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Executive Summary of IOGP's 449-Page eDNA Research for Oil & Gas Operations

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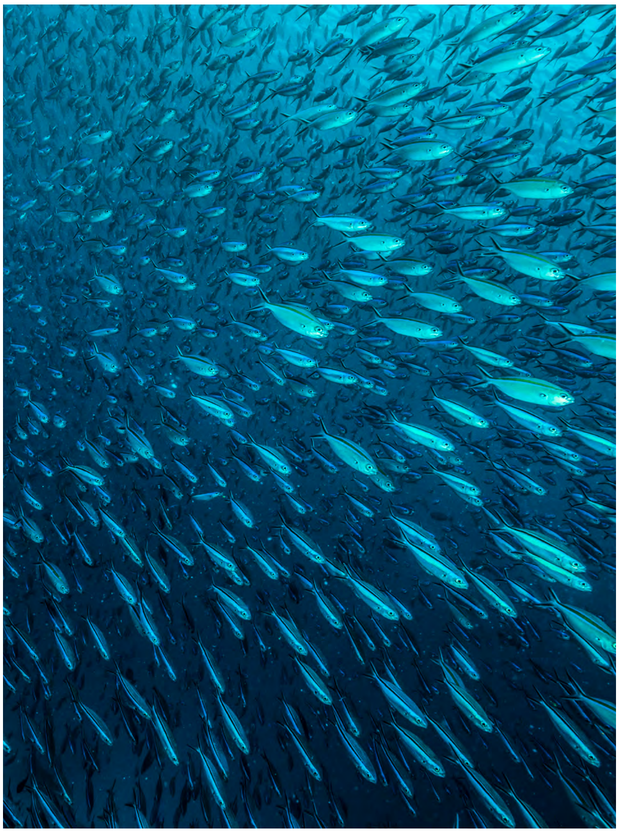
Who are the IOGP?

The IOGP are the global voice of the Oil & Gas industry, pioneering excellence in safe, efficient, and sustainable energy supply – an enabling partner for a low carbon future.

Their Members, integrated energy companies, national oil companies, independent upstream operators, service companies, and industry associations operate around the globe, supplying over 40% of the world's oil and gas demand. For almost 50 years, they have been serving the upstream industry as a unique forum to share know-how and good practices in the areas of safety, health, environment, engineering and, now, industry and energy transitions.

They work with over 2,250 experts from Member organizations to identify and share knowledge and good practices to improve performance across the industry.



Their membership includes:

What is the Environmental Genomics Joint Industry Programme?

The IOGP Environmental Genomics Joint Industry Programme (JIP 34) was launched in June 2019 to coordinate research aimed at exploring the application of eDNA-based analyses in environmental assessments and monitoring of offshore and onshore operations.

Its goal was to develop and advance environmental genomics technologies for energy applications and promote their understanding.

In November 2024, they published the draft of this research, covering four chapters totalling 449 pages. These chapters covered:

- Efficacy of eDNA vs. Conventional Methods
- eDNA Sampling Standards and Guidelines
- Laboratory Analysis Guidelines and Best Practices for Environmental Genomics Applications Relevant to the Energy Sector
- Industry Guidance on Bioinformatics Analysis Standards and Guidelines for eDNA Data relevant to O&G

Here, we synthesise the key findings of this research with a focus on actionable insights for sustainability professionals with responsibility for nature within their organisations.

"Environmental genomics for the characterisation and monitoring of biodiversity is an emerging application being developed and implemented by academics, industry, and regulators around the world.

It has the potential to provide more complete biodiversity data than conventional methods and also has the virtues of being more cost-effective and faster."

Wendy Brown
IOGP Environment Director

Who are NatureMetrics?

NatureMetrics is a world leader in delivering nature data and intelligence, deploying cutting-edge technology to generate biodiversity insights at scale using environmental DNA (eDNA), Earth Observation (EO), and advanced data science and AI.

Our Nature Intelligence Platform is transforming how businesses report their nature impact, bringing a scalable solution to biodiversity monitoring, equipping global businesses for new nature reporting commitments.

Driving impact for over 600 clients across 110+ countries, we are a Earthshot Prize 2024 Finalist, TechNation Future Fifty 2025 company, Bloomberg Top 25 UK Startup to Watch, a Bloomberg NEF Finalist 2024, and nominated for the Google Geo for Good Impact Awards.

Foreword

The oil and gas sector operates in some of the world's most ecologically sensitive environments—coastal zones, deep offshore habitats, freshwater systems, and terrestrial corridors. As regulatory expectations evolve and the importance of biodiversity in corporate risk and sustainability strategies grows, the need for reliable, cost-effective, and scientifically credible environmental monitoring tools has never been greater.

Environmental DNA (eDNA) is increasingly recognised as a valuable tool in this context. It enables the detection of a wide range of organisms—many of which are difficult or impossible to observe using conventional methods—by analysing genetic material left behind in water, soil, or sediment. In recent years, eDNA has moved from the margins of ecological research into applied biodiversity monitoring, with growing uptake across industry, academia, and government agencies.

This two-part guidance, developed as part of the IOGP Environmental Genomics Joint Industry Programme, aims to support informed, consistent, and practical use of eDNA within oil and gas operations. The first chapter provides a critical review of the comparative strengths and limitations of eDNA and conventional biodiversity monitoring approaches, drawing on over 200 peer-reviewed studies.

The second sets out clear, actionable sampling standards to help field teams and contractors implement eDNA methods effectively and minimise risk of contamination or data loss. A third and fourth chapter were also produced, covering Laboratory Best Practice and Bioinformatics, which will be covered in a later guide.

These documents do not advocate for the replacement of existing methods wholesale. Rather, they reflect a growing consensus: that eDNA can add substantial value when integrated thoughtfully into environmental monitoring frameworks. By improving species detection, reducing field time, and enhancing safety, eDNA represents an opportunity to modernise biodiversity assessment practices while maintaining scientific rigour.

We hope these guides will support both early adopters and experienced practitioners in applying eDNA methods responsibly and effectively across the lifecycle of oil and gas projects—from baseline surveys through to decommissioning and restoration.

Guy James
Energy Sector Lead

Chapter 1: Efficacy of eDNA vs. Conventional Methods

This chapter provides an assessment of environmental DNA (eDNA) and conventional biodiversity monitoring methods across marine, freshwater, and terrestrial habitats relevant to the oil and gas sector.

It evaluates when and where eDNA methods can be applied effectively, either as standalone tools or in combination with traditional surveys, based on over 200 peer-reviewed studies.

Key Findings

Species Detection

- eDNA methods are generally more sensitive than conventional methods for detecting species presence, particularly at low abundance.
- eDNA is effective at identifying small, cryptic, or otherwise difficult-to-observe taxa.

Community Assessment

- eDNA is well suited to broad biodiversity surveys, although it often yields different community compositions compared to conventional approaches.
- Differences are particularly evident in community-level ecological indices, where eDNA may not align directly with morphology-based metrics (e.g. AMBI, Maturity Index).

Quantifying Abundance

- Current eDNA techniques have limited ability to estimate organism abundance or biomass reliably, particularly for larger taxa.

eDNA efficacy at Project Phase

Phase	Potential Role of eDNA	Notes
Baselining	Broad biodiversity assessment; species inventories	Particularly useful in offshore or remote locations
Exploration & Production	Monitoring of sensitive or indicator species	Can complement acoustic/visual surveys
Spill Response	Detection of microbial communities, pollution indicators	Applicable for microbial recovery monitoring
Decommissioning	Evaluation of benthic community recovery	Use in conjunction with sediment analysis
Restoration	Tracking return of biodiversity	Effective for early detection of recolonising species

Operational Advantages of eDNA

Table 1.0 - Advantages of eDNA-based biomonitoring and conventional methods at different stages

Advantages

Field Logistics

- Lower field effort: eDNA sampling typically requires fewer personnel and less specialised training.
- Reduced HSE risk: Non-invasive methods reduce exposure to hazardous materials and field hazards.

Taxonomic Breadth

- Enables analysis across a wide range of taxa (vertebrates, invertebrates, microbes) from a single sample type.
- Requires minimal taxonomic expertise at the point of collection.

Sample Processing

- Standardised laboratory workflows can handle multiple samples and taxa simultaneously.
- Faster sample-to-data turnaround is achievable in some contexts, depending on lab capacity.

	Advantages of eDNA	Advantages of Conventional Monitoring
Field work	• Samples easy to collect, require less time and limited expertise • Sampling more effective, independent of species activity and habitat • Samples can be obtained in parallel to other monitoring activities • No need to use towed equipment near industrial installations • Sampling non-invasive • Samples preservation using non- hazardous solutions	• Visual observations, netting or trapping provide instant, real-time data • Camera traps and other trapping devices have comparable low unit costs • Can complement acoustic/ visual surveys
Sample analysis	• High-throughput automated sample processing • Reduced time and costs when many samples processed simultaneously • No need for taxonomic expertise • Same samples can be used for surveying multiple taxonomic groups	• Turnaround time of sample processing and storage can be very short • Sample processing requires a relatively simple equipment
Output data	• More taxa consistently detected • More sensitive to detect rare species • Broader taxon range data available • Possible identification of inconspicuous and cryptic taxa • Species identification less subjective, depending solely on taxonomic coverage of reference database • Retroactive analyses possible	• Species Identification possible if taxonomic expertise available • Abundance data obtained through counting specimens • Biomass, age and health state can be reported • Biotic indices are well established

Table 2.0 - Prospective eDNA methods to assess ecological impacts energy industry activities in marine environment

eDNA method	Target taxa	Aims and Expected results	Current status
Baseline surveys			
Water eDNA metabarcoding/qPCR	Marine mammals (cetaceans)	Avoid disturbance and interference with migratory routes for selected sites	Ready to use
Water eDNA metabarcoding	Fish/pelagic macrofauna	Detect sensitive species/ avoid fishing spots	Ready to use
Bulk DNA metabarcoding	Zooplankton	Surface water plankton taxonomic composition	Development phase
	Benthic macrofauna	Benthic macrofauna taxonomic composition	Development phase
Sediment eDNA metacoding	Benthic meiofauna	Meiofauna taxonomic composition	Development phase
	Benthic microbial community	Microbial taxonomic composition	Ready to use
Exploratory and production drilling			
Water eDNA metabarcoding	Bottom fish and other fauna	Assess bottom water biological quality	Development phase
Sediment eDNA metabarcoding	Benthic meiofauna and microbial community	Assess sediment biological quality	Development phase
Oil spills and remediation			
Water/sediment eDNA metabarcoding	Microbial community	Assess the impact of contaminants	Ready to use
Water eDNA metabarcoding/qPCR	Fish/pelagic macrofauna	Detect sensitive species	Ready to use
Decommissioning			
Bulk DNA metabarcoding	Hardbottom invertebrates	Assess epibenthic diversity	Development phase
Water eDNA metabarcoding/qPCR	Invasive non-native species (INNS)	Detection of INNS	Ready to use
Restoration			
Bulk DNA metabarcoding	Benthic macrofauna	Congruence with baseline studies	Development phase
Water eDNA metabarcoding/qPCR	Fish/pelagic macrofauna	Detect sensitive species, reintroduction of species	Ready to use
Paleogenomics - sediment ancient DNA	Macrophytes, macrofauna	Reconstruct reference conditions of impacted ecosystems	Development phase

Constraints

Ecological Interpretation

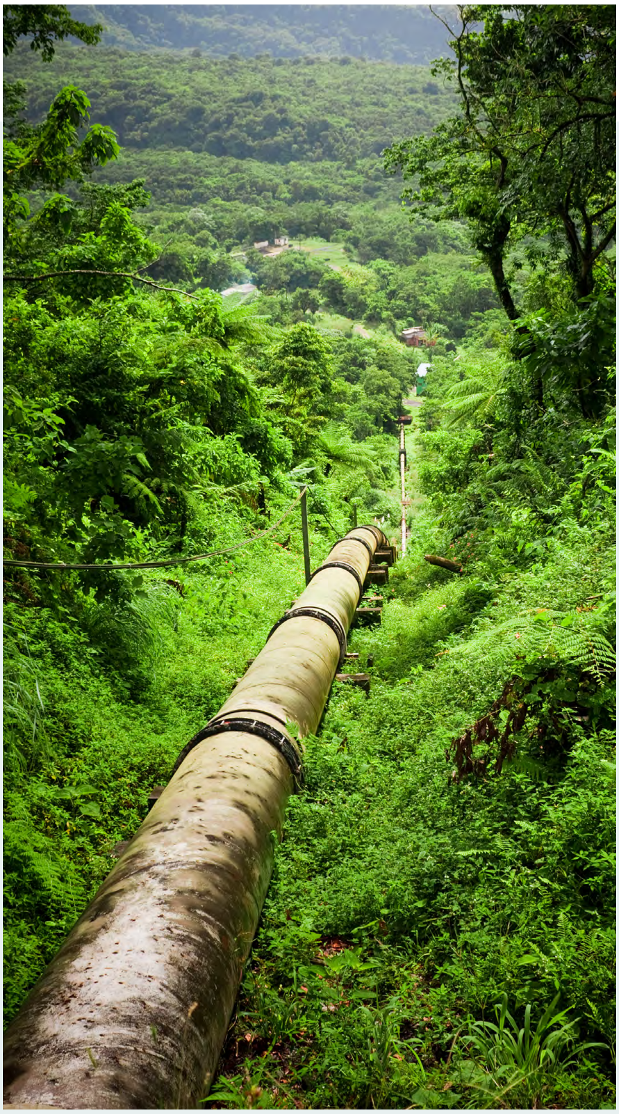
- Interpretation of ecological condition (e.g. biotic indices) is constrained by ongoing development of eDNA-based equivalents to morphology-derived metrics.

Data Reliability

- Variability in DNA degradation, transport, and shedding rates can affect spatial and temporal resolution.
- Potential for contamination requires rigorous quality control and validation.

Regulatory Acceptance

- In some jurisdictions, eDNA is not yet accepted as a primary monitoring tool without supporting conventional data.



Limitations and Areas for Further Development

Quantitative Metrics

- Additional work is needed to correlate eDNA read counts with organism abundance or biomass.

Standardisation

- Continued development of protocols is required to ensure consistency in sampling, analysis, and reporting.

Database Gaps

- Limited reference libraries for certain taxa can constrain species-level identification.

Integration with Ecological Indices

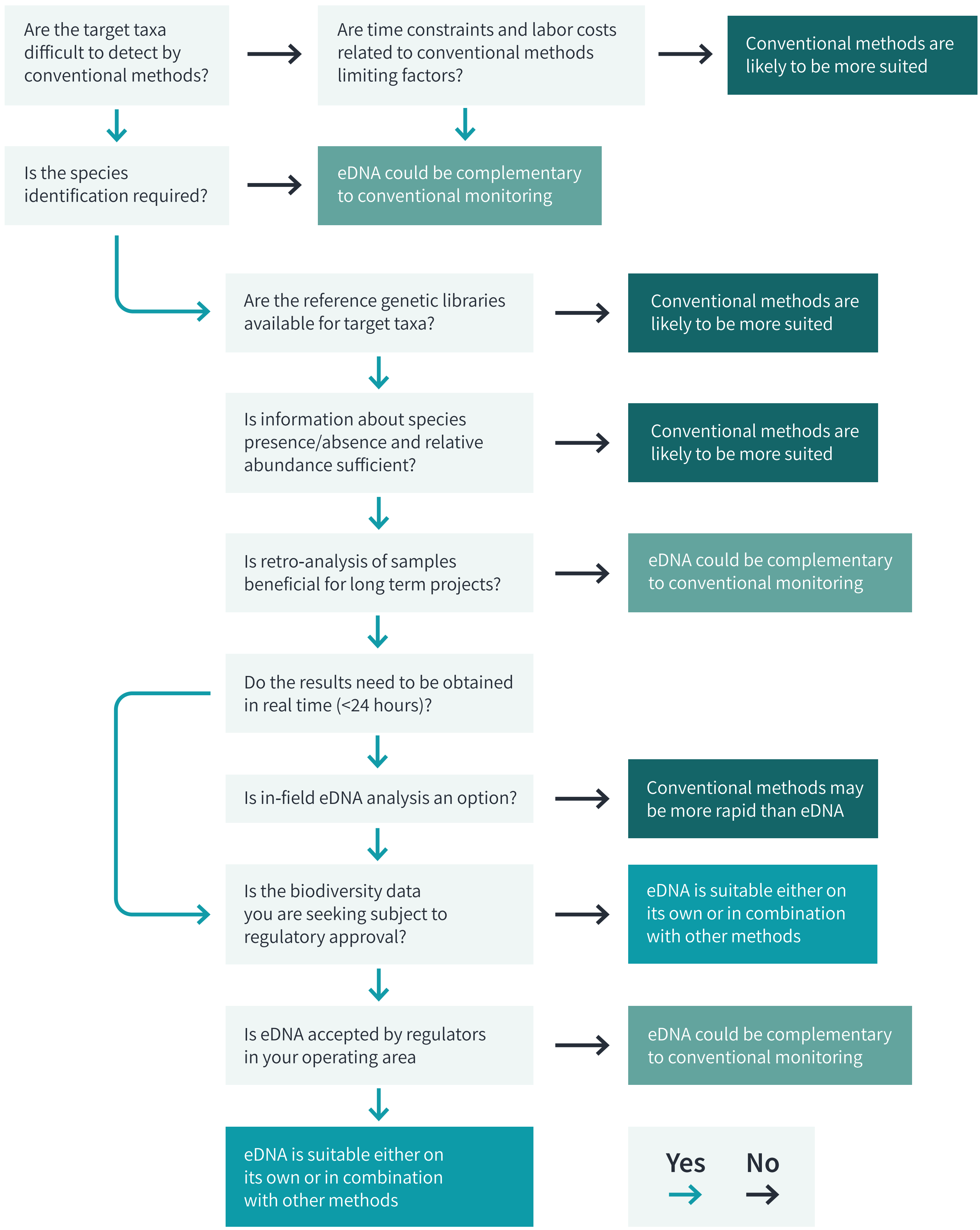
- Research is ongoing to align eDNA outputs with established ecological assessment frameworks.

Conclusion

The evidence reviewed indicates that eDNA methods are sufficiently mature for targeted applications within the oil and gas sector, particularly for species detection and broad-scale biodiversity assessments. However, their use in regulatory or impact assessment contexts should be aligned with specific monitoring objectives and, in many cases, supported by conventional data.

Integration of eDNA into environmental monitoring strategies should be based on suitability for the habitat, taxa of interest, and type of ecological insight required. Combined methods (eDNA and conventional) offer the most comprehensive approach in many scenarios.

Figure 3.0 - Decision tree for choosing between eDNA and conventional species identification/biodiversity assessment methods



Chapter 2: Sampling standards and guidelines

This chapter outlines good practice standards for the collection of environmental DNA (eDNA) samples in marine, freshwater, and terrestrial environments. It provides technical and operational guidance to support consistent, reliable biodiversity monitoring across oil and gas project phases.

Context and Relevance

The growth in eDNA use for biodiversity monitoring has outpaced the establishment of industry-wide standards. To ensure data quality, reproducibility, and regulatory credibility, consistent field protocols are needed. This guidance consolidates current best practices and offers baseline recommendations suitable for oil and gas contexts, especially where data may inform environmental assessments, impact monitoring, or stakeholder reporting.

Key Principles for eDNA Sampling

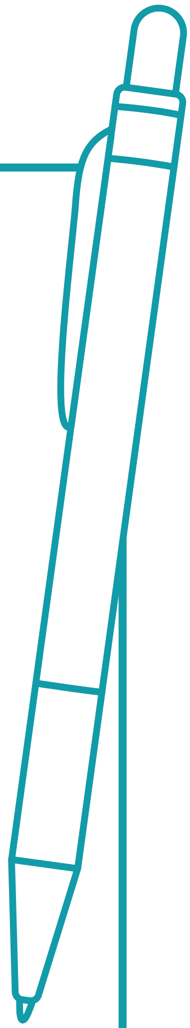
Contamination control is essential at all stages—from field collection through to laboratory processing.

Sampling design must align with monitoring objectives, taking into account habitat characteristics and target taxa.

Standardisation of procedures supports cross-project comparisons and regulatory engagement.

Metadata recording is integral to data interpretation and auditability

General Recommendations for Field Sampling



Planning and Preparation

- Clear objectives: Define species or communities of interest and intended ecological insights (e.g., presence/absence vs. community structure).
- Reference sites: Incorporate baseline or control sites where possible to interpret temporal or impact-related changes.
- Replicates: Use biological and technical replicates to ensure robustness, especially in heterogeneous environments.

Sample Collection

- Use sterile, single-use equipment wherever possible.
- Minimise sample handling and exposure to reduce risk of cross-contamination.
- Ensure appropriate preservation methods are used immediately after collection (e.g., freezing, ethanol, buffer solutions).

Contamination Prevention Measures

The guidance outlines procedures to reduce contamination risk, which is a primary concern in eDNA applications due to the sensitivity of detection:

Field protocols:

- Collect samples upstream or upwind of any disturbance.
- Process negative controls in the field (e.g., blank filters, sterile water).
- Clean or change gloves and tools between each sample.

Equipment:

- Use pre-sterilised containers and filtration units.
- Avoid re-use of field gear unless validated cleaning protocols are in place.

Personnel training:

- Ensure that all team members involved in sampling understand contamination risks and follow procedures consistently.

Sample Types by Habitat

Environment	Typical Sample Types	Notes
Marine	Water, sediment	Use depth-integrated or discrete samples depending on objectives
Freshwater	Water, sediment, biofilm	Flow conditions and turbidity affect sampling strategy
Terrestrial	Soil, bulk arthropods, surface swabs	Heterogeneity requires spatial replication

Sample Preservation and Transport

- Preservation methods should be selected based on sample type and analysis timeline. Options include:
  - Immediate freezing (preferred where feasible)
  - Ethanol or DNA preservation buffer for field conditions without refrigeration
- Labelling and documentation must be clear, consistent, and linked to field metadata and chain-of-custody records.
- Transport logistics must maintain sample integrity (e.g., cold chain), especially for marine or remote locations.

Sampling Design Considerations

- Spatial replication: Helps account for local variation, particularly in patchy habitats.
- Temporal sampling: Should align with biological cycles (e.g., breeding seasons, migration) and project phases.
- Volume and filtration:
  - Larger volumes may increase detection likelihood, but must balance with filter clogging risk.
  - The guidance suggests filtering 1–5 litres of water per sample in typical applications.

Metadata and Documentation

A consistent approach to metadata is vital for the interpretation and reuse of eDNA datasets. Recommended information includes:

- GPS location, date, time, habitat descriptors
- Environmental conditions (e.g., temperature, salinity, turbidity)
- Sample type, volume, preservation method
- Equipment used and any deviations from standard protocol

Limitations and Practical Constraints

- Remote sampling sites: Require logistical planning to preserve sample quality and maintain documentation.
- Filter clogging and turbid waters: May necessitate pre-filtration or adjusted volumes.
- Field conditions: Can affect contamination control; for example, windy or wet environments may increase risk.

Alignment with Regulatory Expectations

Although eDNA is not yet universally accepted as a regulatory method, adhering to robust, standardised sampling protocols will support:

- Greater confidence in data for decision-making
- Transparent and auditable environmental assessments
- More efficient engagement with regulators, particularly in permitting or compliance contexts

Conclusion

The chapter provides a practical framework for the consistent and defensible collection of eDNA samples in oil and gas contexts. Following these standards will improve data quality and enable more effective integration of eDNA into environmental management systems.

Further refinements are expected as the field matures, but the current guidance is sufficient to support responsible deployment of eDNA in both exploratory and operational phases.

Access the full IOGP Report Chapters **here.**

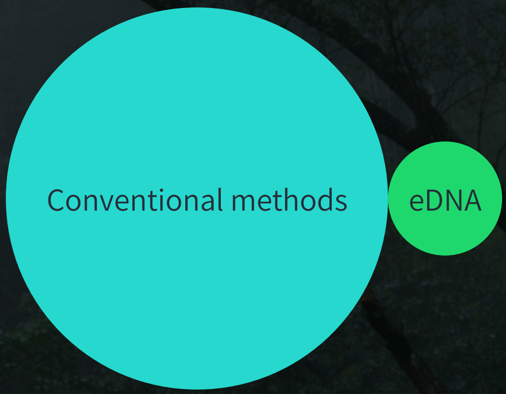
CASE STUDY

Optimising environmental impact assessments in the Peruvian jungle

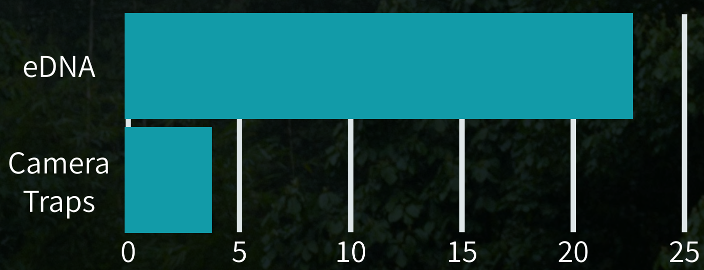
REPSOL

Repsol worked with NatureMetrics to test the efficacy of eDNA vs traditional biodiversity monitoring methods in the Peruvian jungle. eDNA surveys identified 5x as many fish and mammal species in one twelfth of the time, including 12 IUCN red-listed species not found using other methods.

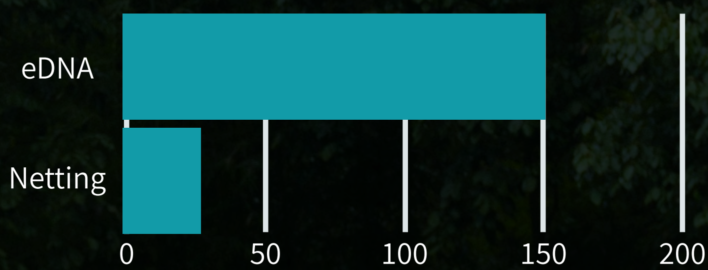
Person days required in remote field stations

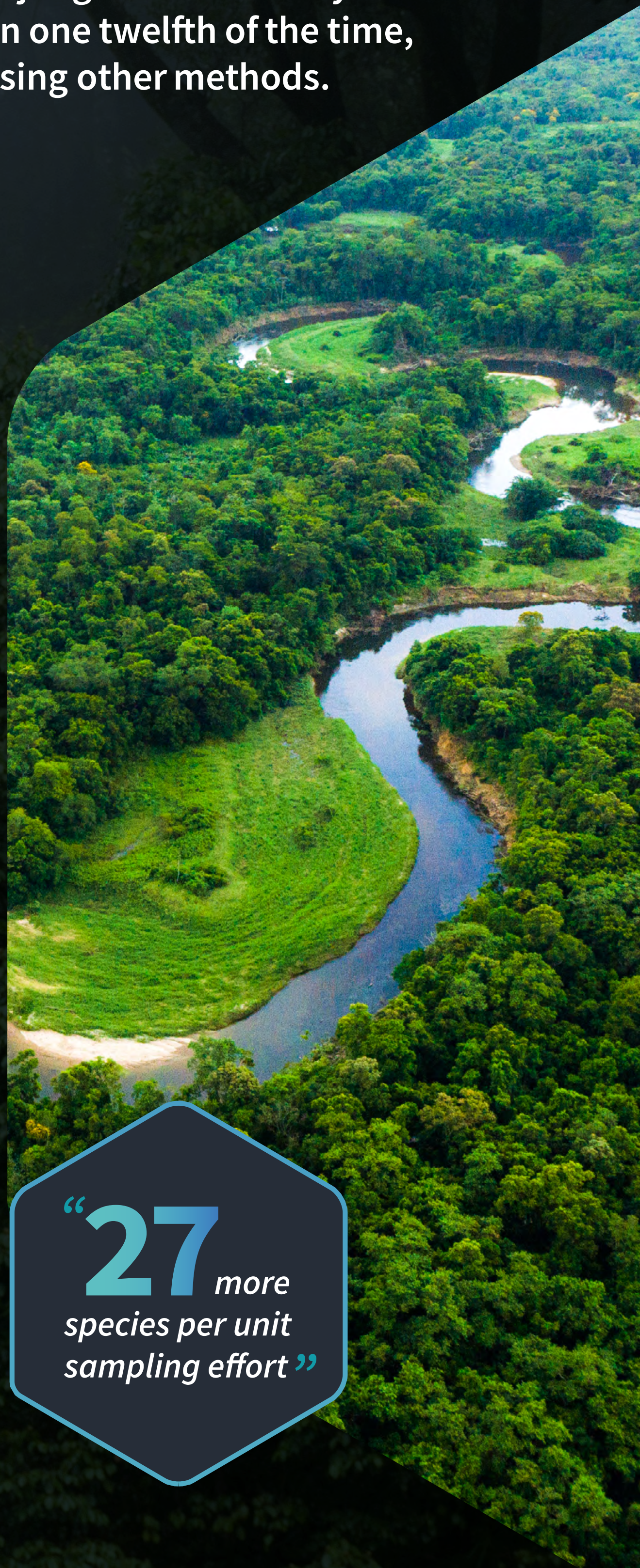


Mammal surveys



Fish surveys





"27 more species per unit sampling effort"

CASE STUDY

Searching for aquatic species in the Peruvian Amazon

WWF

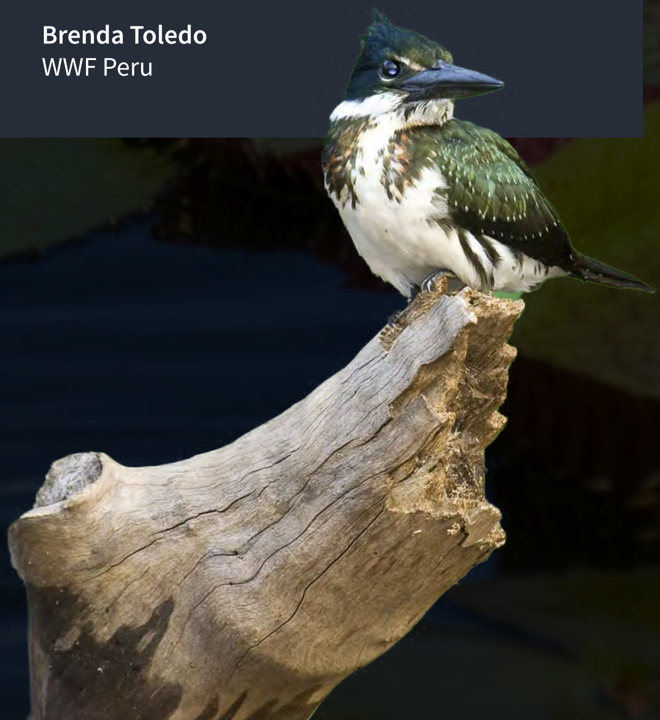
WWF Peru approached NatureMetrics to help survey six aquatic species including Amazon manatees, pink river dolphins and migratory catfish along the Marañónriver in the Northern Peruvian Amazon as part of their Healthy Rivers programme.

Traditional methods would have meant conducting separate surveys and multiple trips, but with eDNA they could all be surveyed together. Three trips later, we delivered a comprehensive set of data to WWF covering a vast array of aquatic and non-aquatic species, including the six target species.

"This was a vast, landscape-level survey, stretching from the Andean slopes in the east to the Brazilian border in the west.

To survey this length of river for just a few species using traditional techniques would have taken many more person hours, requiring multiple trips and resulting in less reliable, auditable and systematic data."

Brenda Toledo
WWF Peru

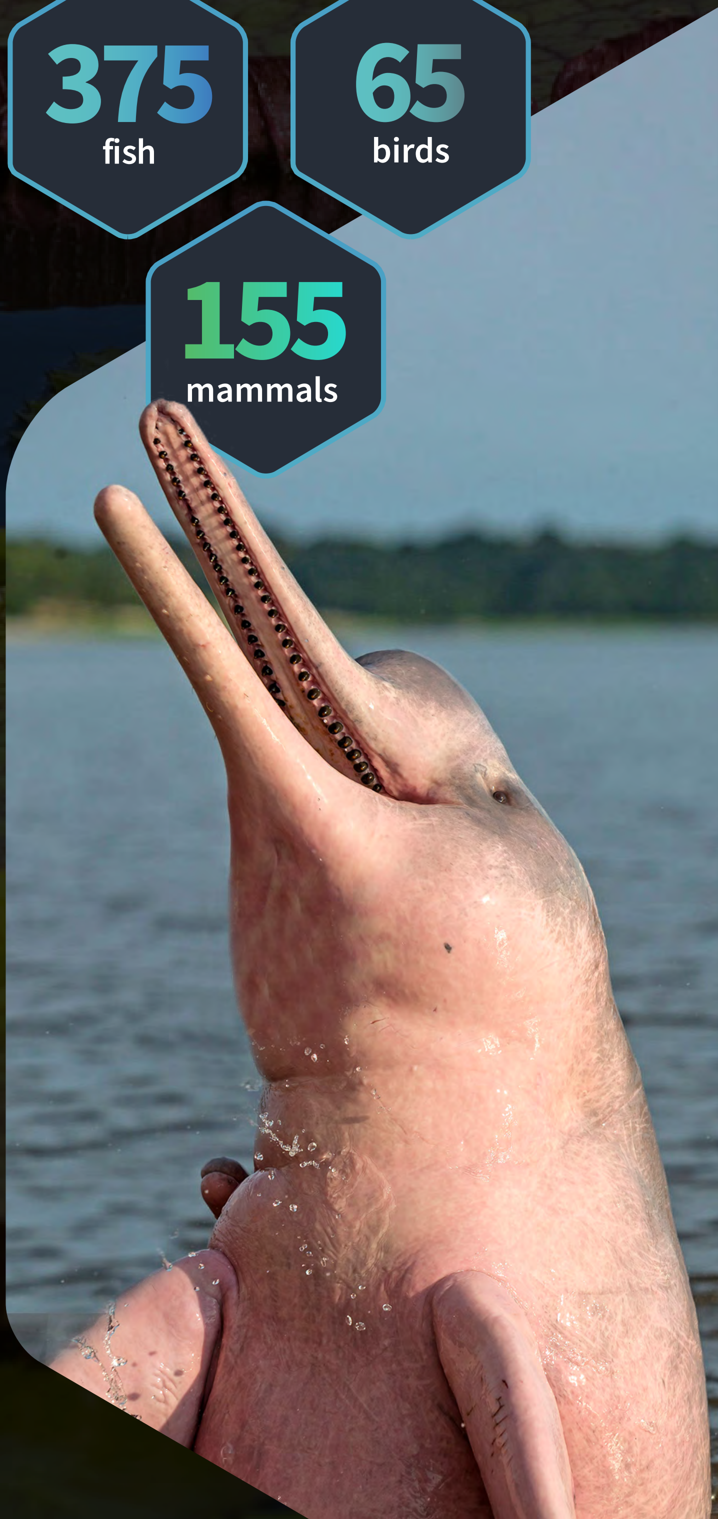


The results from just 3 surveying trips:

375 fish

65 birds

155 mammals



CASE STUDY

Pioneering study with EDF Renewables and Natural Power transforms biodiversity monitoring for offshore wind

EDF renewables

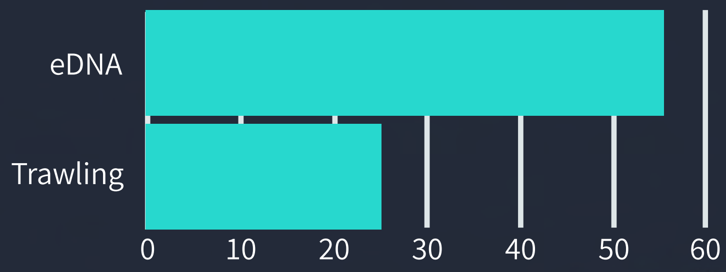
natural power

Offshore wind's rapid expansion has exposed critical limitations in traditional fish surveying methods such as trawling. eDNA promised a safer, more humane, and lower impact alternative.

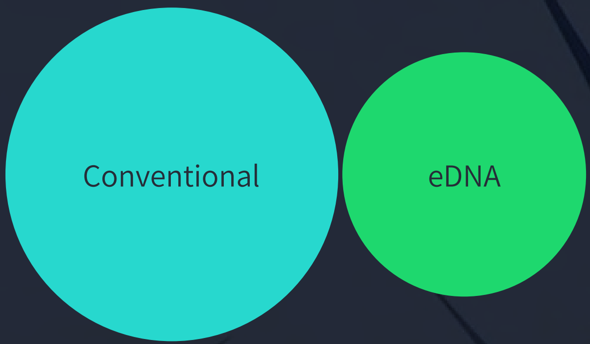
EDF Renewables and Natural Power partnered with NatureMetrics to study eDNA's efficacy vs. conventional methods.

The study established eDNA as an effective solution and revealed significant cost and time savings plus improvements in data quality.

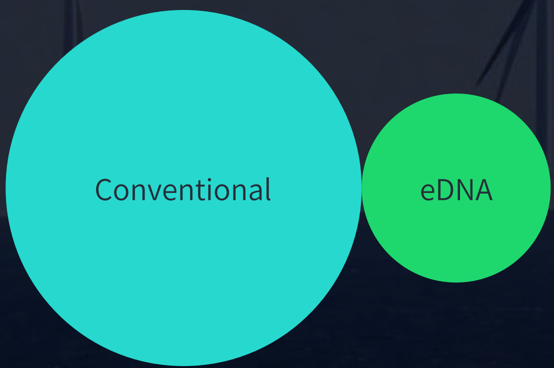
Species detection by method



Vessel time required



Personnel resources required



Survey Highlights

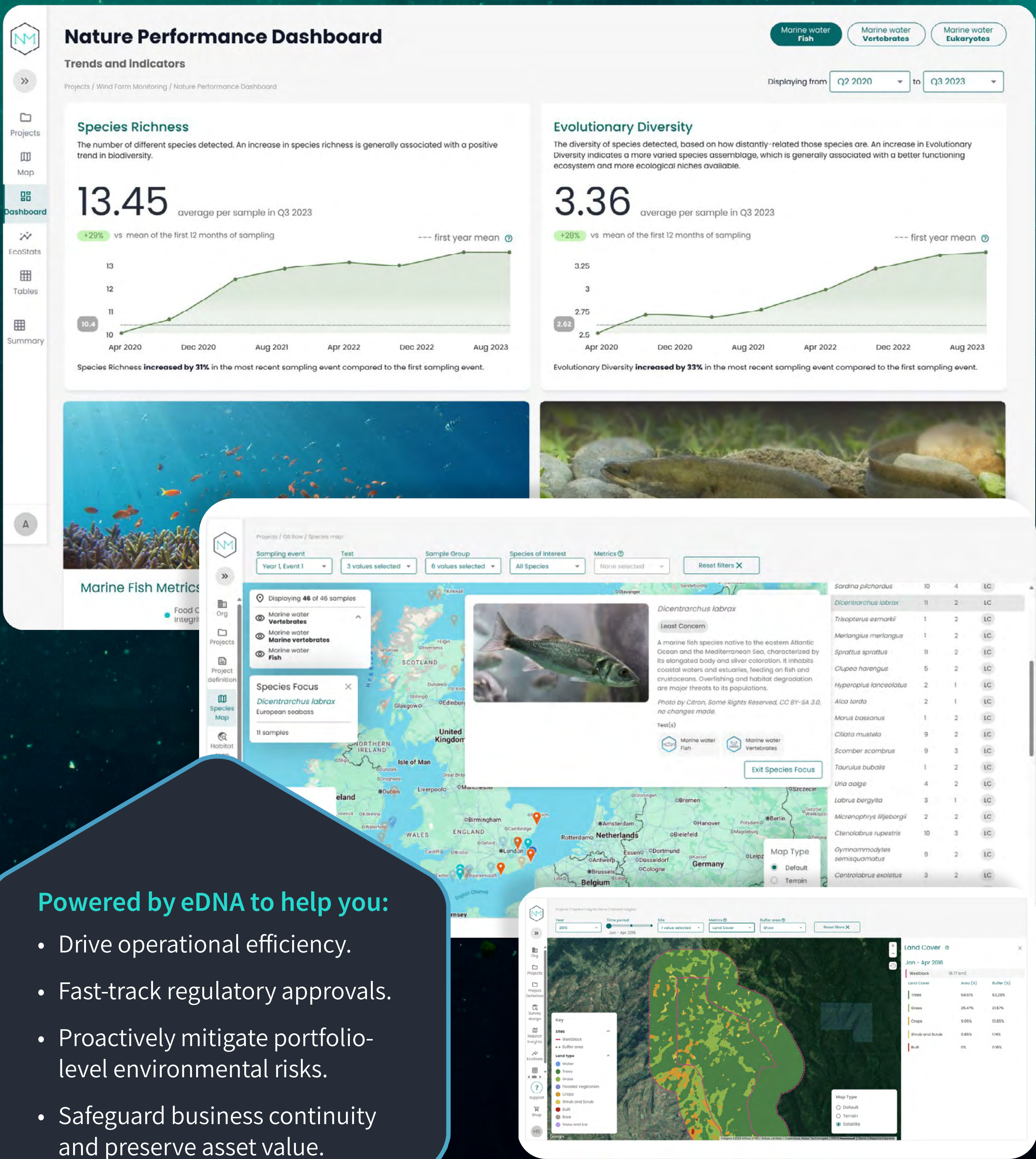
- Collected first of its kind species data supporting artificial reef hypothesis.
- 4 marine mammal species detected.
- Identified seabirds, including great cormorant and common guillemot.
- Detected important species missed by trawling, including European eel & Atlantic salmon.
- Led to 40% reduction in vessel time and 70% reduction in personal resources.

"eDNA-based surveys are a market-ready solution to optimise consenting phase surveys of offshore wind site development, as well as ongoing monitoring and targeted mitigation strategies."

Michelle Elliot
Principal Environmental Consultant at Natural Power

NatureMetrics Intelligence Platform

Turning nature into data and insights that drive sustainable growth, accelerate project timelines, and protect your assets from environmental risk.



Powered by eDNA to help you:

- Drive operational efficiency.
- Fast-track regulatory approvals.
- Proactively mitigate portfolio-level environmental risks.
- Safeguard business continuity and preserve asset value.

PRODUCT SPOTLIGHT

Species Data + Habitat Insights

Combine eDNA and earth observation data for unrivalled nature insights.

Instantly quantify habitat connectivity

Evaluate how well habitats are connected across landscapes. Identify fragmentation and opportunities to enhance ecosystem resilience. And support nature recovery and large-scale conservation planning.

Map habitats and land use change

Identify nine key land cover types (including water, woodland, shrubland, and grassland). Track shifts in natural vs. human-impacted areas over time. And measure habitat composition for biodiversity impact assessments.

Measure vegetation health (EVI)

Use satellite-derived vegetation data to assess habitat quality and ecosystem productivity. Track year-on-year changes in plant health to detect early signs of degradation or recovery. And inform carbon sequestration and natural capital assessments.

Calculate Human Modification Index (HMI)

Carry out nuanced assessments of landscape change and human impact. Particularly valuable for conservation prioritisation, land management planning, and monitoring of changes in natural habitats over time.

Generate Biodiversity Intactness Index (BII)

Identify predicted areas of high biodiversity value to plan conservation and restoration interventions with this global dataset. Based on a combination of modelled Abundance and Compositional Similarity to an undisturbed baseline.

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DNA-BASED MONITORING

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