

## ENVIRONMENTAL DNA

- Environmental DNA (eDNA) is the **genetic material left by organisms in the environment**.
- eDNA is **increasingly being used** to detect the presence of species and assess biodiversity, but broad-scale best practices are still being developed.
- This affects the **quality, accessibility, and usefulness of data**.
- Non-invasive eDNA sampling can **complement or enhance conventional approaches**, as it can be a highly sensitive, rapid, and cost-effective tool for biodiversity monitoring.
- Creating unified eDNA data best practices and developing DNA reference libraries will ensure eDNA detection methods are **applied consistently to accurately inform conservation and wildlife management**.

### What is the issue?

Environmental DNA (eDNA) is defined as the genetic material left by organisms in the environment. It includes DNA from cells, tissues, fluids, and excrement. eDNA can be collected and detected in various sample types like water, soil, aerosols, and food items.

Analyses of eDNA offer a highly sensitive, rapid, and cost-effective method to detect the presence of species and assess wildlife communities and biodiversity. This information can be used to inform the [IUCN Red List of Threatened Species™](#) and other conservation tools, as well as for the management of wildlife and natural resources.

The rapid adoption of eDNA biomonitoring tools since the first manuscript was published in 2008 has led to a **growing need for steps to be taken to quantify uncertainty and ensure eDNA detection methods are applied consistently and appropriately**.

### Why is this important?

Detection of rare and hard-to-find species is especially valuable in wildlife management. Non-invasive eDNA sampling can complement or enhance conventional approaches such as visual searches or electrofishing. It can be conducted by trained citizen scientists and is often **more sensitive and accurate than other available methods**. For example, detection of eDNA from threatened species can complement traditional visual surveys to delimit critical habitats for protection.



*The invasive Burmese python is extremely secretive and lives in the Everglades National Park in Florida. Burmese pythons predate on native mammal populations, causing declines in some areas of more than 90%. The detection rate for Burmese pythons improved greatly from 1% with visual searching and trapping to more than 90% in some cases with eDNA data. Detecting the Burmese python can inform their range delimitation as the population moves north and also help detect new populations beyond the current range. (R. Cammauf/NPS)*

The method can also help focus invasive species control efforts and identify newly colonised ranges or travel corridors. Further, sequencing of eDNA from many species at once (called metabarcoding) can help investigate changes in wildlife communities, like fish stocks, as well as monitor the impacts of habitat change and restoration efforts.

Environmental DNA is also **rapid and cost-effective compared to other biomonitoring methods**. It can speed up our ability to detect changes in biodiversity to better track progress towards global goals for healthy and functioning ecosystems. The detection of eDNA can inform what we know about species'

ranges and their genetic diversity, wildlife communities, and indicator species for management and restoration efforts. eDNA-based studies have the power to aid in the investigation of biodiversity impacted by some of the main drivers of biodiversity loss: climate change, land-use change, pollution, over-exploitation, and invasive species.

The process of detecting small amounts of eDNA requires careful validation for each target species and habitat. Therefore, methods are often modified to account for unique characteristics such as closely related species, low DNA levels, and dynamic environments – like fast flowing water. This has led to **eDNA methods often being specific for individual settings, laboratories, or projects, which could benefit from standards and best practices.**

## What can be done?

The incorporation of broad-scale standards and best practices for eDNA-based detection methods can **help ensure that they are applied consistently to inform conservation and management efforts more accurately.** They can also increase the inclusive adoption of these methods, and help improve the quality, accessibility, and usefulness of data.

Like all wildlife survey methodologies, eDNA-based tools have limitations, including some inherent uncertainties that are challenging to model or predict. Guidance by an eDNA expert is beneficial throughout all aspects of the process, including study design, field collection, laboratory analysis, and data interpretation.

Careful study design and data interpretation are especially important since eDNA molecules can break down over time and be transported in the environment. False-positive and -negative detections of eDNA could lead to costly, inappropriate, or time-consuming management interventions. While some challenges persist, major improvements in best practices have been made in the field, including the incorporation of suitable experimental designs and controls for eDNA data interpretation.

**Unified standards and best practices could also facilitate the integration of eDNA tools into biomonitoring schemes.** This could help natural resource managers understand the quality of the study and allow for the **comparison of results across space and time.** Further, this can enable broad-scale monitoring across jurisdictional boundaries at regional to global levels, including surveys of under-represented species and geographic areas.

There are a number of published national eDNA-based reports (including in Finland, Canada, and

Australia) and best practices manuscripts. **However, the establishment and adoption of broad-scale standards for eDNA data collection and interpretation is still in development.** The drafting of standards is benefiting from a dedicated international forum, the [International eDNA Standardization Task Force](#), and their engagement with international standardisation bodies such as the International Organisation for Standards (ISO).

To deploy eDNA monitoring methods appropriately and inclusively, **it is important to foster education, community engagement, and transparent discussions on best practices, capabilities and limitations of the technology.** Co-design of communication frameworks, study plans, and decision support tools by scientists and natural resource managers will help ensure robust and accurate eDNA data.

The natural resource community benefits from inclusive and standardised international practices and engagement with diverse and under-served groups globally. The scientific community can work together to improve reference DNA libraries, data, and sample archiving practices and repositories. With rapidly advancing eDNA methodology, effective dissemination through scientific networks is important to ensure broad communication for efficient uptake.

Environmental DNA detection methods provide novel biodiversity monitoring opportunities. The use of standardised eDNA detection methods can **foster mutual trust and engagement and improve confidence in eDNA data,** the decisions they inform, and conservation outcomes.

### Where can I get more information?

[Efficacy of eDNA as an early detection indicator for Burmese pythons](#)

[Guidance on the Use of Targeted Environmental DNA \(eDNA\) Analysis for the Management of Aquatic Invasive Species and Species at Risk](#)

[A practical guide to DNA-based methods for biodiversity assessment](#)

[Roadmap for implementing environmental DNA \(eDNA\) and other molecular monitoring methods in Finland](#)

[Biodiversity monitoring using environmental DNA](#)

[Critical considerations for the application of environmental DNA methods to detect aquatic species](#)

[A validation scale to determine the readiness of environmental DNA assays for routine species monitoring](#)

[The Global Taxonomy Initiative 2020: A Step-by-Step Guide for DNA Barcoding](#)