

# Implementation and standardization of molecular monitoring methods

Tiina Laamanen, Kristian Meissner & Veera Norros

Nordic WFD WG4 meeting 26.09.2024



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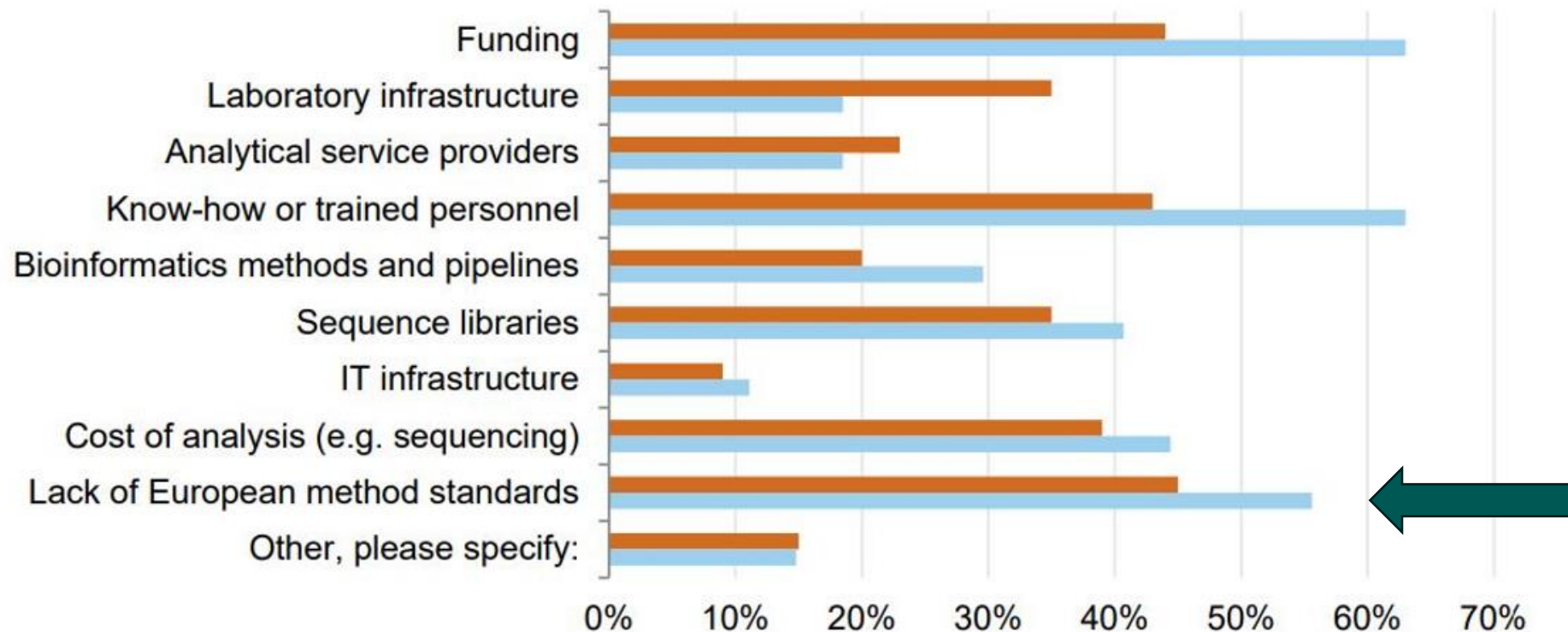
# Why do we need national and international coordination of molecular monitoring methods implementation?

- Several environmental directives require to report data on biodiversity
- We need reliable tools to assess the effect of management actions
- **Molecular methods have reached critical maturity - their implementation has started worldwide**
- The field is fragmented, – risk of unnecessary duplication of efforts, method pluralism and resulting **incompatibility of the end results**
- Some of the desired endpoints are ultimately international – European, or global biodiversity assessments, international legislation, identification of patterns and effective measures

# The key limiting factors are lack of funding, expertise and method standards

- We received a total of 171 responses to our international survey

Norros et al. (2022)





# Standards for monitoring with molecular tools: some definitions

Standards  $\neq$  "Guidelines" or "SOPs"

Standardization  $\neq$  harmonization / intercalibration

*A document, **established by international consensus and approved by a recognized body that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context.** Standards are based on consolidated results of science, technology and experience, **and aimed at the promotion of optimum community benefits.***



This talk is on **standardization of method use in a legislative context,**  
**not** on standardizing method use in research!



# We need international standards for molecular methods...

- to improve legislative monitoring.
- to avoid past mistakes.
- to establish trust.
- to enable method uptake into routine use.
- to improve accuracy.
- to improve comparability.
- to save time.
- to improve inclusivity.
- to generate markets.
- to produce (global) impact.



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# Past mistakes: methodological pluralism

Example: The EU water framework directive

Countries were "allowed" to keep their methods

Little **trust** in other national methods →

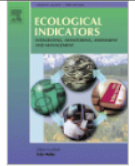
Intercalibration took 20 years  
(harmonization)!

However, in the end, methods still needed to be standardized...





Ecological Indicators

Volume 18, July 2012, Pages 31-41



Three hundred ways to assess Europe's surface waters: An almost complete overview of biological methods to implement the Water Framework Directive

Sebastian Birk<sup>a</sup>  , Wendy Bonne<sup>b</sup>, Angel Borja<sup>c</sup>, Sandra Brucet<sup>b</sup>, Anne Courrat<sup>d</sup>, Sandra Poikane<sup>b</sup>, Angelo Solimini<sup>e</sup>, Wouter van de Bund<sup>b</sup>, Nikolaos Zampoukas<sup>b</sup>, Daniel Hering<sup>a</sup>



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# Ok, but why ISO / (CEN)?

- Members represent many nations
- Standards are permanent, revision cycle
- Ready-to-use pipelines for creating international consensus agreements
- Industry is used to work with standards
- Have relevant Technical Committees to host "biological" groups e.g. ISO TC147, CEN TC230

→ international/global  
→ stable, yet flexible  
→ transparent, reliable



→ trustworthy



→ well established

# International standardization is already underway

- Dedicated international standards working groups in CEN 230 WG 28 and ISO/TC 147/SC 5/WG13 "Environmental DNA and RNA methods"
- EN 17805:2023 Sampling, capture and preservation of environmental DNA from water → ISO EN
- Efforts to engage the international eDNA community in standardization through the International eDNA Standardization Task Force **iESTF** ([www.iestf.global](http://www.iestf.global))







# standard and NWIP projects

## Ongoing/ starting activities

1. ISO EN 17805:2023 Sampling, capture and preservation of environmental DNA from water
2. PRESERVATION AND EXTRACTION OF MACROINVERTEBRATE BULK SAMPLES
3. SAMPLING, PRESERVATION AND EXTRACTION OF BENTHIC PERIPHYTIC DIATOMS
4. MEASURING QUALITY AND QUANTITY OF EXTRACTED DNA
5. TARGET SPECIES DETECTION
6. METABARCODING TO SURVEY BIOLOGICAL COMMUNITIES



TC 147 WG 13 Meeting in South Korea, October 28<sup>th</sup> 2024

Kristian Meissner

Florian Leese (D)

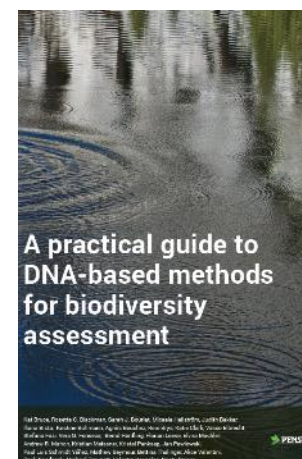
**Martyn Kelly (UK)**

John Darling (USA)

Cathryn Abbott (CAN)

Katy Klymus (USA)

Donald Baird, Mehrdad  
Hajibabaei (CAN), Kirsty  
Deiner (CH)



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# Recommendation



Use international method standards to reduce risk and ensure molecular method uptake for reliable biodiversity monitoring and assessments and data comparability (ISO/CEN)



We need to QUICKLY and INCLUSIVELY mobilize relevant international stakeholders (e.g. iESTF)



Future need: a relevant and mandated entity to oversee novel method uptake and to set a list of needed standards

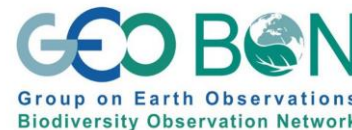


# Syke's ongoing actions & projects



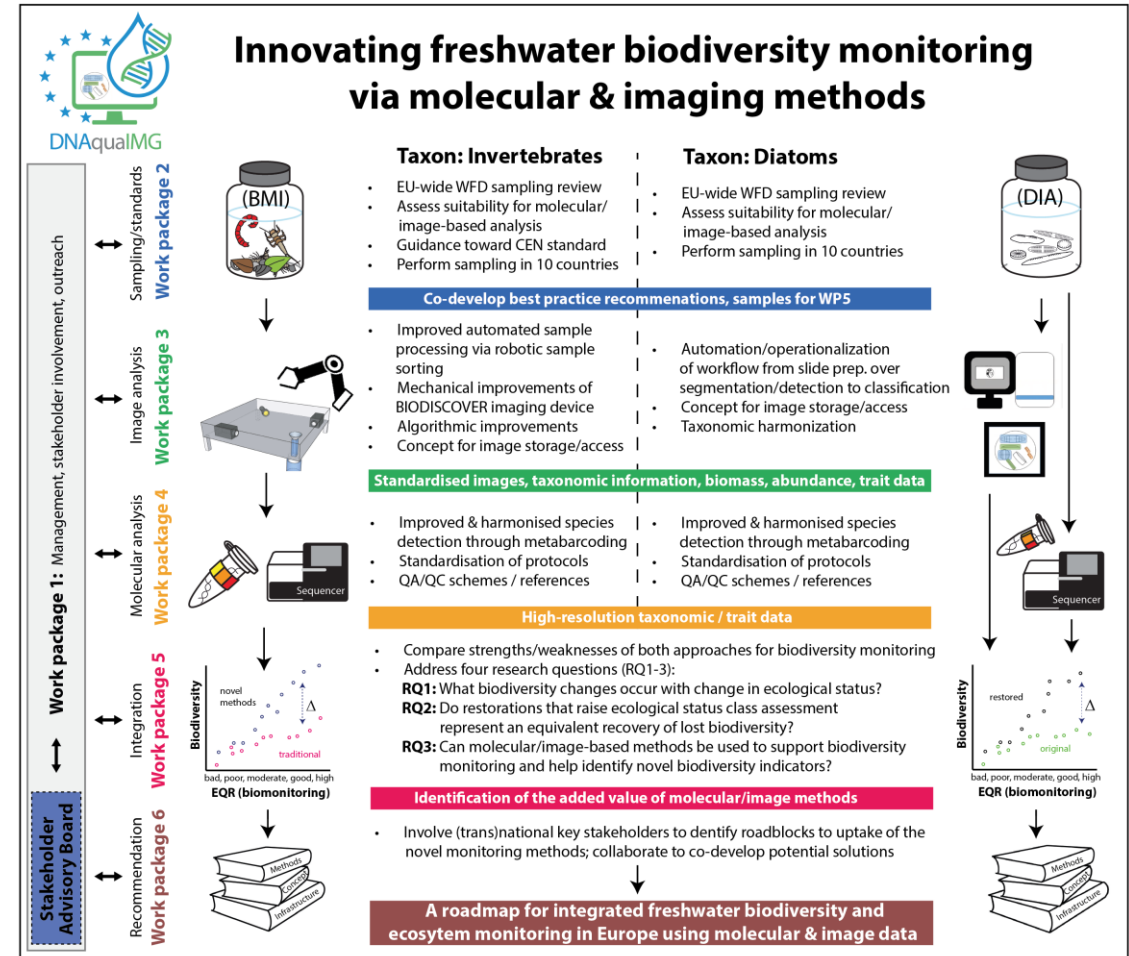
# Ongoing activities in Finland developing and implementing molecular monitoring methods

- International collaboration with GEOBON, iBOL, GBIF
- Numerous national and international research and development projects are currently running
  - funded by e.g. BIOMON program, the Research council of Finland, EU LIFE programme, Horizon Europe, and Biodiversa+
- Molecular monitoring methods are also part of the national environmental monitoring strategy
  - Working groups have started on September 2023



# DNAqualMG

- BIODIVERSA+funded project with partners from 11 countries combines DNA metabarcoding and image-based methods to provide more comprehensive biodiversity insight
- Lead by Florian Leese, University of Duisburg-Essen  
Syke's team: Kristian Meissner PI, Tiina Laamanen, Mikko Impiö, Veera Norros
- More information: <https://dnaquaimg.eu/>



 **BOKU**, University of Natural Res., Vienna


 **AU**, Aarhus University


 **INRAE**, French National Inst. for Agriculture, Food, Env.

 **UCD**, University College Dublin


 **UNFSM**, University of Nis


 **CUAS**, Carinthia Univers. of Applied Sciences

 **SYKE**, Finnish Environment Institute

 **BGBM**, Botanical Garden & Botanical Museum Berlin

 **CIBIO**, Research Centre in Biodiversity & Gen. Resour.

 **SLU**, Swedish University of Agricultural Sciences

 **MU**, Masaryk University

 **JYU**, Univers. of Jyväskylä

 **UDE**, University of Duisburg-Essen (coordinator)

 **UniLodz**, University of Lodz

**Our consortium**

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# eDNAqua-Plan

- Horizon Europe funded, 18 EU-partner project is promoting synergies, harmonization and interoperability between existing EU initiatives and resources linked to the generation, storage, analysis and accessibility of molecular data from marine and freshwater ecosystems
- Syke's team: Tiina Laamanen, Kristian Meissner, Veera Norros
- Syke is leading the task "Identification of workflows used currently for DNA-based biodiversity monitoring"
- More information:  
<https://ednaaquaplan.com/>





# eDNA-Monitor

- Ministry of Environment Finland BIOMON –program funded project (2022-2024)
- Lead by Kristiina Vuorio
- Target groups: Phytoplankton, benthic diatoms, zooplankton, and benthic invertebrates
- Testing, developing and validating the suitability of molecular methods for the assessment of the ecological status of water bodies
- Use samples from existing freshwater and the Baltic Sea monitoring programs
- Complementing zooplankton reference sequence libraries
- More information: <https://www.syke.fi/projects/eDNAMonitor>



# OBSGSESSION

- Horizon Europe funded project aims to monitor & predict biodiversity change and its drivers in both terrestrial and freshwater ecosystems through Earth Observation technologies
- Lead by Petteri Vihervaara, Syke
- Coordinator: Maria Hällfors, Syke
- Biodiversity pilots combining eDNA and EO data
- Pilot area in Finland: Kokemäenjoki River catchment area
- More information: <https://www.obsgession.eu/>



OBSGSESSION Kick-off, Tuusula, Finland, January 2024  
Photos: Pensoft



# PRIODIVERSITY Life



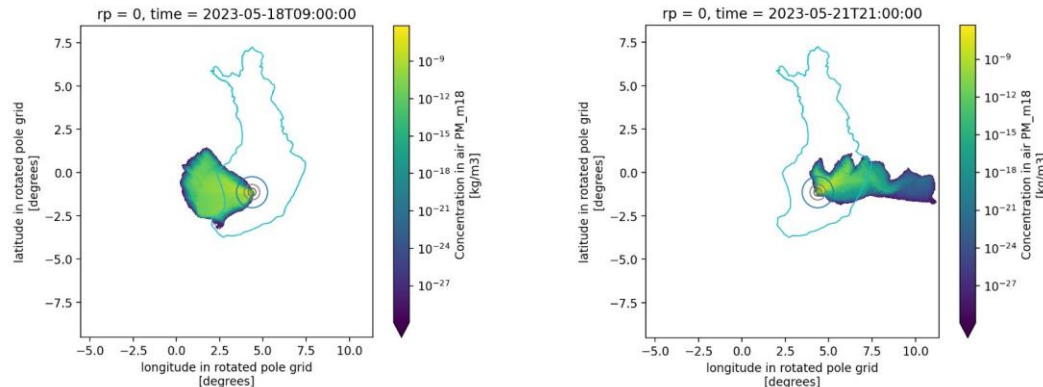
- With EUR 50 million in funding, eight-year (2024-2031) Priodiversity LIFE project is the largest project to combat biodiversity loss ever implemented in Finland
- The aim is to collect best practices and find new forms of funding to preserve biodiversity
- Development of molecular monitoring of species composition and the state of habitats (Veera Norros, Tiina Laamanen, Kristian Meissner & Henna Snåre)
  - In 2024: review of the technological readiness and possibilities of molecular methods
    - 3-5 methods selected for further development and piloting 2025 --> , in national and international collaboration
    - Building upon the national eDNA roadmap and a TRL review article (Laamanen et al, in prep.), linked with several ongoing projects and national and international coordination efforts (e.g. iESTF)



# SPORELIFE

Airborne eDNA samplers and  
sample processing in the lab  
Photos: Veera Norros

- Academy of Finland funded (2023-2027) project is combining eDNA and flow cytometry with integrated atmospheric modelling for bioaerosols and biodiversity monitoring
- Lead by Veera Norros, Syke & Mikhail Sofiev, FMI
- DNA of most terrestrial groups is found in the air – potential for integrative sampling (as water eDNA in aquatic environments)
- Major challenge: at what scale does airborne eDNA provide biodiversity information?
  - Can we target a specific scale by adjusting sampling conditions (timing, location, height)?





Potential source areas of  
two airborne eDNA  
samples collected on  
different days



# Finnish Nature Information Hub

- Ministry of Environment funded Finnish Ecosystem Observatory FEO project published luontotieto –webpage: <https://luontotieto.syke.fi/en/>


**Luontotieto**FI**EN**

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[Front page](#) → [Monitoring and methods](#) → [Nature monitoring methods](#) →  
eDNA and other monitoring methods based on molecular biology

## eDNA and other monitoring methods based on molecular biology

With the help of molecular biology, we can improve the coverage, accuracy, and cost-effectiveness of environmental monitoring, enabling a much more complete picture of biodiversity and the state of the environment and their trends.



# DNA-based data management

- Developing a national data management system
  - Academy of Finland – funded FinBif FIRI development project (2021-2026) is preparing for the management of DNA-based species observations
  - Different options are on the table
- Managing and utilizing DNA-based data alongside traditional data is involved in many ongoing international projects
  - E.g., HEU-projects OBSGESSION, eDNAqua-Plan
- DNA-based species observations integrated into common biodiversity databases - GBIF and OBIS have developed a shared model
  - Comprehensive guidelines and metadata template
  - User-friendly tools for data input are available and under development
- Promotion of data flow between databases (e.g., OBIS → GBIF, BOLD → GBIF)





# Thank you!

We thank all eDNA roadmap co-authors:

Terhi Iso-Touru, Aapo Kahilainen, Sirpa Lehtinen, Katileena Lohtander-Buckbee, Henrik Nygård, Taina Pennanen, Marja Ruohonen-Lehto, Päivi Sirkiä, Sanna Suikkanen, Mikko Tolkkinen, Eeva Vainio, Sannakajsa Velmala, Kristiina Vuorio & Petteri Vihervaara

National eDNA roadmap (Norros et al. 2022):  
<http://hdl.handle.net/10138/342992>



tiina.laamanen(at)syke.fi,  
kristian.meissner(at)syke.fi,  
veera.norros(at)syke.fi



Photo: Tiina Laamanen