AI in conservation: A horizon scan

Elspeth Grace, Associate Programme Officer,
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Nature Economy (UNEP-WCMC)

21st May 2025

PROTEUS HORIZON SCAN WEBINARS

A series of webinars for Proteus Partners about the latest trends and developments in biodiversity policy, initiatives, data and tools

LOGISTICS

- **Scheduling:** 30 minutes for presentation and 30 minutes for discussion/ Q&A
- **Recording:** Presentation is recorded, Chatham House Rule for discussion
- **Future topics**: Your suggestions are welcome!

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AGENDA

- Introduction to AI use in conservation
- The potential for AI to revolutionize conservation: A horizon scan
- Opportunities for UNEP-WCMC
  - CITES trade database
  - Protected Planet
  - Incorporating biodiversity in AI models
- Discussion on opportunities for Proteus Partners

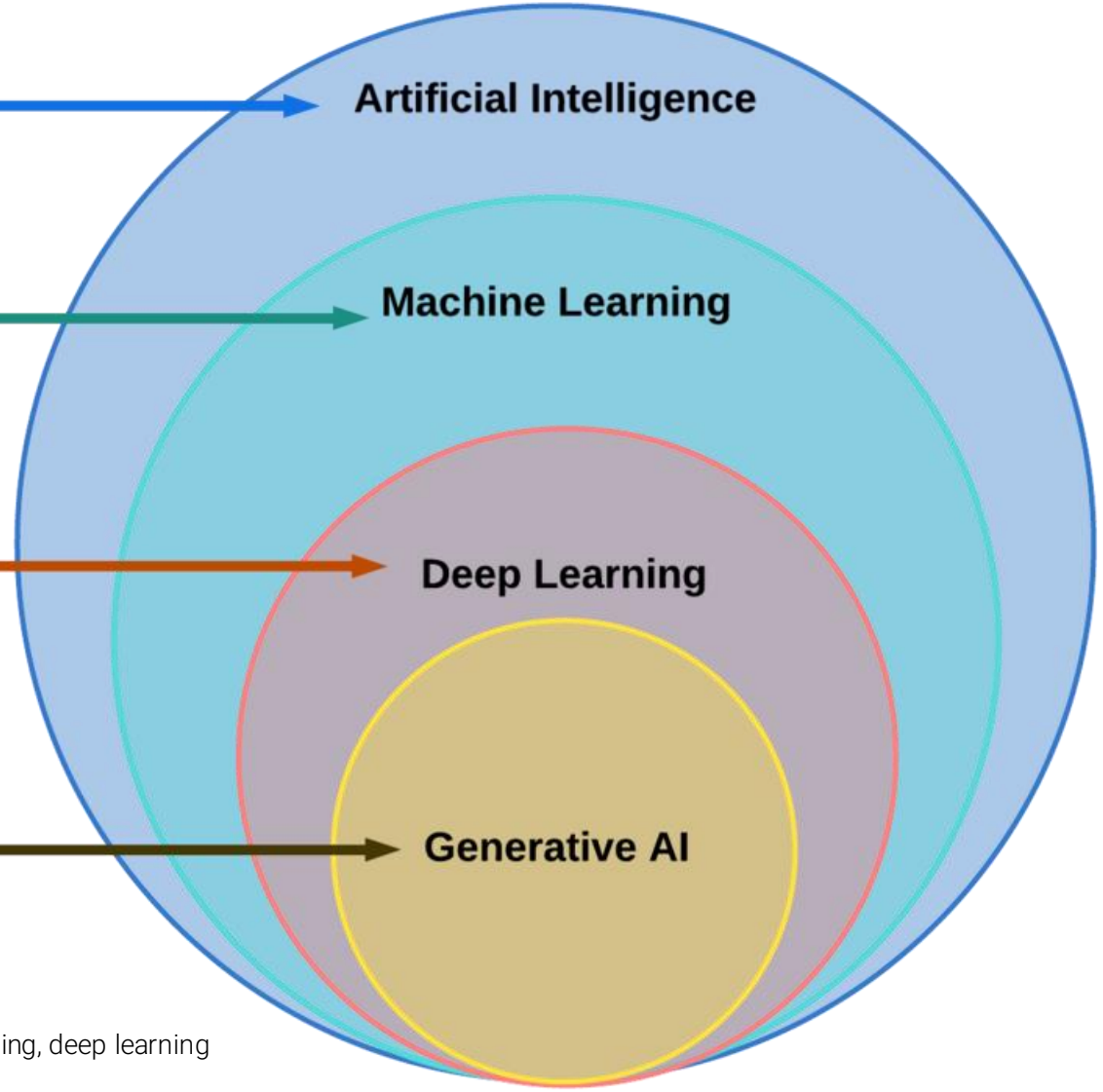
WHAT DO WE MEAN WHEN WE SAY AI?

Artificial Intelligence
AI involves techniques that equip computers to emulate human behavior, enabling them to learn, make decisions, recognize patterns, and solve complex problems in a manner akin to human intelligence.

Machine Learning
ML is a subset of AI, uses advanced algorithms to detect patterns in large data sets, allowing machines to learn and adapt. ML algorithms use supervised or unsupervised learning methods.

Deep Learning
DL is a subset of ML which uses neural networks for in-depth data processing and analytical tasks. DL leverages multiple layers of artificial neural networks to extract high-level features from raw input data, simulating the way human brains perceive and understand the world.

Generative AI
Generative AI is a subset of DL models that generates content like text, images, or code based on provided input. Trained on vast data sets, these models detect patterns and create outputs without explicit instruction, using a mix of supervised and unsupervised learning.



Source: Unravelling AI complexity – A comparative view of AI machine learning, deep learning and generative AI (Popova Zhuhadar, 2023)

WHERE CAN AI FIT INTO CONSERVATION WORK?

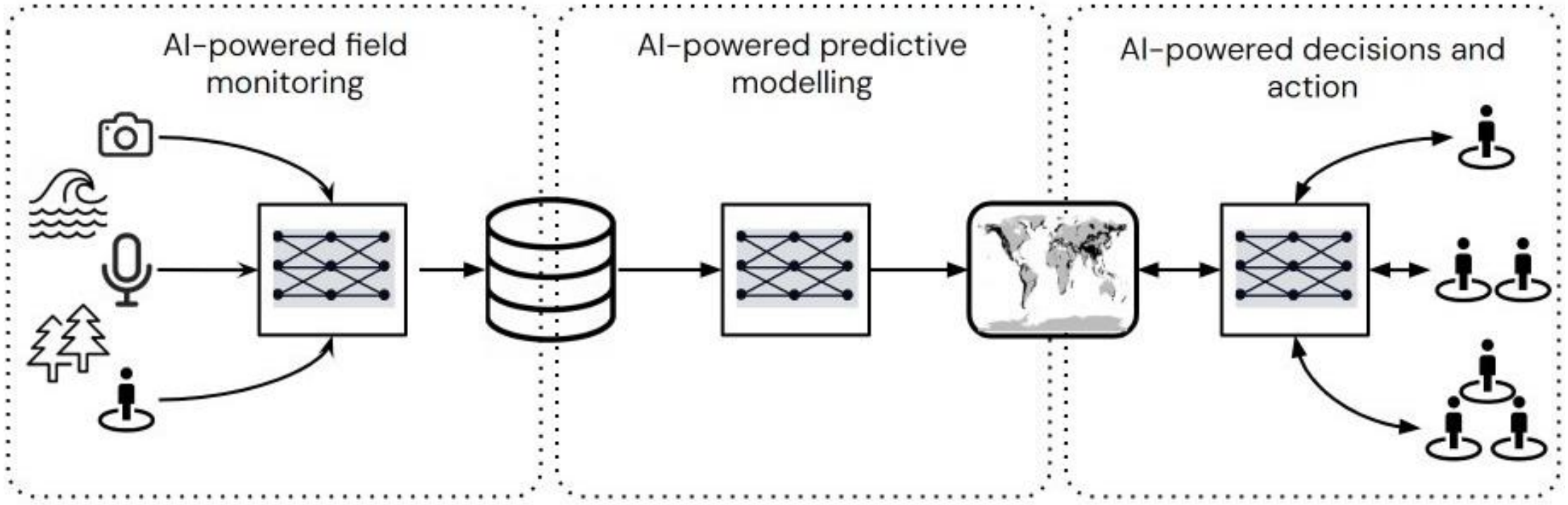
Challenge

Conservation uses a lot of data, which can be drawn from lots of sources

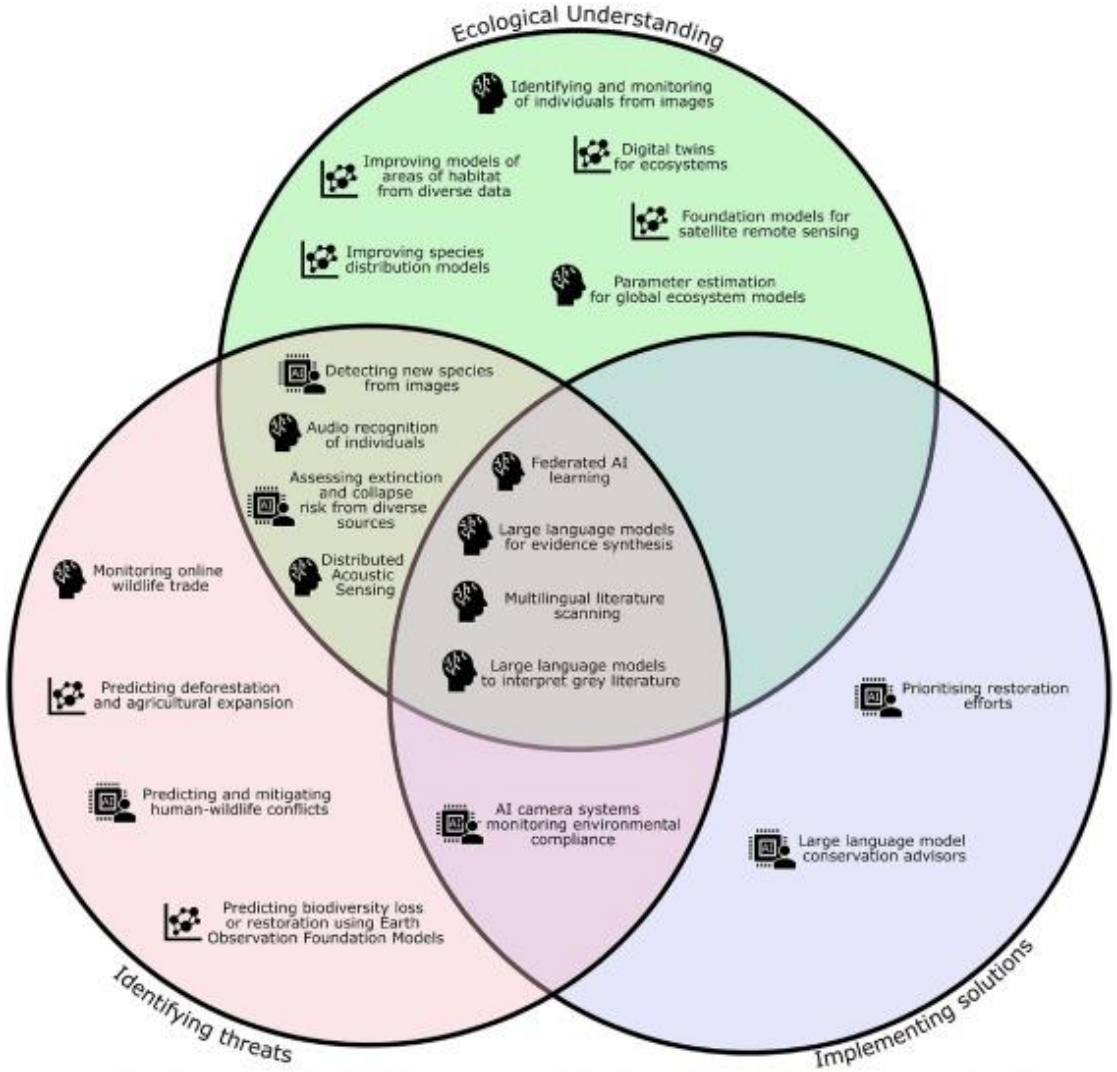
Large amounts of data need lots of processing power to draw conclusions and outputs from

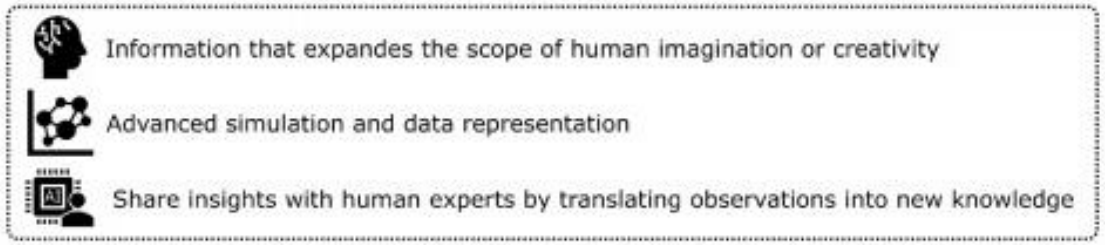
Need to translate outputs into actions and decisions by a variety of actors

Opportunity



THE POTENTIAL FOR AI TO REVOLUTIONIZE CONSERVATION: A HORIZON SCAN





Trends in Ecology & Evolution

Reynolds et al., Trends in Ecology and Evolution, 2025

INFORMATION THAT EXPANDS THE SCOPE OF HUMAN IMAGINATION OR CREATIVITY

For ecological understanding (E)

E5: Identifying and monitoring of individuals from images

E6: Parameter estimation for global ecosystem models

ET1: Audio recognition of individuals

ET2: Distributed acoustic sensing

For identifying threats (T)

T3: Monitoring online wildlife trade

Multi-purpose (ETS)

ETS1: Federated AI learning

ETS2: Multi-lingual literature scanning

ETS3: Large language models for evidence synthesis

ETS4: Large language models to interpret grey literature

ADVANCED SIMULATION AND DATA REPRESENTATION

For ecological understanding (E)

E1: Improving species distribution models

E2: Improving models of areas of habitat from diverse data

E3: Foundation models for satellite remote sensing

E4: Digital twins for ecosystems

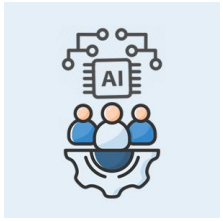
For identifying threats (T)

T1: Predicting deforestation and agricultural expansion

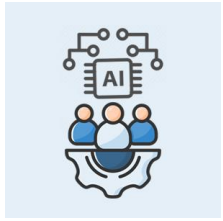
T2: Predicting biodiversity loss or restoration using earth observation foundation models

SHARE INSIGHTS WITH HUMAN EXPERTS BY TRANSLATING OBSERVATIONS INTO NEW KNOWLEDGE

For ecological understanding & threats (ET)

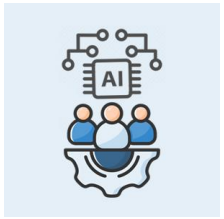


ET3: Detecting new species from images

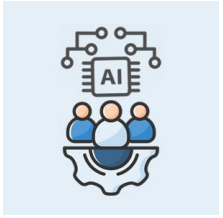


ET4: Assessing extinction and collapse risk from diverse sources

For identifying threats (T)

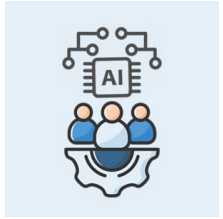


TS1: AI camera systems monitoring environmental compliance

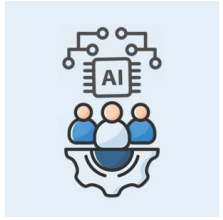


T4: Predicting and mitigating human-wildlife conflicts

Implementing solutions (S)



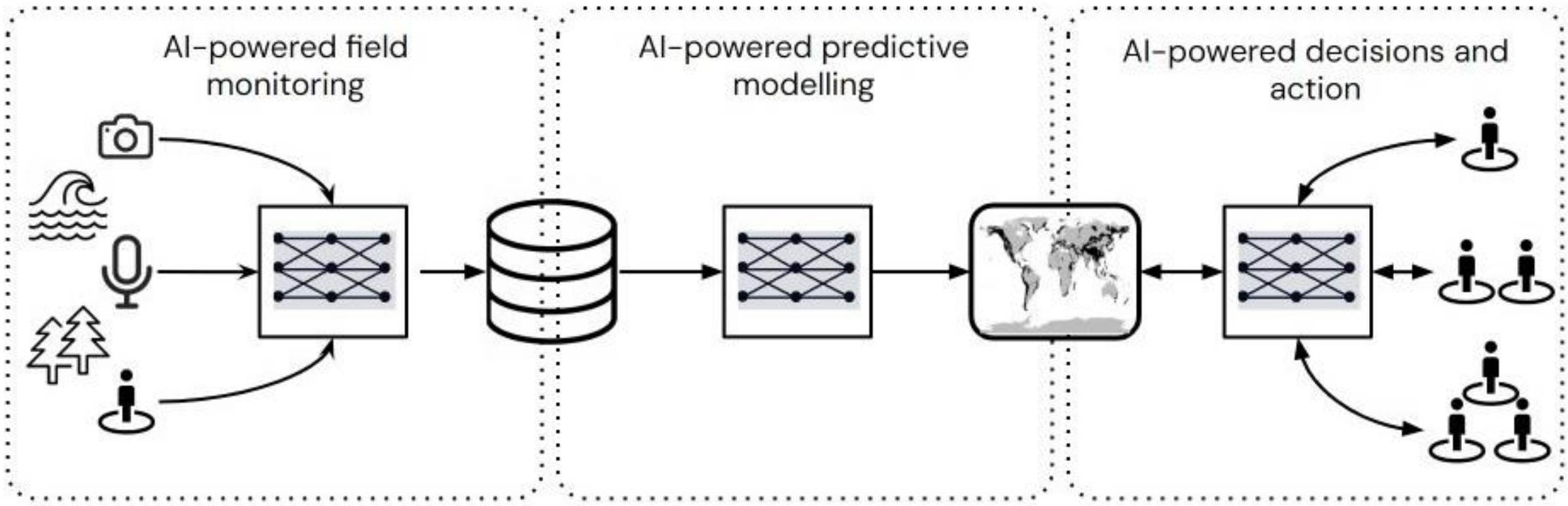
S1: Prioritising restoration efforts



S2: Large language model conservation advisors

Opportunities for UNEP-WCMC

OPPORTUNITIES RELEVANT TO UNEP-WCMC



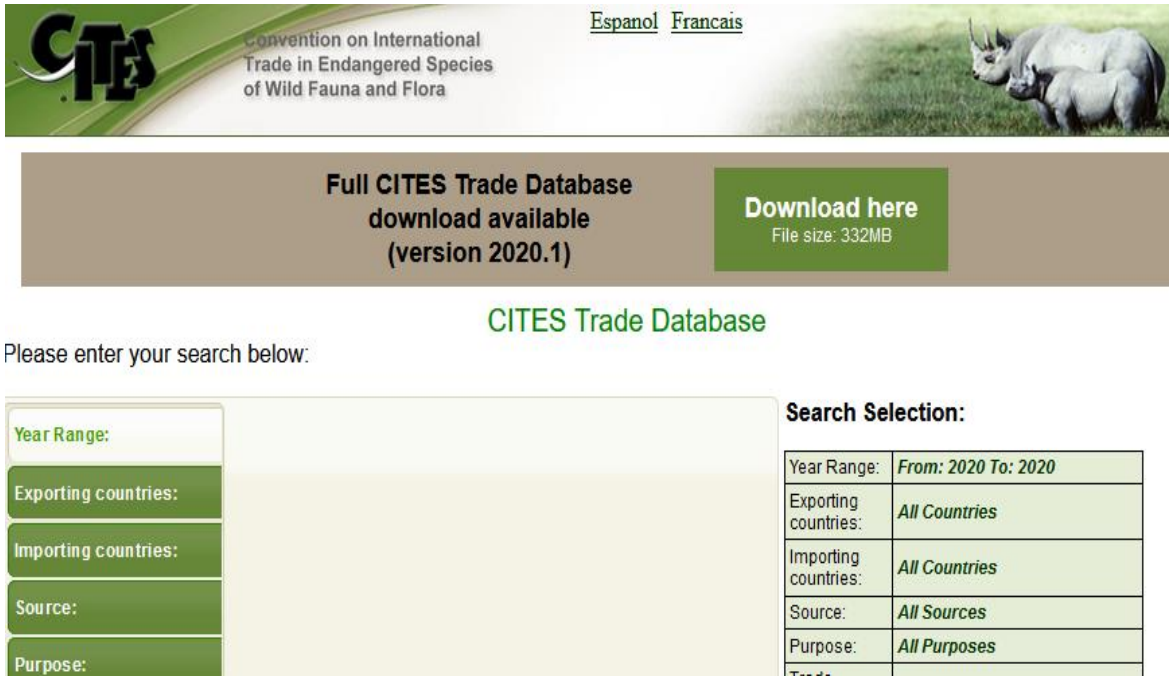
Tap near real time data sources to solve data gaps

Predict complex nature-related systems and provide up-to-date monitoring metrics

Train specialized Large Language Models with high quality inputs to address biodiversity problems

Make it easier to navigate the complexity of nature data and knowledge

EXAMPLE 1: WILDLIFE TRADE MANAGEMENT TOOLS



CITES Trade Database

- Managed by UNEP-WCMC
- Receive Annual Reports from Parties and the CITES Sec.
- Format and upload
- Species+ backend
- CITES front end

AI-POWERED BIODIVERSITY PROTECTION

Leveraging LLMs for Sustainable Wildlife Trade *(an example)*

- Biological traits influence how species **respond to environmental pressures, human exploitation, and conservation efforts**
- These traits are **key indicators** of how a species might respond to **human exploitation, habitat change, and climate change**
- **Goal:** Build a **comprehensive, structured dataset** on species life history traits to assess sustainability of **regulated trade** (e.g., **CITES**, **NDF-support tool**) and identify additional species that may **benefit from management/regulation**.

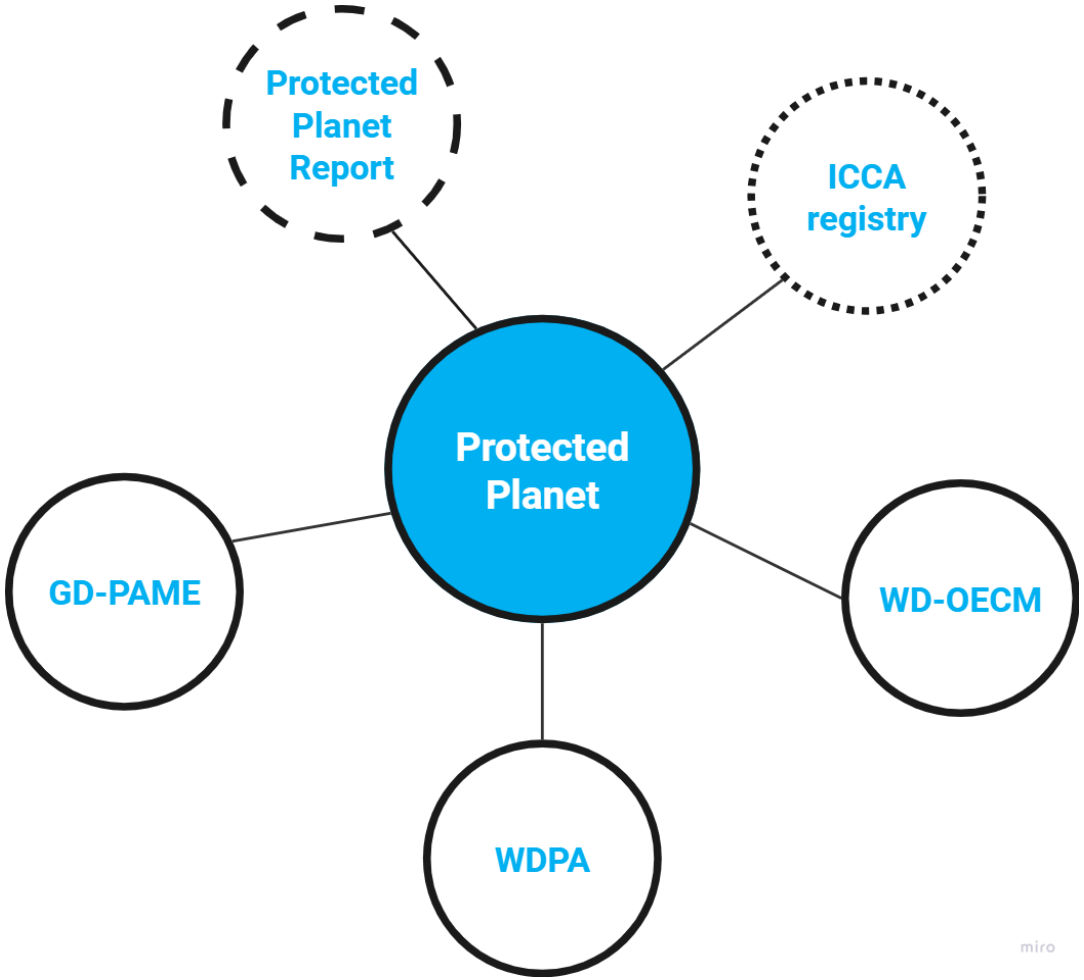
Extract Key Traits from Scientific Literature: LLMs can process **millions of biodiversity papers, reports, and databases** to identify life history traits of species.

Structure Data for Use: Convert extracted information into **structured formats**

Connect Species Traits with Conservation Policies: Map species characteristics to legal frameworks (e.g., CITES Appendix I/II/III)

Predict risk of overexploitation: Convert extracted information into **structured formats**

EXAMPLE 2: PROTECTED AREA MANAGEMENT EFFECTIVENESS

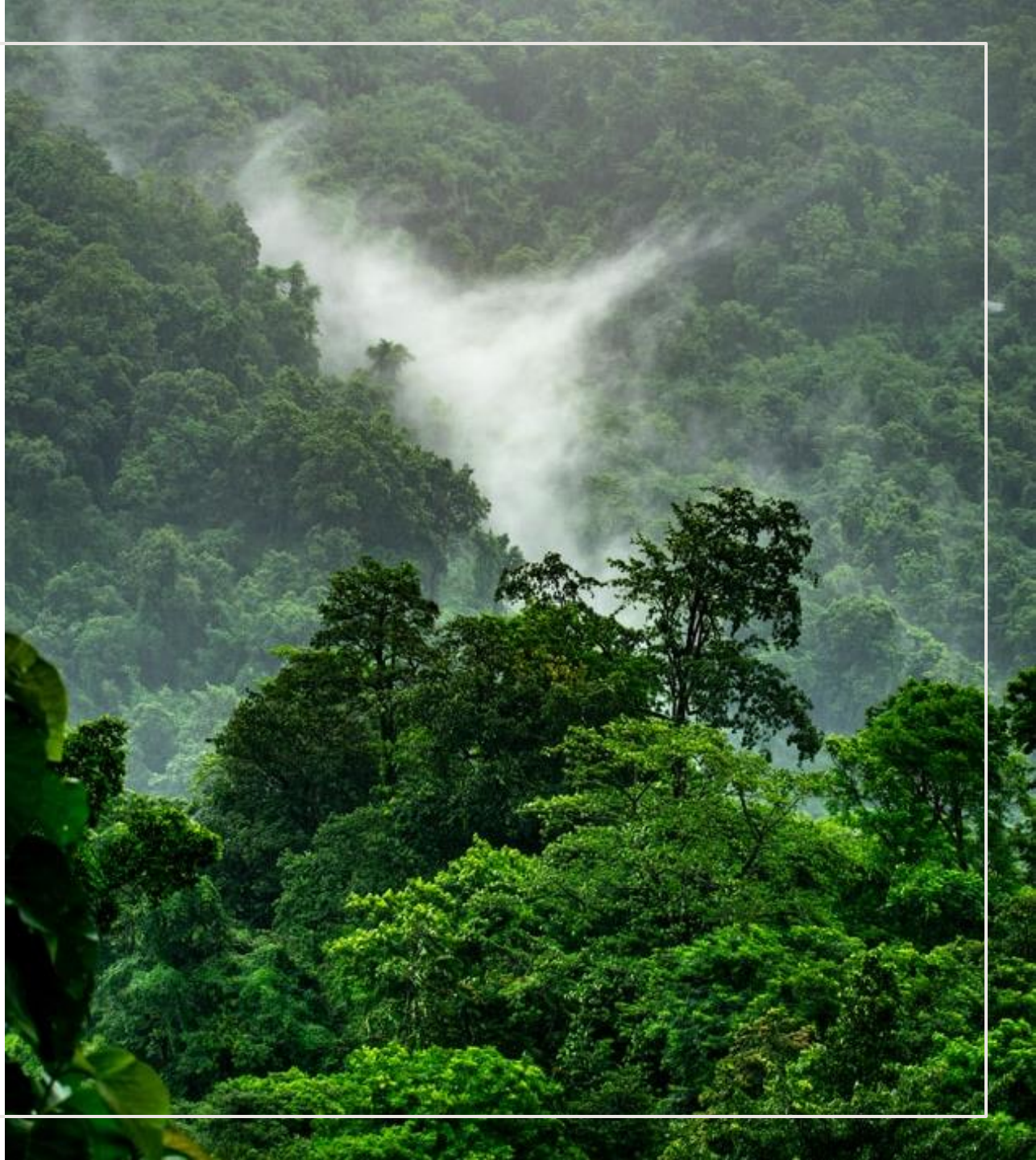


Protected Planet manages and makes available data on Protected areas and OECMs

- Manages the:
  - World Database on Protected Areas
  - World Database on Other Effective Area-based Conservation Measures
  - Global Database on Protected Area Management Effectiveness
  - ICCA Registry
- Produces a biennial Protected Planet report:
  - The latest was released in 2024 - https://digitalreport.protectedplanet.net/

HOW COULD AI HELP IMPROVE MANAGEMENT EFFECTIVENESS REPORTING?

- Effectiveness depends upon protected and conserved areas successfully conserving the biodiversity values
- Assessing the effectiveness of protected and conserved areas at the site and global level is challenging *(governance, data challenges)*
- Information is compiled in the Global Database on Protected Area Management Effectiveness (GD-PAME), but very little information is available *(6.8% of protected areas in the WDPA have been assessed)*
- Role for tech, remote sensing and data analytics improve site-level and global assessment



EXAMPLE 3: ADDING BIODIVERSITY DIMENSION TO AI MODELS AND ALGORITHMS?

- Need for high-quality data sources
  - LLMs are data-driven - output quality depends on quality, diversity and credibility of data.
- Model Architecture and LLM integration
  - Need for structure and domain knowledge and expertise to bring the biodiversity data world together with AI in a way that makes sense: expert human involvement is essential.
- Accuracy and validation
  - Expert human knowledge in biodiversity is essential to validate outputs. Need fact-checking pipelines and to train the models over time.
- User experience and deployment of tool
  - Languages, context, users, open data, ethical considerations, model sustainability (optimizing efficiency to reduce CO_2).
  - Biodiversity questions often require location data, requiring geospatial analysis and tools to answer accurately

Large language models possess some ecological knowledge, but how much?

Filip Dorm[a,b], Joseph Millard[c], Drew Purves[d], Michael Harfoot[e], Oisin Mac Aodha[b]

[a]*School of Architecture, Civil and Environmental Engineering (ENAC), École Polytechnique Fédérale de Lausanne (EPFL), Switzerland*
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[c]*Department of Zoology, University of Cambridge, United Kingdom*
[d]*Google DeepMind, United Kingdom*
[e]*Vizzuality, United Kingdom*

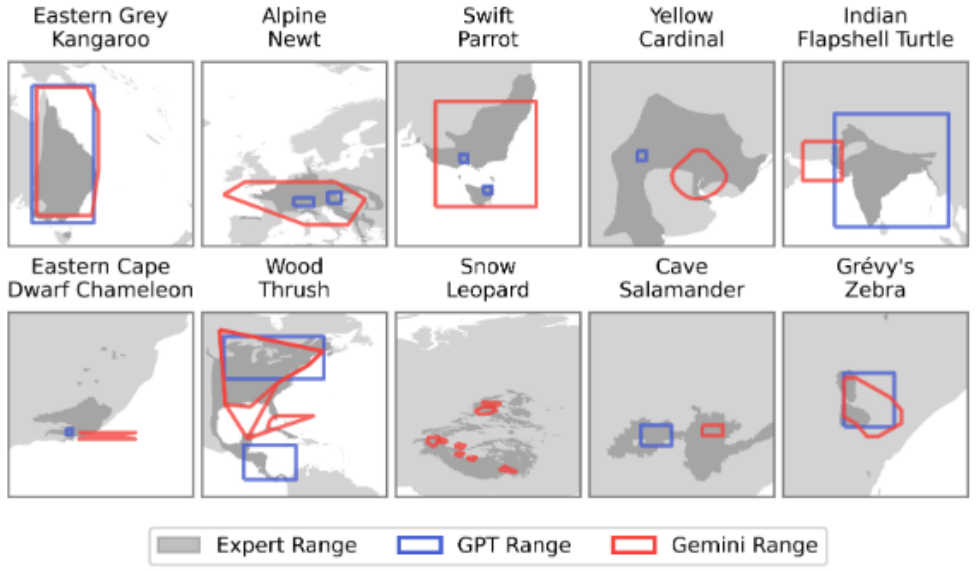
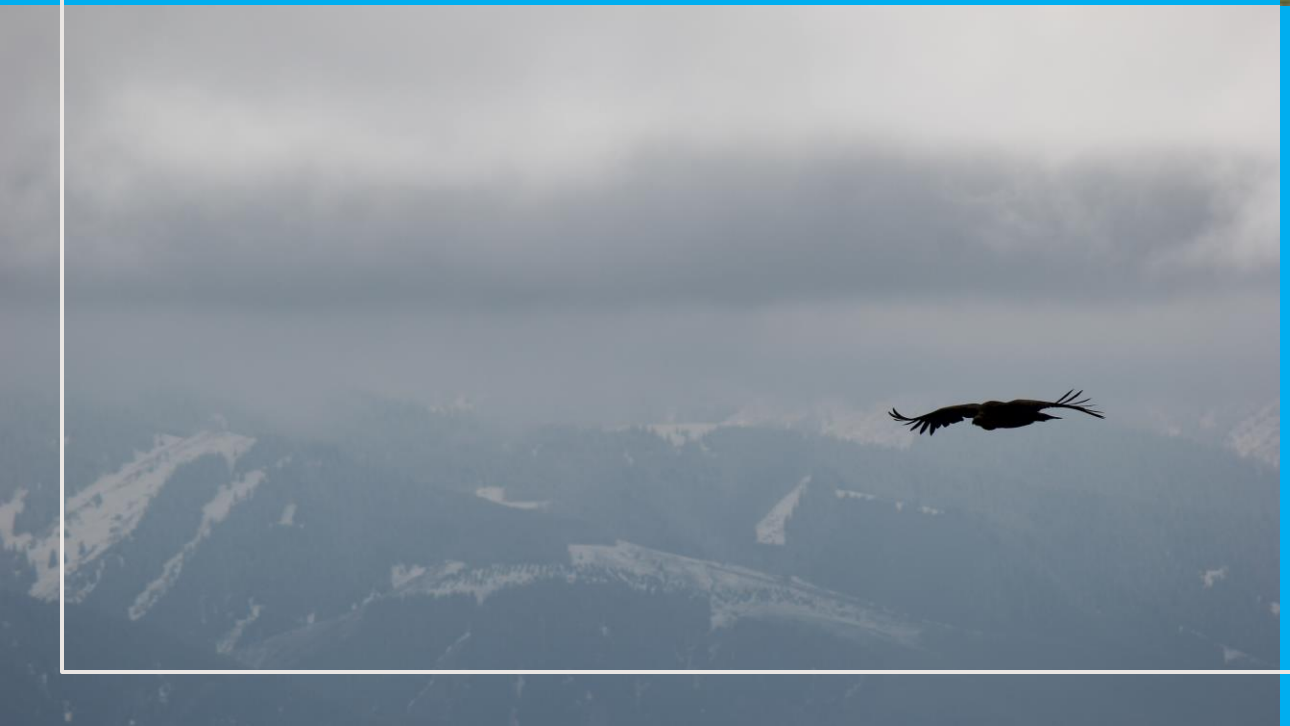


Figure 8: **Task 2: Range Maps.** Here we display range maps for a subset of species generated by `Gemini 1.5 Pro` (red) and `GPT-4o` (blue) as well as the expert-derived range maps from IUCN (dark gray) we use for evaluation.

BUILDING FOUNDATIONAL DATASETS USING AI

Land Cover Change Data: Develop foundational datasets to track and analyse land cover changes, supporting environmental planning and conservation efforts.

Species Distribution and Trends: Establish robust data systems to inform **government and business** decisions on species protection and ecosystem management.



Conservation Best Practices: Create a centralized knowledge base that highlights **effective conservation strategies**, ensuring shared learning across sectors.

Policy Integration with Tech Innovation: Collaborate with tech companies to embed **biodiversity policy insights** into emerging AI solutions and platforms.

SUMMARY OF OPPORTUNITIES

- Short-Term Impact:
  - Faster, automated sustainability assessments.
  - Improved wildlife trade monitoring.
- Long-Term Impact:
  - AI-driven risk predictions to prevent extinctions.
  - Dynamic conservation policies based on real-time data.
  - Support for CITES, CMS, CBD, and other conservation efforts.
- AI will transform conservation efforts but need cross-disciplinary collaboration

RISKS AND MITIGATION: A BRIEF OVERVIEW

Risks to security:

- Accidental disclosure of sensitive information
- Hallucinations and false outputs from generative AI tools, presented as fact

Risks related to trust and ethics:

- Difficulties of verifying / validating AI outputs
- Lack of transparency in data processing and analysis
- Risks of biases in data / algorithms

AI environmental impact

- AI is energy intensive, and places demand on land and water

Example mitigations and response options

- Guidelines and training for staff on safe usage
- 'Ground truthing' of AI models against trusted data and knowledge
- Work with tech AI 'disruptors' and other innovators to be part of the change, shape the outputs to be positive for nature
- Choose suppliers / partners with care
- Research the impacts, aim to guide policy

Discussion: Opportunities for Proteus Partners

Thank you

UN environment programme

WCMC