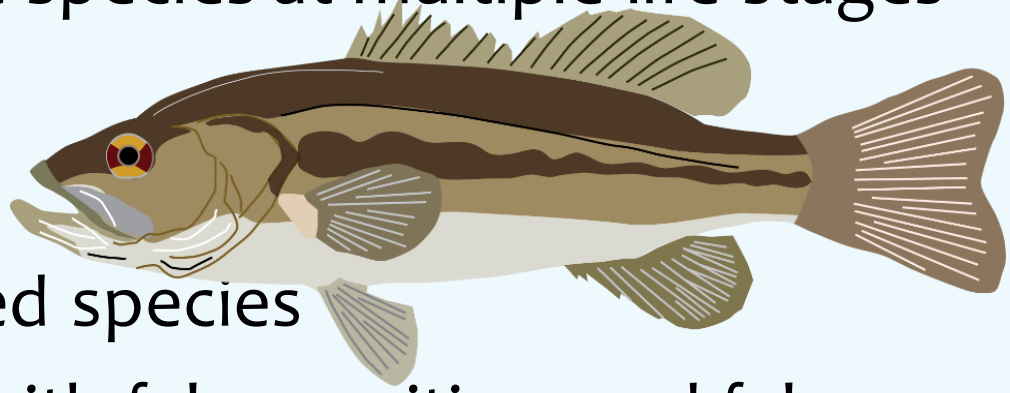
Rather it is brought there

Penaluna et al. 2021

Take home messages

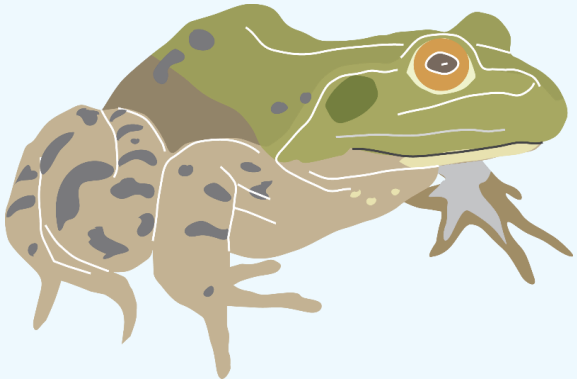
Opportunities

- eDNA is more sensitive than traditional approaches at detecting invasive species
- It detects rare and elusive species at multiple life-stages



Challenges

- eDNA is limited to targeted species
- eDNA can ave problems with false positives and false negatives



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