AI Tools for Addressing Conservation and Biodiversity

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Images: Tuolumne River in the Sierra Nevada; overlay | Adobe Stock. Graphic: Mikel Shybut

Summary Points

Biodiversity Crisis

Biodiversity is declining globally at unprecedented rates due to a variety of cascading and compounding anthropogenic impacts including climate change, habitat destruction, pollution, and overexploitation.

To address this crisis, governments around the world, including California, have committed to the 30x30 initiative, which sets a goal of conserving 30% of the world's lands and waters by 2030 to protect and restore biodiversity.

High quality data on the distribution of species and ecosystems are vital for establishing baselines and monitoring progress towards successfully meeting these goals, but are often costly or time consuming to collect. Additionally, existing data are frequently incomplete or biased toward only a small fraction of the world.

Preserving the State's biodiversity will require coordinating efforts across a wide range of sectors, including researchers and scientists, policy makers, land managers, local communities, and other organizations.

Artificial Intelligence

Advances in the fields of artificial intelligence (AI) and machine learning (ML) are a promising avenue for supporting researchers and practitioners in the conservation and biodiversity space. AI's ability to detect complex patterns that traditional algorithms cannot make it a powerful tool for analyzing the large amounts of biodiversity data being collected.

Today, AI and ML tools have been most often deployed in the conservation space to augment the collection and processing of data—such as those generated via automated sensors or satellite imagery—but there is broader potential for its use, including furthering improvements in data collection, drawing inferences or predictions from existing data, and directly assisting decision making.

The application of AI to biodiversity and conservation requires careful consideration of the potential risks. These include tools or models that produce incorrect or biased information, technology that exacerbates existing inequities, or the undermining of the data rights of local communities.

Disaster Resilience Initiative

CCST's Disaster Resilience Initiative is generously supported by the State of California through a one-time funding allocation in the 2021-2022 State budget. This allocation supports the transmission of information between science and technology experts and policymakers focused on the overlapping, intersecting, and compounding nature of disasters in California.

Moderator

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Example AI Applications

The following applications of AI in conservation and biodiversity represent just a small portion of the work being conducted by the panelists and other researchers in this space.

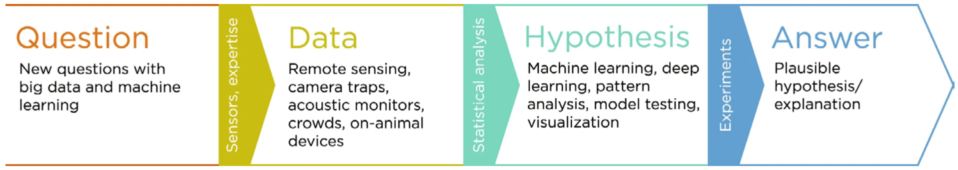

Figure: How machine learning can contribute to the scientific method.

Tuia, D., Kellenberger, B., Beery, S. et al. Perspectives in machine learning for wildlife conservation. Nat Commun 13, 792 (2022).

Responsible AI

While AI offers incredible potential for addressing critical biodiversity and conservation needs, it also introduces risks, such as bias or incorrect information from improperly deployed tools.

Dr. Sara Beery, as part of the Global Partnership on AI's project on Responsible AI Strategy for the Environment, coauthored a report creating a comprehensive roadmap for developing AI capacity in this space, with cross-sectoral recommendations aimed at addressing data needs and building infrastructure, identifying key opportunities for developing tools, conducting public engagement and outreach, and cultivating funding opportunities.

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Global Partnership on AI (GPAI). (2022). *Biodiversity & Artificial Intelligence: Opportunities and Recommendations.* Report, November 2022.

Decision Making Assistance

As techniques for observing and measuring biodiversity loss increase in efficiency and sophistication, they run the risk of outpacing decisionmakers' abilities to respond and mitigate their impacts.

Dr. Millie Chapman is leveraging methods from decision theory and machine learning to inform decision making in the face of environmental uncertainty while considering the broader context of unbalanced power dynamics, transparency, and algorithmic or data biases.

For example, using reinforcement learning (RL)—a subfield of machine learning that focuses on developing an agent that interacts with highly dynamic and uncertain systems—she and her collaborators have demonstrated how RL can be used to solve decision making problems in the conservation space, such as setting fisheries quotas.

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Lapeyrolerie, M., Chapman, M., Norman, K., & Boettiger, C. (2022). Deep Reinforcement Learning for Conservation Decisions. *Methods in Ecology and Evolution.*

Chapman, M., Xu, L., Lapeyrolerie, M., & Boettiger, C. (2023). Bridging Adaptive Management and Reinforcement Learning for More Robust Decisions. *Philosophical Transactions of the Royal Society B.*

Preventing Wildlife Poaching and Trafficking

Illegal wildlife poaching directly threatens biodiversity of at risk ecosystems and endangered species, with potential negative impacts on human health, national security, and economic development. Efforts to combat these activities are often constrained by the limited resources of law enforcement agencies as well as fragmented datasets that are not interoperable.

Dr. Bistra Dilkina and her collaborators are developing tools to enhance enforcement efforts, using ML to identify areas at high risk of poaching, predicting likely trafficking routes, and optimizing patrol routes and strategies for disrupting illegal activities.

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Xu, L., et al. (2020). Stay Ahead of Poachers: Illegal Wildlife Poaching Prediction and Patrol Planning Under Uncertainty with Field Test Evaluations (Short Version). *2020 IEEE 36th International Conference on Data Engineering (ICDE)*, 1898-1901.

Ferber, A., Griffin, E., Dilkina, B., Keskin, B., & Gore, M. (2023). Predicting Wildlife Trafficking Routes with Differentiable Shortest Paths. In A. A. Cire (Ed.), *Integration of Constraint Programming, Artificial Intelligence, and Operations Research (CPAIOR 2023), Lecture Notes in Computer Science* (Vol. 13884). Springer, Cham.

Mapping Wetland Ecosystems

In much of the United States, wetland maps are out of date—sometimes by multiple decades—due to the costs of mapping with manual, labor intensive methods. Existing wetland mapping algorithms rely on commercial data for high resolution maps or have coarse spatial resolution when using free data.

Dr. Kumar Mainali and his team trained an AI model to efficiently map wetlands based on freely available remote sensing data at high spatial resolutions on the scale of 1 meter, improving the detection and monitoring of wetlands and wetland change. With these gains in efficiency and use of free data, wetland maps can be updated more frequently, capturing seasonal changes and allowing for more varied geography to be analyzed.

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Mainali, K., Evans, M., Saavedra, D., Mills, E., Madsen, B., & Minnemeyer, S. (2023). Convolutional Neural Network for High-Resolution Wetland Mapping with Open Data: Variable Selection and the Challenges of a Generalizable Model. *Science of the Total Environment*, 861, 160622.

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