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Guidance for Effective and Equitable Area-based Conservation Technology and Innovation

Consultation Version 1.0

INTERNATIONAL UNION FOR CONSERVATION OF NATURE

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Guidance for Effective and Equitable Area-based Conservation Technology and Innovation

Consultation Version 1.0

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Executive Summary

Purpose and Context

The Guidance for Effective and Equitable Area-based Conservation Technology provides place-based conservation decision-makers with clear, structured guidance to support the ethical, effective, and responsible use of technology. Developed through the Tech4Nature Partnership between IUCN and Huawei, the guidance responds to growing pressure on place-based conservation decision makers to scale effective and measurable conservation outcomes in the run-up to 2030, while ensuring that technology adoption strengthens governance, equity, rights, and long-term conservation outcomes rather than undermining them.

Across the conservation sector, digital tools and innovative approaches are increasingly promoted as solutions to complex challenges. However, many organisations face persistent difficulties translating technological potential into durable conservation impact. Common challenges include fragmented decision-making, donor-driven pilot projects that fail to scale, insufficient attention to governance and consent, weak data accountability, and technologies that sit outside established management and reporting systems. When poorly governed, technology adoption can introduce operational, reputational, and rights-based risks.

This guidance shifts the focus from technology-led experimentation to disciplined, standards-aligned decision-making. Rather than promoting specific technologies or prescribing a step-by-step pathway, it provides a structured guide to support decision-makers in Protected and Conserved Areas (PCAs) in asking the right questions, making assumptions explicit, and determining whether, when, and under what conditions technology is appropriate. It is designed to strengthen judgement, accountability, and clarity in complex, real-world contexts.

Across its seven themes, the guidance brings into view a consistent set of considerations that place-based conservation decision-makers are routinely required to navigate when adopting technology, including environmental impact, cultural appropriateness and compatibility with traditional knowledge, gender-responsiveness, cost-effectiveness and accessibility, long-term sustainability, and the conditions under which approaches can be responsibly scaled.

Alignment with Global Conservation Frameworks

The guidance is explicitly designed to operate across multiple, complementary global conservation standards and policy commitments. The Kunming–Montreal Global Biodiversity Framework provides the overarching strategic direction, particularly through Target 3, while also reinforcing broader objectives related to effective planning, inclusive governance, monitoring, and long-term sustainability (CBD, 2022).

These commitments are translated into operational guidance through established standards and guidance, including the IUCN Global Standard for Effective and Equitable

Protected and Conserved Areas (IUCN Global PCA Standard), guidance on Other Effective Area-based Conservation Measures (OECMs), and guidance on Indigenous Peoples' and local communities' conserved territories (Jonas and Woodley, 2024; Stevens et al., 2024; Woodley et al., 2026). Each plays a distinct role within the guidance document. The IUCN Global PCA Standard provides a management effectiveness and continuous improvement lens for PCAs. Guidance on OECMs ensures legitimacy across diverse governance models beyond formally designated protected areas. Guidance on Indigenous Peoples' and local communities' conserved territories safeguard rights, governance and authority, free, prior and informed consent (FPIC), and respect for traditional knowledge systems.

In addition, the guidance draws on a coherent set of IUCN and partner guidance addressing biodiversity monitoring and impact assessment, inclusive and equitable implementation of Target 3, and ecological connectivity ensuring that technology decisions are grounded in governance, evidence, equity, and long-term ecological coherence.

By embedding technology decision-making within this integrated architecture, the guidance document helps decision-makers situate technology choices within existing governance and accountability systems. It enables the holistic design, justification, documentation and reporting of technology decisions in ways that are consistent with global biodiversity commitments, while remaining appropriate to local governance, capacity, and ecological realities.

Structure and Design of the Framework

The guidance document is organised around seven Core Themes, each structured around five practitioner-facing questions, resulting in 35 questions in total. These questions reflect real decision points encountered by decision-makers when considering, deploying, or reviewing technology in area-based conservation contexts.

The seven Core Themes are:

1. **Technology Selection and Readiness**
2. **Inclusive Innovation and Co-Design**
3. **Ethical Data Governance and Accountability**
4. **Capacity Building and Learning Systems**
5. **Monitoring, Evaluation, and Adaptive Planning**
6. **Financing Conservation Technology Sustainably**
7. **Greening Conservation Technology**

For each question, the guidance document follows a consistent internal structure designed to support reflective and informed decision-making:

- An overview section explaining why the issue matters and how it relates to conservation outcomes, governance requirements, and global standards.
- An action section outlining practical considerations and approaches.
- A "Practitioners should" summary highlighting key points of attention and responsibility.
- A structured table presenting relevant technology categories and associated tools, showing how these relate to global frameworks and highlighting practical considerations for managers when assessing, selecting, and implementing technology.
- A curated reference list grounding each question in authoritative guidance, evidence, and recognised best practice.

At the end of each theme, the guidance document includes a dedicated "Relevant Standards, Tools and Templates" section that is specific to the topic of that theme. These sections signpost authoritative standards, guidance documents, tools, and reference resources that provide additional context and grounding for the issues explored in each theme. Used alongside the

thematic questions, they support informed interpretation, strengthen alignment with recognised frameworks, and help practitioners situate technology-related decisions within established bodies of knowledge, without prescribing implementation approaches or processes.

Together, the themes and their supporting resources form a governance-centred guide that prioritises conservation outcomes, legitimacy, equity, and durability over technological novelty.

Guidance for Decision-Makers in Protected and Conserved Areas

The guidance is primarily designed for place-based conservation decision-makers who hold responsibility for selecting, designing, deploying and governing technologies within PCAs. As a secondary audience, the framework supports other affected stakeholders to understand what responsible, rights-based and effective conservation technology adoption looks like in practice, enabling constructive dialogue and accountability around place-based technology decisions.

Across all audiences, the guidance emphasises inclusive approaches that recognise and empower women, youth, Indigenous Peoples, and local communities as rights-holders, knowledge-holders, and essential partners in effective and ethical conservation. It is relevant to site-based managers and conservation organisations, Indigenous Peoples and community governance bodies, policymakers and public agencies, technology developers and providers, donors and funding organisations, as well as researchers, capacity-building institutions, and cross-sector partners working in PCAs. Together, these actors form the enabling ecosystem required to ensure that technology adoption in area-based conservation is responsible, equitable, and aligned with global biodiversity goals.

The guidance is intentionally modular and non-linear. Practitioners are not expected to work through every theme or question, nor to follow a predefined sequence. Instead, the document can be used to inform internal discussions, guide programme design, review existing initiatives, or support justification and documentation of technology-related decisions.

In practice, practitioners engage with the guidance by selecting relevant themes or questions, reflecting on the contextual guidance provided, and using the tables and summaries to clarify assumptions, responsibilities, and constraints. Importantly, the guidance supports decisions about when technology should be adapted, delayed, or not used, enabling decision-makers to prioritise governance readiness, rights, consent, environmental sustainability, or institutional capacity over technological efficiency or speed when necessary.

Overall Contribution

The Guidance for Effective and Equitable Conservation Technology provides decision-makers with a robust, standards-aligned guide for making technology decisions that are ethical, defensible, and fit-for-purpose. By embedding technology adoption within established conservation frameworks and making governance, rights, and capacity conditions explicit, the framework enables practitioners to make clearer, more accountable decisions under real-world constraints. In doing so, it supports the responsible scaling of area-based conservation action while safeguarding rights, legitimacy, and long-term conservation outcomes.

Acknowledgements

We gratefully acknowledge the individuals, organisations and partners whose contributions informed the development of this Guidance for Effective and Equitable Area-based Conservation Technology and Innovation: Consultation Version 1.0.

This guidance document has been developed through a targeted process of dialogue, technical review and consultation with IUCN experts.

The guidance also draws on learning generated through Tech4Nature, a global collaboration between IUCN and Huawei that brings together conservation expertise, digital innovation and local leadership to support effective and equitable area-based conservation. Since 2020, Tech4Nature flagship and satellite initiatives have tested and applied a wide range of technologies across ecological and governance contexts. These experiences have informed the principles and recommendations presented throughout this guidance.

As a consultation document, Version 1.0 is intended to evolve through continued application, learning and feedback. We therefore extend our appreciation to the practitioners, partners and rights holders whose ongoing experience and insights will contribute to future iterations of this guidance.

Purpose, Scope, and Audience

Purpose of the Guidance Document

Across the conservation sector, technology and innovation are increasingly promoted as critical enablers of area-based conservation. However, despite this uptake, many place-based conservation actors have identified challenges in translating technological potential into long-term, equitable conservation outcomes (Speaker et al., 2021; Tabor et al., 2024). These challenges are magnified by growing pressure on place-based decision-makers to demonstrate results at scale by 2030. Without clear, structured guidance tailored to real governance contexts, there is a risk that technology adoption accelerates in ways that prioritise speed, visibility and innovation narratives over effectiveness, equity and long-term integrity.

A substantial body of work addresses effective area-based conservation management. This includes IUCN Standards and Guidance such as the IUCN Global Standard for Effective and Equitable Protected and Conserved Areas: Standard, Version 2.0 (IUCN Global PCA Standard) (Woodley et al., 2026) and the IUCN framework for monitoring biodiversity in protected areas and other effective area-based conservation measures (Dalton et al., 2024). Other available resources focus on the conservation technology tools and solutions available, highlighting innovative applications and their contexts. These include PANORAMA Solutions in Focus, Global Species Action Plan (GSAP) Species Conservation Knowledge, Information, Learning, Leverage and Sharing (SKILLS) platform Tech4Species page and WILDLABS. However, there remains a need for a single, coherent framework that brings together governance, rights, finance sustainability and learning specifically for conservation technology and innovation in Protected and Conserved Areas (PCAs).

The purpose of this document is to provide clear guidance for the ethical, effective, and responsible integration of digital tools, technologies, and innovations into place-based conservation efforts worldwide. It serves as a decision-making resource for practitioners in protected and conserved areas, helping them to make informed and context-sensitive choices when adopting technology.

At its core, the guidance document is committed to advancing effective area-based conservation outcomes while upholding traditional knowledge systems, respecting Indigenous rights and free, prior and informed consent (FPIC), promoting equity and inclusion, and fostering innovation that is transparent, accountable, and designed for long-term impact.

Scope of Application

This document is intended for use across a wide range of conservation settings and governance contexts grounded in area-based conservation. It applies to:

- PCAs: including national parks, nature reserves, community-conserved areas, and transboundary landscapes and seascapes.
- Other Effective Area-Based Conservation Measures (OECMs) and Indigenous and Traditional Territories (ITTs): recognising governance diversity and the importance of Indigenous stewardship.

- Species monitoring and conservation initiatives: particularly where these efforts are linked to or embedded within broader area-based conservation.
- Restoration and stewardship programmes: across both terrestrial and marine ecosystems.
- Cross-sector partnerships and technology ecosystems: where collaboration supports conservation outcomes.

The guidance applies across all governance types recognised in the IUCN Global PCA Standard (Woodley et al., 2026) and Kunming-Montreal Global Biodiversity Framework (KM-GBF) (CBD, 2022), including:

- Indigenous-led governance
- Collaborative governance
- Private protected areas
- Government-led protected areas
- Co-managed protected areas

In this guidance document, conservation technologies are understood broadly as digital, analytical or sensor-based tools and systems used to support conservation planning monitoring, decision-making, enforcement, participation and learning. This guidance addresses the full range of digital and technological domains relevant to conservation, including:

- Data collection and monitoring technologies such as remote sensing, artificial intelligence (AI)-enabled tools, and Internet of Things (IoT) devices.
- Data governance and ethical data use, with attention to equity and rights-based approaches.
- Emerging technologies including blockchain, digital identities, gamification, and smart contracts.
- Enabling environments that support the responsible adoption, scaling, and sustainability of technology.

Primary Audiences

The guidance is designed to support actors involved in conservation technology decision-making, implementation and governance within place-based conservation contexts, recognising that responsibility over conservation technology vary across governance arrangements.

Primary audiences are place-based conservation decision-makers who hold responsibility for selecting, designing, deploying and governing technologies within PCAs. Based on governance arrangements, these actors include:

- PCA managers and site-based staff responsible for day-to-day decision-making.
- Conservation non-government agencies (NGOs) and networks coordinating programmes and partnerships within PCAs.
- Indigenous Peoples and local communities, as rights-holders, governance actors (decision-makers), and knowledge-holders.
- National and sub-national policy-makers and agencies overseeing PCA governance.
- Technology developers, innovators, and providers working in or with conservation organisations.
- Donors, investors, and funding organisations supporting conservation and technology innovation.

As a secondary audience, the guidance supports other affected stakeholders to understand what responsible, rights-based and effective conservation technology adoption looks like in practice, enabling constructive dialogue and accountability around place-based technology decisions.

Across all audiences, the guidance emphasises inclusive approaches that empower women, youth, Indigenous Peoples, and local communities, recognising their vital contributions to effective, ethical conservation and responsible technology adoption.

Together, these audiences represent the spectrum of actors needed to ensure that technology adoption in PCAs is ethical, effective, and aligned with global biodiversity goals.

Using the Framework

Modularity and Use Pathways

The guidance document has been designed as a modular resource. Each thematic section can be used independently or in combination, depending on organisational priorities, user needs, and conservation contexts. This structure ensures flexibility and usability across diverse settings while maintaining coherence with global biodiversity targets and recognised best practice standards.

The guidance can be applied at different levels of action, from leadership and strategic planning to operational practice and field-level decision-making. It is also structured to feed directly into capacity-building platforms such as the GSAP SKILLS platform, ensuring that its content can be adapted into accessible training resources, learning modules, and practical tools for organisations and practitioners.

The guidance supports multiple pathways of use, including:

- Self-guided exploration and organisational reflection
- Integration into online learning modules and bite-sized courses on the GSAP SKILLS platform.
- Embedding within organisational policies, partnerships, and decision-making processes

By drawing on the guidance, users can:

- Support implementation of the KM-GBF, with emphasis on Targets 1–4 and an explicit focus on Target 3 (30x30).
- Address common challenges in PCAs, including governance, equity, adaptive management, and technology adoption, while aligning with the IUCN Global PCA Standard.
- Strengthen rights-based approaches to the governance and management of conservation technologies applied in OECMs and ITTs.
- Guide the ethical, responsible, and effective adoption of technology in alignment with global best practice and local contexts

Core Themes

The *Core Themes* of this guidance document are grounded in globally recognised principles of effective and equitable conservation practice. They reflect the values of inclusive governance, rights-based approaches, adaptive management, and ethical technology adoption. Together, they provide a foundation for planning, decision-making, governance, and community participation in the use of technology across diverse conservation contexts.

Each theme is designed to support structured thinking and informed decision-making about the use of technology in conservation. The guidance document provides guiding questions, insights, strategic actions, and case study examples to help users assess readiness, identify risks, recognise opportunities, and select context-appropriate pathways. The themes reinforce values of rights-based governance, equity and inclusion, and respect for Indigenous and local knowledge systems. They promote ethical and sustainable approaches to technology adoption that can be applied across diverse governance contexts.

The guidance is modular and does not require engagement with all seven Core Themes at once. Users can focus on the area's most relevant to their responsibilities while also encour-

aging cross-sector collaboration and holistic approaches. Some users may wish to follow the entire pathway, from initial technology selection through to long-term sustainability and impact. Others may prefer to focus on specific themes that address their immediate needs, expand to others over time and draw on complementary training and resources through the IUCN GSAP SKILLS Platform. The guidance is intended to be revisited, supporting adaptive use as contexts, challenges and opportunities evolve.

Relationship to Other Frameworks, Standards, and Initiatives

This guidance document is designed to complement and reinforce existing global commitments rather than duplicate them. It translates high-level standards into practical pathways for conservation technology adoption, helping practitioners connect global objectives with site-level realities. Its alignment with the KM-GBF is central, particularly Target 3 (30x30), while also supporting Targets 1–4 and broader rights-based and equitable governance goals. It is consistent with the IUCN Global PCA Standard (Woodley et al., 2026), the Nagoya Protocol on Access and Benefit-Sharing (CBD, 2011), and guidance on OECMs and territories and areas conserved by Indigenous Peoples and local communities (ICCAs) (Jonas and Woodley, 2024; Stevens et al., 2024), ensuring that technology adoption is firmly rooted in equity, legitimacy and rights.

The guidance also provides a bridge to delivery mechanisms such as the IUCN GSAP SKILLS Platform, where its modular content will be translated into accessible training and capacity-building resources. It further reflects Convention on Biological Diversity (CBD) voluntary guidelines and established best practice on ethical and responsible technology use. In this way, it ensures coherence with global standards while offering practitioners clear, context-sensitive guidance for implementation.

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Introduction

Understanding the Context

The adoption of technology in conservation does not occur in isolation. It is shaped by systemic, infrastructural, and cultural dynamics that determine whether digital tools can deliver on their promise. Recognising these dynamics is essential before introducing new systems, platforms, or devices.

Key challenges include:

- Limited infrastructure such as electricity, devices, and mobile networks, which continues to restrict access in remote or resource-constrained landscapes.
- Barriers of language, literacy, and cultural mismatch, where training formats and platform interfaces fail to reflect local users and lead to exclusion.
- Weak maintenance pathways, where devices are unsuited to harsh environmental conditions or lack local repair capacity.
- Governance misalignment, when technologies are deployed outside established decision-making processes in Protected and Conserved Areas (PCAs), Other Effective Area-Based Conservation Measures (OECMs), or Indigenous and Traditional Territories (ITTs), creating mistrust and community resistance.
- Donor and market pressures that favour novelty and rapid rollout over co-design, iteration, and the integration of traditional knowledge.
- Emerging risks in data governance, including lack of transparency, absence of informed consent, and inadequate benefit-sharing, which undermine trust and conflict with principles such as the Nagoya Protocol and the CARE Principles for Indigenous Data Governance.

Global standards consistently emphasise that technology must be applied in ways that are place-based, rights-based, and governance-appropriate. The Kunming–Montreal Global Biodiversity Framework (KM-GBF) highlights this in its call for equitable and effective governance of expanded conservation areas under Target 3 (30x30). This guidance document responds by offering principles and pathways that help practitioners navigate these dynamics and adapt technology adoption to local realities.

Before You Begin: Is Technology the Right Fit?

This guidance document is designed to support practitioners who are considering the use of technology in their work. However, not every conservation challenge requires a technological solution. Taking time to reflect before investing in new tools can prevent wasted resources and ensure that efforts remain aligned with conservation goals.

Start by asking yourself:

- What is the primary conservation objective you are trying to achieve?
- What specific challenges are preventing progress toward that objective?

- Are these challenges linked to communication, monitoring, data, transparency, participation, funding, or governance?
- Could technology provide a meaningful pathway to address these issues, or would efforts be better directed toward strengthening governance, partnerships, or ecological processes through non-digital means?

If the challenges are connected to areas where digital solutions can add value, this document provides structured guidance to help assess readiness and support ethical, effective, and context-appropriate adoption. If the challenges lie elsewhere, it may be more effective to focus on non-technological strategies before considering digital tools.

Once technology is identified as a potential enabler, the seven *Core Themes* provide step-by-step pathways to help practitioners plan, implement, and evaluate adoption in line with global standards. It is also important to consider how any new tools will connect with existing systems to avoid fragmentation and strengthen conservation strategies over the long term.

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Theme 3: Ethical Data Governance and Accountability

Framing and Relevance

This theme focuses on how data generated through conservation technologies is governed, and why governance is essential for legitimacy, trust, and equity. It addresses who owns and controls data, how access and consent are determined, how risks and harms are managed, and how decision-making authority is shared, particularly where data relates to Indigenous Peoples, local communities, and protected and conserved areas.

It draws on principles from the Collective benefit, Authority to control, Responsibility, and Ethics (CARE) Principles for Indigenous Data Governance (Carroll et al., 2020; 2021), the Nagoya Protocol (CBD, 2011) where data relates to genetic resources or associated knowledge, and the IUCN Global Standard for Effective and Equitable Protected and Conserved Areas: Standard, Version 2.0 (IUCN Global PCA Standard) governance criteria, particularly Criteria 1.1, 1.2, and 1.3 on legitimacy, voice, transparency, and accountability, with Criterion 1.4 supporting adaptive governance (Woodley et al., 2026). This theme also contributes to the goals of Kunming–Montreal Global Biodiversity Framework (KM-GBF) Target 3 (30x30) by strengthening the enabling conditions for equitable data governance in the management, monitoring, and reporting of protected and conserved areas.

Ethical data governance extends beyond technical data management. It includes clarity over ownership and authority across the data lifecycle, consent that is ongoing, revocable, and collective, and co-governance arrangements that embed protocols, social and cultural values, and governance systems into digital infrastructures. The theme also addresses risks of surveillance, misuse, bias, misinterpretation and unintended harm from emerging technologies, alongside the environmental impacts of digital systems. Finally, it emphasises inclusive governance, recognising that empowering women, youth, Indigenous Peoples and local communities with real decision-making authority is critical to ensuring conservation technologies support equity, accountability, and long-term sustainability.

This theme will help you

- Make informed decisions about ethical, legal, and environmental aspects of conservation technology data governance.
- Understand options for data ownership, sovereignty, accountability, and benefit-sharing across the data lifecycle.
- Strengthen trust through clear rules on consent, ownership, access, transparency, (grievance mechanisms/feedback loops) and review.
- Identify and manage risks of surveillance, misuse, bias, misinterpretation, and unintended harm associated with emerging technologies.
- Support inclusive and equitable governance of data in the management and monitoring of protected and conserved areas.

Key Questions for Practitioners

1. Who owns the data generated by conservation technologies, and how is access determined?
2. How can informed consent be secured and withdrawn in digital conservation projects?
3. How can communities co-govern conservation data systems to reflect their rights and values?
4. What are the risks of surveillance, misuse, or unintended harm from emerging technologies?
5. How can women, youth, and Indigenous Peoples be empowered to govern Conservation data systems?

> ***Question 1: Who owns the data generated by conservation technologies, and how is access determined?***

Overview

In many conservation initiatives, data ownership is either undefined or claimed by the implementing organisation or technology provider. This can create significant tensions, particularly when the data relates to traditional territories, biodiversity knowledge, or community use patterns. Local communities, including Indigenous Peoples, may have no legal or practical authority over the data collected on their lands. Without clarity on ownership, questions around access, accountability, and benefit-sharing are difficult to resolve. These risks are often embedded in procurement processes. Contracts and partnership agreements may overlook who controls cloud-based data, how artificial intelligence (AI) outputs are stored or updated, or whether conservation actors retain rights over the data they generate. Weak procurement standards can lead to unequal power dynamics and long-term dependency on external platforms.

Ownership is not only a technical or legal matter but also a question of justice and legitimacy. Data governance frameworks must account for who decides what counts as data, whose knowledge is visible or erased, and who benefits from its use. In global commons such as the oceans, ownership disputes are especially acute. Marine science highlights persistent tensions around who controls and accesses shared data, noting that data producers and hosting institutions often retain ownership while access is shaped by ethical governance frameworks, technical capacity, and institutional power (Zhu et al., 2024). Without clear rules defining rights, responsibilities, and safeguards, actors with greater resources and analytical capacity may dominate data access and interpretation, reinforcing existing inequalities in the use of shared biodiversity information (Zhu et al., 2024).

At the same time, infrastructures for biodiversity and carbon monitoring embed values and priorities that may not align with local perspectives. Large-scale data systems often prioritise information that serves global markets or scientific reporting needs, which can sideline Indigenous ecological knowledge and local governance systems (Urzedo et al., 2025). To address these risks, ownership models must be place-based, reflecting customary law, cultural values, and community rights, while also balancing interoperability with global systems.

Action

1. Co-develop data governance agreements

Data governance must begin with clearly defined ownership and access rights. Practitioners should co-develop governance agreements with rights-holders that specify who owns different data layers, who can access them, under what conditions, and how benefits are shared. For territories and areas conserved by Indigenous territories and areas conserved by Indigenous Peoples and local communities (ICCAs), agreements must uphold custodians' governance authority, record free, prior, and informed consent (FPIC) granted through the appropriate customary institutions, and clearly set out rights and benefit-sharing arrangements in line with custodians' wishes (Stevens et al., 2024). Where appropriate, open data policies must be adapted to account for sensitive

or community-controlled information. Legal frameworks and data-sharing agreements can formalise these structures and reduce future conflicts.

At the procurement stage, contracts should address data storage arrangements, intellectual property rights, model ownership if AI is used, and terms for ethical data management. Where blockchain is proposed to support data provenance or sharing, architectures are typically designed so that primary data remain off chain while smart contracts govern licences, access permissions, embargoes, and reuse conditions, allowing data originators to retain control and stewardship rather than ceding authority to centralised repositories (Lewis et al., 2023).

The other effective area-based conservation measures (OECMs) Guidance advises engaging stakeholders and using traditional knowledge alongside science, with culturally appropriate communication of monitoring, while IUCN Global PCA Standard Criterion 3.7 covers documenting who controls information and how it is reported (Woodley et al., 2026; Jonas and Woodley, 2024). Templates and checklists can help ensure that technology sourcing reflects principles of equity, transparency, and long-term accountability.

2. Prioritise local providers or community-led solutions

When possible, local providers or community-led solutions should be prioritised to align with KM-GBF Target 22 on equitable participation, which promotes equitable participation and locally grounded governance (CBD, 2022). The Target 3 '30x30' Guide reinforces that monitoring and reporting must integrate reciprocal benefit-sharing, ensuring that equity and authority over data remain with rights-holders rather than external actors (WWF and IUCN WCPA, 2023). The OECMs Guidance likewise emphasises that governance and management must address equity, including participation and access arrangements that keep authority with rights-holders (Jonas and Woodley, 2024). Map these agreements within the IUCN Global PCA Standard dossier to ensure traceability and accountability.

3. Measure and report indicators of equitable governance

For equitable governance of monitoring and reporting, record decision-making roles and participation under IUCN Global PCA Standard Criteria 1.1, 1.2, and 1.3, document resourcing and procedural arrangements under Criterion 3.1, and capture performance indicators such as access request turnaround time, consent renewal frequency, and data sharing outcomes under Criterion 3.7. The IUCN Biodiversity Monitoring Framework Sections 4.5 and 6.5 emphasises iterative learning, review, and documentation of governance and capacity outcomes (Dalton et al., 2024).

The IUCN Biodiversity Monitoring Framework Sections 6.4, 6.5, and 7.3 highlights approaches that can be used to record roles, permissions, safeguards and review processes within evaluation dossiers.

4. Design ownership agreements that cover the entire data lifecycle

To deepen accountability, ownership agreements should be designed for the entire data lifecycle. This means clarifying rights from the point of collection (e.g., camera trap images, environmental DNA (eDNA) samples), through processing and analysis (e.g., AI models, cloud storage), to long-term archiving and reuse. Combining the CARE Principles with the Findable, Accessible, Interoperable, Reusable (FAIR) Principles helps ensure data is both technically usable and ethically governed (Carroll et al., 2020; 2021). Apply the IUCN Biodiversity Monitoring Framework Sections 6.4, 6.5, and 7.3 to document ownership, access approvals and safeguards within monitoring systems so that governance arrangements remain transparent and verifiable. Follow the IUCN Biodiversity Monitoring Framework Sections 4.5 and 6.5 to structure evaluation processes that record who holds ownership and responsibility at each stage of the data lifecycle, ensuring transparency and accountability in practice. This dual approach prevents data from becoming extractive while ensuring it remains useful for conservation outcomes. For Indigenous and Traditional Territories (ITTs) and overlaps with

Indigenous and community conserved areas, apply the ICCAs guidance by ensuring that FPIC from the appropriate customary authorities is formally documented in governance or partnership agreements that also clarify custodians' rights and responsibilities (Stevens et al., 2024). These arrangements should support custodians' effective participation in decision-making processes, demonstrating compliance with IUCN Global PCA Standard Criteria 1.1, 1.2, and 3.1 (Woodley et al., 2026).

Ownership and access must be linked to sustainability considerations. Data infrastructures have lifecycle costs and environmental impacts, particularly through energy use and e-waste from hardware. The United Nations Environment Programme's 2025 sustainable procurement guidelines for data centres and servers set out operational and procurement criteria covering energy use, infrastructure efficiency, and hardware lifecycles, which can be incorporated into hosting and service agreements to ensure that sustainability requirements are addressed alongside technical and contractual considerations (UNEP, 2025). Agreements should include sustainability clauses that address the lifecycle and safe disposal of obsolete digital devices and servers, reflecting evidence that poorly managed end-of-life Information and Communications Technology (ICT) equipment contributes significantly to global e-waste and associated environmental harms (Baldé et al., 2024). Therefore, practitioners should ensure that hosting and technology agreements specify responsibilities for equipment reuse, recycling, and certified disposal, and assign accountability for compliance throughout the system lifecycle. Embedding these provisions reinforces that ethical data governance encompasses not only fairness and responsibility, but also long-term environmental and operational sustainability. Record these clauses in budgets and management plans and file evidence of financing and responsibilities under IUCN Global PCA Standard Criterion 3.1, with periodic reporting of energy and storage indicators under Criterion 3.7 and use the IUCN Biodiversity Monitoring Framework Section 6.5 and7.3 to guide continuity planning and technology management.

5. Implement safeguards, clear attribution and governance boards to address geopolitical risks

Ownership frameworks should also address geopolitical risks. In shared systems such as marine biodiversity databases or carbon credit registries, powerful states or corporations may use open access as a pathway to control, undermining community authority. Multilateral safeguards, clear attribution, and governance boards with community seats can mitigate these risks. Embedding Indigenous protocols into digital data systems through mechanisms such as Traditional Knowledge and Biocultural Labels provides a practical way to record Indigenous provenance, authority, and permissions within digital infrastructures, supporting Indigenous control and stewardship over data derived from their lands, resources, and knowledge (Golan et al., 2022). The Target 3 '30x30' Guide interprets KM-GBF Target 3 as requiring equitable governance and accountability in shared systems, ensuring that open access upholds rights-holder authority rather than eroding it (WWF and IUCN WCPA, 2023). The IUCN Global PCA Standard Criteria 1.1, 1.2, and 1.3 also requires transparent, accountable governance arrangements that make outputs accessible in ways that respect rights-holders' authority (Woodley et al., 2026). These safeguards ensure that open access does not equate to open exploitation. Align data-sharing permissions and procedures across agencies and communities so that access rules remain consistent along ecological networks, following the guidance in the Guidelines for conserving connectivity (Hilty et al., 2020).

Relevant standards and guidance:

KM-GBF Target 3 (*Ensure and enable that by 2030 at least 30 per cent of terrestrial, inland water, coastal and marine areas are effectively conserved and managed through ecologically representative, well-connected and equitably governed systems of protected areas and other effective area-based conservation measures*), Target 19 (*Mobilise financial resources for biodiversity from all sources*), Target 21 (*Ensure that knowledge is available and accessible to guide biodiversity action*), and Target 22 (*Ensure participation in decision-making and access to justice and information related to biodiversity for all*); IUCN Global PCA Standard Criterion 1.1 (Demonstrate supportive legal, policy or customary framework), Criterion 1.2 (*Ensure* legitimacy and voice), Criterion 1.3 (*Achieve transparency and accountability*), Criterion 3.1 (*Develop a long-term management strategy*), and Criterion 3.7 (*Implement monitoring, evaluation and adaptive management*); IUCN Biodiversity Monitoring Framework Section 4.5 (*Ongoing monitoring cycles*), Section 4.5.2 (*Storage, backup and archiving*), Section 6.4 (*Combining forms of knowledge*), Section 6.5 (*Continuity risks: Avoiding disruptions and gaps in data*), and Section 7.3 (*Technology-based approaches*); OECMs Guidance; Target 3 '30x30' Guide; CARE Principles; FAIR Principles; Free, prior and informed consent (FPIC); ICCAs Guidance; Traditional Knowledge and Biocultural Labels; Guidelines for Conserving Connectivity; UNEP Sustainable Procurement Guidelines for Data Centres and Servers (2025)

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Practitioners should:

- [ ] Clearly define who owns different types of data, including raw data, processed data, and any models or outputs generated from analysis.
- [ ] Agree in advance who can access data, for what purposes, and under what conditions, and record these rules in governance or partnership agreements.
- [ ] Ensure that all data governance arrangements are developed with the FPIC of Indigenous Peoples and local communities, using the appropriate customary authorities.
- [ ] Recognise and respect Indigenous data sovereignty by ensuring that communities retain authority over data generated on their lands, territories, or from their knowledge.
- [ ] Address data storage, intellectual property, and access rights explicitly at the procurement stage, including where cloud platforms or Artificial Intelligence tools are used.
- [ ] Adapt open data policies so that sensitive, culturally restricted, or community-controlled information is protected rather than automatically made public.
- [ ] Use governance agreements to clarify responsibilities across the full data lifecycle, from collection and analysis to long-term storage, sharing, and reuse.
- [ ] Apply the CARE and FAIR principles together so that data remains usable for conservation while being governed ethically and responsibly.
- [ ] Build safeguards into shared or cross-boundary data systems to prevent misuse, ensure proper attribution, and maintain the authority of rights-holders.
- [ ] Include sustainability responsibilities in data and technology agreements, covering energy use, long-term storage, and the safe reuse or disposal of digital equipment.

Technology Overview and Strategic Considerations

Table 3.1. A structured overview of key technology categories and associated tools that outlines how each aligns with relevant global frameworks and highlights practical considerations for managers when assessing, selecting, and implementing technology within conservation contexts.

Category	Technologies	How the technology aligns with global frameworks	Considerations for managers
Verifiable data ownership & logs	Blockchain	The IUCN WCPA Impact Report promotes accountability, transparency, and equitable governance, creating an enabling context for the responsible use of emerging tools in conservation finance and reporting. The KM-GBF promotes transparent reporting and equitable access to verified records under Section J (16). Transparency and grievance mechanisms are highlighted in the IUCN Global PCA Standard Criterion 1.3.	Use blockchain where verifiable records of data access, edits, and benefit-sharing are needed; document what is written on-chain and who controls keys to meet transparency expectations.
Data hosting & access control	Google Cloud, Amazon Web Services	The IUCN Monitoring Framework (2024, Section 5.2) stresses data management planning, storage, access, and documentation for monitoring programmes. The IUCN Global PCA Standard Criteria 3.1 and 3.7 require adequate capacity and planning for implementation, and systems for monitoring, evaluation, and reporting. The KM-GBF outlines transparent and accountable data management under Section J (16).	Define data tiers, roles and retention; set metadata and audit trails; budget for ongoing hosting so monitoring and reporting obligations can be met.
Aggregation & sharing portals	Digital data aggregation platforms	The IUCN Monitoring Framework (2024, Section 5.3) highlights planning for data flows and sharing. The KM-GBF requires transparency and agreed procedures for data sharing and access under Section J (16). The IUCN Global PCA Standard Criterion 1.3 requires transparent governance and accessible reporting processes, ensuring that data sharing and aggregation follow agreed procedures and accountability standards.	Configure platform permissions, versioning and data-use statements; record who can view, download or reuse datasets to meet transparency requirements.

Category	Technologies	How the technology aligns with global frameworks	Considerations for managers
Official registries for area data	Protected Planet / WDPA & WD-OECMs	The OECMs Guidance directs recognition and reporting of site information to global inventories, ensuring that data submission respects legitimate governance and community agreements. The KM-GBF Target 3 mandates recognition and reporting of protected and conserved areas through official registries. The IUCN Global PCA Standard Criteria 1.1, 1.2, and 2.2 require recognition of legitimate governance authorities and documentation of site context and values for reporting.	Align boundaries, governance notes and any access restrictions with community agreements before submission; keep records current as governance evolves.
Open spatial data access	UN Biodiversity Lab	The Target 3 '30x30' Guide promotes accessible biodiversity data with safeguards for sensitive or culturally restricted information. The KM-GBF ensures accessible biodiversity information with safeguards for sensitive or culturally restricted data under Section J (16). The IUCN Global PCA Standard Criterion 1.3 requires transparency and equitable access to information, with safeguards for sensitive or culturally restricted data.	Use UN Biodiversity Lab to publish non-sensitive layers and document any cultural or privacy limits on access defined with rights-holders.

Question 2: How can informed consent be secured and withdrawn in digital conservation projects?

Overview

Consent is often treated as a one-time event or a checkbox during project planning, rather than a continuous process. In some cases, communities are unaware that their data is being collected or used for secondary purposes. This is particularly problematic with passive technologies such as remote sensors or AI-enabled analysis of community-derived datasets. Without robust consent mechanisms, projects risk violating trust, privacy, and community rights. Research on forest and climate governance highlights that consent, including FPIC, is often weakened when it is treated as a one-off consultation rather than an ongoing process with mechanisms for accountability and influence. Studies of REDD+ and related initiatives show that where FPIC and participation are confined to initial engagement without sustained opportunities for communities to shape decisions or challenge outcomes, affected groups are more likely to contest project results and benefit-sharing arrangements, undermining trust and legitimacy (Larson et al., 2022). These findings underline that informed consent must be understood as iterative and revisitable, particularly in contexts where project impacts and data uses evolve over time, if digital conservation initiatives are to maintain long-term legitimacy and support (Larson et al., 2022).

Informed consent must be ongoing, revocable, and transparent. Communities should have the ability to understand, agree to, and later withdraw from conservation data initiatives without penalty. Withdrawal is often overlooked, particularly in digital systems where data may already have been aggregated or shared. Respecting withdrawal requires systems that allow data to be deleted, returned, or anonymised, rather than retained indefinitely. This need for revocability is reinforced by guidance on geospatial data for the public good, which emphasises that consent and governance arrangements must account for evolving risks and uses of spatial data over time, rather than assuming that initial agreement is sufficient. Where geospatial data may create social, environmental, or rights-based risks, policy and legal frameworks should enable controls to be adjusted, restricted, or withdrawn as circumstances change, reinforcing the need to design revocability and adaptive safeguards into data agreements from the outset (UN-GGIM, 2024).

Consent must also be collective as well as individual. For Indigenous Peoples and local communities, decisions about conservation technologies often rest with governance systems that represent the group, not only individuals. In practice, consent in initiatives such as REDD+ is often channelled through existing community and governance structures. However, experience shows that these arrangements only support legitimate consent when they give communities real influence over decisions and clear ways to raise concerns, rather than relying on formal representation alone (Larson et al., 2022).

Passive technologies create specific challenges relating to surveillance concerns. Remote sensing technologies including satellites and drones can capture data about people and human activities without their knowledge or consent, raising significant concerns about privacy, surveillance, and the feasibility of applying traditional informed consent processes at scale (York et al., 2023). Conservation monitoring research shows that drone surveys conducted without prior notice or collective consent may be perceived as surveillance, undermining trust and leading to resistance from local communities, highlighting the social risks of bypassing appropriate consent processes (Sandbrook et al., 2021). Social media and citizen science data are often reused for purposes beyond their original context, raising privacy and consent concerns where clear agreements or user awareness are lacking (Di Minin et al., 2021). These cases require new models of consent oversight such as advisory boards, opt-out registers, or restrictions on secondary data use.

Finally, consent should cover not only social risks but also environmental and technological impacts. Communities cannot make fully informed decisions about the adoption or use

of digital technologies if they are unaware of the energy demands, material inputs, and environmental footprints associated with digital infrastructures. Evidence shows that the rapid turnover of digital devices and inadequate management of end-of-life ICT equipment contribute substantially to global e-waste and environmental harm, while gaps in data and transparency limit understanding of these impacts (Baldé et al., 2024). Therefore, transparency around energy use, device lifecycles, and disposal pathways should be treated as a core condition for meaningful participation in decisions about digital infrastructure, particularly in contexts where communities may bear long-term environmental and waste management burdens.

Action

1. Ensure that consent is ongoing, informed and revocable

Ethical data governance requires systems for ongoing, informed, and revocable consent. Tools should be designed with opt-in and opt-out functionality, and communities must be fully informed about how their data will be collected, used, stored, and shared. Emerging digital identity approaches offer ways to manage consent dynamically, allowing permissions for specific sensors, datasets, or AI reuse to be granted, time-limited, or withdrawn as data uses and risks evolve, rather than being fixed in static agreements. Self-sovereign identity mechanisms using decentralised identifiers and verifiable credentials can support fine-grained authorisation, validity periods, and revocation for Internet of Things devices and associated data access, enabling permissions to be updated or withdrawn through credential lifecycle management rather than static credentials (Dayaratne et al., 2024). Embed Indigenous data sovereignty into digital and Internet of Things (IoT) system design from the outset and use participatory data governance processes to enable ongoing and revocable consent, ensuring communities retain control over how data are collected, accessed, and used rather than relying on one-off or externally defined agreements (Bowen and Hinze, 2022).

To strengthen these processes, consent should be structured as a continuous dialogue. This means revisiting consent whenever the scope of technology changes, for example, if a camera trap dataset is re-used for AI training or shared across borders. Dynamic consent models, which allow permissions to evolve over time, are particularly useful. In practice, tools that support community level control over data can help enable such approaches. The Mapeo app used in Amazonian Indigenous communities operates offline and enables communities to document and manage geospatial data in the field, with full ownership of the data retained by the communities themselves (Digital Democracy, n.d.).

2. Governance and management of technologies should operate within Indigenous and local community systems

In practice, such tools must operate within Indigenous governance systems. Indigenous Guardians programmes in Canada operationalise Indigenous governance by ensuring that monitoring and information management activities are led by communities and aligned with their laws, priorities, and decision-making authority, reinforcing community control over how information is generated, used, and shared (TNC Canada, 2016).

For Traditional Territories and Indigenous Peoples the ICCAs guidance requires FPIC to be obtained from the appropriate customary authorities and reflected in formal agreements that clarify custodians' governance authority, rights and benefit-sharing arrangements (Stevens et al., 2024). These agreements must be negotiated and approved through culturally grounded processes so that custodians retain meaningful decision-making power over activities and knowledge concerning their territories. The IUCN Global PCA Standard Criterion 2.1 requires governance and management to operate effectively within the social and economic context, including respecting the rights and roles of Indigenous Peoples and local communities, while the OECMs Guidance requires governance arrangements that recognise and uphold rights-holders' authority (Woodley et al., 2026; Jonas and Woodley, 2024).

CARE Principles and FPIC provide frameworks for shaping these processes (Carroll et al., 2020; 2021). Dashboards and local data governance committees can serve as mechanisms for review, transparency, and accountability throughout the technology lifecycle. Record committee mandates and membership under IUCN Global PCA Standard Criteria 1.1, 1.2, and 1.3, budget lines for their operation under Criterion 3.1, and set review cadence and simple indicators for consent renewals and withdrawal actions under Criterion 3.7. Set review cadence and simple indicators for consent renewals and withdrawal actions using the IUCN Biodiversity Monitoring Framework Sections 4.5, 6.4 and 6.5 to ensure that monitoring systems remain responsive and transparent.

Consent should also extend to collective rights, ensuring that Indigenous governance systems have authority over group-level decisions about data (Swiderska, 2012). In ITTs and ICCAs contexts, FPIC must be granted through the appropriate customary authorities, reflecting the collective rights and governance institutions of custodians. These decisions should be formally recorded in governance or partnership agreements consistent with the ICCAs guidance, which requires culturally grounded approval processes and clear articulation of rights and responsibilities (Jonas and Woodley, 2024). Referencing these documented FPIC outcomes in site governance evidence supports compliance with IUCN Global PCA Standard Criteria 1.1, 1.2, and 1.3 by demonstrating legitimate representation and transparent decision-making.

3. Establish collective oversight committees to address passive technologies

Consent frameworks should anticipate passive technologies. For satellites, drones, and AI scraping, direct opt-in may not be possible. In such cases, governance structures such as community protocols, oversight committees, or participatory audits can provide collective oversight and ensure legitimacy. Follow the IUCN Biodiversity Monitoring Framework Sections 6.4 and 6.5 to guide disclosure of risks and governance safeguards in consent processes, and the IUCN Global PCA Standard Criterion 2.1 which requires credibility in addressing sensitive contexts. Consent should also include clear information about data value and risks, including commercial use, secondary applications, and environmental impacts, to meet KM-GBF Target 21 on equitable and transparent governance (Dalton et al., 2024; Woodley et al., 2026). Where data and imagery flow across ecological networks or borders, align permission and redaction standards with the Guidelines for conserving connectivity so participants encounter consistent consent rules across the landscape (Hilty et al., 2020).

4. Include environmental impacts of technologies

Finally, attention to environmental impacts completes a rights-based approach to consent in digital conservation projects. Evidence shows that the environmental footprint of digital infrastructures, particularly through device turnover and end-of-life mismanagement, remains poorly understood despite its significant contribution to global e-waste and environmental harm (Baldé et al., 2024). Therefore, consent processes should encompass ecological and technological impacts, as communities cannot make fully informed decisions without visibility of lifecycle effects such as storage demands, energy use, and e-waste, linking sustainability considerations directly to justice, accountability, and long-term viability. This aligns with KM-GBF Target 19 on resource sustainability (CBD, 2022). In practice, practitioners should include sustainability disclosures in consent discussions and agreements and update them as systems evolve. File these disclosures in management plans and budgets under IUCN Global PCA Standard Criterion 3.1 and report energy and storage indicators under Criterion 3.7, applying the IUCN Biodiversity Monitoring Framework Section 6.5 to ensure that these factors are tracked and reviewed over time.

Relevant standards and guidance:

KM-GBF Target 19 (*Mobilize $200 Billion per Year for Biodiversity From all Sources, Including $30 Billion Through International Finance*) and Target 21 (*Ensure that knowledge is available and accessible to guide biodiversity action*); IUCN Global PCA Standard Criterion 1.1 (*Demonstrate supportive legal, policy or customary framework*), Criterion 1.2 (*Ensure legitimacy and voice), Criterion 1.3 (Achieve transparency and accountability*), Criterion 1.4 *(Demonstrate capacity of governance to adapt*), Criterion 3.1 (*Develop a long-term management strategy*), Criterion 2.1 (*Understand ecological, social and economic context) and Criterion 3.7 (Implement monitoring, evaluation and adaptive management*); IUCN Biodiversity Monitoring Framework Section 4.5 (*Ongoing monitoring cycles*), Section 6.4 (*Combining forms of knowledge*) and Section 6.5 (*Continuity risks: Avoiding disruptions and gaps in data*); OECMs Guidance (*CARE Principles and FPIC*); ICCAs Guidance; Target 3 30x30 Guide.

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Practitioners should:

- [ ] Treat informed consent as an ongoing process rather than a one-time agreement at project start.
- [ ] Revisit consent whenever technologies, data uses, partnerships, or project objectives change.
- [ ] Ensure communities clearly understand what data is collected, how it will be used, where it is stored, and who can access it.
- [ ] Provide clear and practical ways for consent to be withdrawn, including named contacts, review bodies, or opt-out mechanisms.
- [ ] Put procedures in place to delete, anonymise, restrict, or return data if consent is withdrawn.
- [ ] Respect collective consent processes by working through recognised Indigenous and local governance institutions, not only individual permissions.
- [ ] Record consent decisions, renewal points, and withdrawals in governance agreements and monitoring documentation so they can be reviewed over time.
- [ ] Establish oversight mechanisms for passive technologies such as satellites, drones, sensors, and AI, where direct opt-in is not always possible.
- [ ] Communicate risks, benefits, and rights in culturally appropriate ways, using local languages and accessible formats.
- [ ] Include information on environmental and technological impacts, such as energy use, storage needs, and e-waste, so communities can make fully informed decisions.

Technology Overview and Strategic Considerations

Table 3.2. A structured overview of key technology categories and associated tools that outlines how each aligns with relevant global frameworks and highlights practical considerations for managers when assessing, selecting, and implementing technology within conservation contexts.

Category	Technologies	How the technology aligns with global frameworks	Considerations for managers
Mobile data collection with consent prompts	CyberTracker, Smartphone Apps	IUCN Biodiversity Monitoring Framework (Section 3.5; Section 4.5) highlights community participation with appropriate training and support. The KM-GBF ensures informed participation (Target 22) and gender-responsive inclusion (Target 23) in data collection and consent procedures. The IUCN Global PCA Standard Criteria 1.1, 1.2, and 1.4 require recognition of legitimate rights-holders, inclusive participation, and adaptive governance processes that enable consent, withdrawal, and grievance mechanisms.	Build explicit consent prompts and withdrawal options into forms; store consent status with each record so it follows the data lifecycle.
Participatory mapping & disclosure	Participatory mapping and dashboards	The OECMs Guidance highlights that monitoring and reporting information should be shared in culturally appropriate and publicly accessible ways that respect informed consent. The KM-GBF requires transparency and culturally appropriate reporting under Section J (16) for participatory mapping and disclosure. The IUCN Global PCA Standard Criterion 1.3 requires transparent and accountable governance, including culturally appropriate communication and informed consent for data publication.	Co-design legends and layers, mark sensitive places as restricted, and publish clear consent statements on dashboards, including how to retract consent for display.

Category	Technologies	How the technology aligns with global frameworks	Considerations for managers
Genetic sampling workflows	eDNA, DNA barcoding	IUCN Biodiversity Monitoring Framework (Section 7.3) describes design and effort for genetic sampling. The KM-GBF requires free, prior and informed participation (Target 22) and gender-responsive consent (Target 23) for genetic and biological sampling. The IUCN Global PCA Standard Criteria 1.1 and 1.2 requires governance arrangements that recognise rights-holders and ensure free, prior, and informed consent for sampling activities.	Obtain FPIC where required before sampling; record sample provenance, consent terms and any sharing limits alongside sequence or barcode data.
Image and acoustic capture in the field	Camera traps, Acoustic sensors	IUCN Biodiversity Monitoring Framework (Section 7.3) recognises these methods. The IUCN Global PCA Standard Criterion 1.3 requires inclusive, equitable governance. The IUCN Global PCA Standard Criteria 1.3 and 1.4 require transparent, equitable, and adaptive governance processes, ensuring consent and protection of privacy or culturally sensitive information. The KM-GBF establishes informed participation (Target 22) and culturally appropriate consent (Target 23) for image and acoustic monitoring.	Post notice and obtain consent where appropriate; mask or restrict images/audio that could identify people or sensitive locations as agreed with communities.

Question 3: How can communities co-govern conservation data systems to reflect their rights and values?

Overview

Top-down governance models often exclude communities from decisions about data collection, management, and application. This is especially problematic in Indigenous and local contexts, where customary law and traditional governance systems are overlooked. The result is a disconnect between data-driven interventions and local legitimacy, which can lead to resistance, data withholding, or project breakdown.

The KM-GBF Target 22 requires that governance systems are inclusive and rights-based, and the IUCN Global PCA Standard Criteria 1.1 and 1.2 requires legitimacy and voice, meaning communities must be recognised as decision-makers in data governance (CBD, 2022; Woodley et al., 2026).

Conservation technologies such as drones, eDNA databases, and AI platforms can reinforce governance inequities when assumptions from external actors are embedded into system design. Decisions about what data is collected, how it is categorised, and how results are interpreted are often made without meaningful community input. This can marginalise or erase local ecological knowledge and create epistemic harm (Urzedo et al., 2025). In the Amazon, participatory mapping initiatives using the Mapeo platform have enabled Indigenous communities to document and manage their own geospatial information, with databases defined and controlled by the communities themselves (Digital Democracy, n.d.).

The OECMs Guidance requires that monitoring systems reflect local cultural and governance contexts, and the IUCN Biodiversity Monitoring Framework Sections 6.4 and 7.3 highlights that governance evaluation should consider accountability, transparency, and the inclusion of diverse knowledge systems (Dalton et al., 2024; Jonas and Woodley, 2024).

Co-governance is more than consultation. It requires communities to share authority in shaping system architecture and governance rules. This involves not only approving or rejecting technologies but also participating in the negotiation of data governance protocols, decision-making processes, and access conditions. Place-based approaches demonstrate that when governance systems reflect local priorities, they strengthen trust and support long-term sustainability (Robinson et al., 2023). The Target 3 '30x30' Guide explicitly requires place-based, inclusive implementation of monitoring and reporting systems to ensure that rights-holders' values shape conservation outcomes (WWF and IUCN WCPA, 2023)

Examples from marine science demonstrates that shared data infrastructures are governed through multi-stakeholder ethical frameworks, including consultation networks and ethics review mechanisms, which are intended to clarify responsibilities, conditions of access, and acceptable use of marine data across institutions and jurisdictions (Zhu et al., 2024). In REDD+ contexts, community protocols have provided formal mechanisms for articulating collective rights and ensuring data systems align with local governance norms (Sunderlin et al., 2014).

Action

1. **Co-design governance arrangements with communities**

Conservation data systems should be embedded in governance arrangements co-designed with communities. This includes the development of local data charters or community-defined governance protocols that reflect cultural values, governance norms, and collective rights. The KM-GBF Target 22 requires shared authority for Indigenous Peoples, while the IUCN Global PCA Standard Criteria 1.1 and 1.2 requires evidence of legitimacy and voice (CBD, 2022; Woodley et al., 2026).

Indigenous Guardians programmes in Canada operationalise this governance-first approach by embedding monitoring and stewardship activities within Indigenous governance systems, ensuring that any conservation tools used

operate under community leadership and that Indigenous institutions retain decision-making authority over how information is generated, interpreted, and applied (TNC Canada, 2016).

Linkages should also be made to broader governance structures for PCAs to reinforce legitimacy and continuity. Record these co-governance structures in the IUCN Global PCA Standard dossier by documenting decision roles under Criteria 1.1, 1.2, and 1.3, allocating budgets, staffing, and schedules under Criterion 3.1, and setting simple performance indicators for access requests, consent renewals, and audit findings under Criterion 3.7. Use the IUCN Biodiversity Monitoring Framework Sections 6.4 and 7.3 to document co-governance structures and indicators in site dossiers so that decision-making roles, budgets, and review processes are clearly recorded and verifiable.

2. Recognise Indigenous and community authority over data decisions

To make co-governance effective, communities should have interpretive authority, the ability to shape what data is collected, how categories are defined, and how outputs are applied. Follow the IUCN Biodiversity Monitoring Framework Sections 4.5, 6.4 and 7.3 to guide documentation of governance arrangements and ensure transparency in how data is interpreted. The Target 3 '30x30' Guide also requires that knowledge systems of Indigenous Peoples are integrated alongside scientific approaches to achieve equitable implementation of KM-GBF Target 3 (WWF and IUCN WCPA, 2023).

Applying both the CARE and FAIR Principles ensures systems are technically functional while respecting sovereignty and ethics (Carroll et al., 2020; 2021). For territories and areas conserved by Indigenous Peoples and local communities, the ICCAs guidance requires that FPIC granted through the appropriate customary authorities is formally documented, along with clear descriptions of custodians' rights, responsibilities and benefit arrangements, so that their governance authority is recognised and upheld in practice (Stevens et al., 2024).

3. Establish mechanisms for community oversight and accountability

Practical mechanisms include data stewardship boards with decision-making power, participatory audits that allow communities to review how data is used, and dashboards that give transparency over access and sharing. These governance structures can be strengthened by ensuring that communities retain direct control over how access to data systems is granted or withdrawn, so that consent and oversight are exercised in practice rather than delegated entirely to external institutions. In such arrangements, community control over permissions can function as a practical veto over dataset access and downstream AI model reuse, aligning data access decisions with principles of data sovereignty.

4. Use technologies that support community control over data

Tools such as community encryption key management in blockchain-based systems, participatory audits, data stewardship boards, and conservation technologies including the Spatial Monitoring and Reporting Tool (SMART) and drones can support shared control over information and decision-making when they are deployed within appropriate governance arrangements.

Self-sovereign identity mechanisms using decentralised identifiers and verifiable credentials can support fine-grained authorisation, time-limited permissions, and revocation for data access associated with IoT systems, allowing access rights to be updated or withdrawn through credential lifecycle management rather than fixed, one-off permissions (Dayaratne et al., 2024).

Embedding Indigenous protocols into digital infrastructures through tools such as Traditional Knowledge and Biocultural Labels provides a practical way to record Indigenous provenance, authority, and permissions, enabling Indigenous Peoples and local communities to exercise control and stewardship over how data are accessed and used (Golan et al., 2022).

5. Review and adapt governance arrangements over time

Governance must also be iterative. As technologies evolve, agreements should be revisited to maintain trust and legitimacy. The KM-GBF Target 22 requires adaptive rights-based governance arrangements, and the IUCN Global PCA Standard Criteria 1.1, 1.2, 1.3, and 3.7 require legitimate, transparent, and evidence-based governance systems that can demonstrate effectiveness over time through periodic reviews (CBD, 2022; Woodley et al., 2026). Connecting digital governance to existing PCAs management structures ensures alignment with broader conservation goals while anchoring systems in local legitimacy. Schedule periodic co-governance reviews alongside management plan reviews and publish plain language summaries of decisions and rationales for communities and partners under IUCN Global PCA Standard Criterion 1.3. Track implementation progress using indicators aligned with the IUCN Biodiversity Monitoring Framework Sections 4.5, 6.4 and 7.3 so that performance is reviewed consistently and remains inclusive and transparent over time.

Relevant standards and guidance:

KM-GBF Target 3 (*Ensure and enable that by 2030 at least 30 per cent of terrestrial, inland water, coastal and marine areas are effectively conserved and managed through ecologically representative, well-connected and equitably governed systems of protected areas and other effective area-based conservation measures*), Target 21 (*Ensure that knowledge is available and accessible to guide biodiversity action*), and Target 22 (*Ensure participation in decision-making and access to justice and information related to biodiversity for all*); IUCN Global PCA Standard Criterion 1.1 (*Demonstrate supportive legal, policy or customary framework*), Criterion 1.2 (*Ensure legitimacy and voice*), Criterion 1.3 (*Achieve transparency and accountability*), Criterion 3.1 (*Develop a long-term management strategy*), and Criterion 3.7 (*Implement monitoring, evaluation and adaptive management*); IUCN Biodiversity Monitoring Framework Section 4.5 (*Ongoing monitoring cycles*), Section 6.4 (*Combining forms of knowledge*), and Section 7.3 (*Technology-based approaches for biodiversity monitoring*); OECMs Guidance; Target 3 '30x30' Guide; CARE Principles; FAIR Principles; Free, prior and informed consent (FPIC); ICCAs Guidance; Indigenous Guardians Toolkit; Traditional Knowledge and Biocultural Labels; Multiple Evidence Base approach; Community Protocols.

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Practitioners should:

- ☐ Co-design data governance arrangements with communities so that decision making authority is shared rather than held only by external organisations.
- ☐ Recognise customary law and community governance systems in all data decisions, including what is collected, how it is managed, and how it is used.
- ☐ Develop local data charters or community protocols that set out cultural values, collective rights, and agreed rules for access, sharing, and acceptable use.
- ☐ Ensure FPIC is obtained through the appropriate customary authorities and formally recorded, including rights, responsibilities, and benefit arrangements.
- ☐ Establish stewardship boards or committees with genuine decision making power over data access, interpretation, and changes to governance rules.
- ☐ Give communities interpretive authority by involving them in defining categories, setting indicators, and agreeing how findings will be interpreted and applied.
- ☐ Use participatory audits, simple reporting, and transparency tools such as dashboards so communities can see how data is accessed, shared, and reused.
- ☐ Apply CARE and FAIR principles together so that data systems remain technically usable while respecting sovereignty, ethics, and collective benefit.
- ☐ Harmonise permission rules and protections across partners and jurisdictions where data moves between sites, so community authority is not weakened as information travels.
- ☐ Fund and maintain co-governance over time by assigning budgets, staffing, procedures, and regular review cycles, and documenting performance and learning in site records.

Technology Overview and Strategic Considerations

Table 3.3. This table provides a structured overview of key technology categories and associated tools, outlines how each aligns with relevant global frameworks, and highlights practical considerations for managers when assessing, selecting, and implementing technology within conservation contexts.

Category	Technologies	How the technology aligns with global frameworks	Considerations for managers
Governance & equity assessment supporting data roles	SAGE, SAPA, GAPA	The OECMs Guidance highlights governance and equity tools that strengthen shared decision-making, grievance handling, and equitable participation in co-governance of data systems. The IUCN Global PCA Standard Criteria 1.3 and 1.4 require transparent, accountable, and adaptive governance processes that ensure equitable participation, grievance handling, and shared decision-making. The KM-GBF promotes equitable participation (Target 22) and gender-responsive decision-making (Target 23) in co-governance of data systems.	Use these tools to document who approves data sharing, what equity safeguards apply, and how grievances are handled; incorporate results into site policies.
Site effectiveness with governance linkages	IMET, METT	The OECMs Guidance recognises PAME tools such as IMET and METT as useful for assessing site management effectiveness and linking governance and reporting processes. The IUCN Global PCA Standard Criteria 3.1 and 3.7 benchmark effective and equitable management by requiring sufficient capacity, planning, and established monitoring systems. The KM-GBF Target 1 links management effectiveness with participatory planning and transparent governance.	Pair PAME results with governance-equity findings to show how communities participate in data decisions and how effectiveness evidence is shared.

Category	Technologies	How the technology aligns with global frameworks	Considerations for managers
Co-developed planning & roles	Miradi	The IUCN Monitoring Framework (Section 4.2) links tool use to iterative planning stages, from defining objectives and scoping to evaluation and adjustment within adaptive management processes. The IUCN Global PCA Standard Criteria 1.1, 1.2, and 1.4 require participatory governance and adaptive management processes that define co-governance roles, decision authority, and accountability mechanisms. The KM-GBF Target 1 (2022) requires participatory and adaptive planning to define co-governance roles and responsibilities for data management.	Use Miradi to document co-governance roles for data stewardship, approvals, and reporting within the plan's decision log.
Spatial layers for tenure & access	GIS	The ICCAs guidance calls for FPIC and co-developed governance using spatial mapping to recognise custodianship, tenure, and equitable access. The IUCN Global PCA Standard Criteria 1.1, 1.2, and 1.4 require recognition of legitimate rights-holders, inclusive participation, and adaptive agreements that reflect tenure, access, and custodianship arrangements. The KM-GBF promotes inclusive participation (Target 22) and gender-responsive recognition of custodianship and access (Target 23) in spatial planning.	Map custodianship, agreed boundaries and access rules as layers; apply them to dashboards and sharing policies that mirror those agreements.

Question 4: What are the risks of surveillance, misuse, or unintended harm from emerging technologies?

Overview

Technologies such as drones, camera traps, eDNA, and AI raise new risks around surveillance and profiling, especially when deployed in politically sensitive or insecure environments. Data collected for conservation purposes can inadvertently be accessed or misused by third parties, including governments, extractive industries, or actors with different agendas. Communities may be exposed to legal, social, or economic harm if their data is shared or misinterpreted. The KM-GBF Target 21 explicitly requires respect for Indigenous rights, knowledge, and data, and the OECMs Guidance requires explicit, fair and effective governance safeguards that protect rights-holders from unintended harms.

These risks are not limited to deliberate misuse. Camera traps may capture people without consent, satellites and drones may expose culturally sensitive locations, and eDNA samples can raise questions of genetic sovereignty. These impacts are not evenly distributed. In India, digital surveillance technologies used in forest conservation have been shown to generate gendered harms, with women experiencing heightened intimidation, self-disciplining behaviour, and reduced access to forest resources, particularly where safeguards such as consent, transparency, and accountability are absent (Simlai and Sandbrook, 2024). Social media data, even when publicly available, can be analysed to infer sensitive information such as the locations and movement patterns of individuals or groups, creating privacy and safety risks that require careful assessment and mitigation (Di Minin et al., 2021). Together, these examples highlight the risk of surveillance creep, where technologies introduced for conservation monitoring expand beyond their original purpose, undermining trust and increasing the potential for social harm if governance safeguards are weak (Sandbrook et al., 2021).

Emerging technologies introduce risks of surveillance, misuse, and unintended harm in conservation practice. AI tools and automated systems can reproduce representational biases embedded in training data, shaping how species, places, and people are interpreted and valued. When such systems are used to summarise, interpret, or translate local knowledge without oversight, Indigenous perspectives and locally grounded values may be simplified, misrepresented, or erased (Urzedo et al., 2025). AI models and biodiversity databases can reproduce global research biases, privileging data from certain species or regions while neglecting others (Skaldina et al., 2024). Automated systems trained on such uneven datasets can privilege dominant scientific framings while marginalising Indigenous ecological knowledge or alternative ways of understanding landscapes, reinforcing existing power asymmetries rather than neutral representations. Remote sensing and large-scale monitoring technologies raise related challenges. Global-scale imagery and standardised classification systems can impose one-size-fits-all categories that fail to reflect local meanings, land-use practices, and cultural relationships with nature.

When applied without attention to place-based knowledge and governance, these approaches risk erasing local values and contributing to surveillance practices that undermine trust and legitimacy (Urzedo et al., 2025). Remote sensing technologies raise similar challenges, as global-scale imagery and standardised classification systems can marginalise or overlook local contexts, values, and meanings when applied without attention to social and cultural difference (York et al., 2023). The IUCN Biodiversity Monitoring Framework Sections 6.4 and 6.5 highlights the need to integrate diverse knowledge systems and to document uncertainties and limitations as part of accountable governance (Dalton et al., 2024). When data flows across ecological networks or administrative borders, apply consistent redaction and permission rules so privacy and cultural protections do not weaken along corridors and transboundary linkages (Hilty et al., 2020).

Emerging technologies also create environmental risks. AI systems and digital infrastruc-

tures require significant energy, water, and raw materials. Training large AI models can have a significant carbon footprint, with reported emissions comparable to those produced by several cars over their lifetimes (Zhuk, 2023). Digital conservation technologies rely on resource-intensive supply chains, including the extraction of rare earth minerals for sensors, servers, and other hardware, which can cause significant ecological damage at the point of production. Rapid hardware turnover then contributes to increasing volumes of toxic e-waste, with environmental and health impacts that are frequently displaced to vulnerable communities through global e-waste flows and informal disposal practices (Baldé et al., 2024). The KM-GBF Target 19 requires sustainability in digital and financial resource use, and the IUCN Global PCA Standard Criterion 3.7 requires monitoring outputs to include lifecycle accountability (CBD, 2022; Woodley et al., 2026). Addressing these risks requires a whole-of-lifecycle approach, linking directly to Theme 7 on greening conservation technology.

Action

1. Conduct comprehensive risk assessments before deploying technologies

All conservation technologies must be assessed for their potential misuse, including unintended consequences and surveillance risks. Data systems should undergo regular ethical and legal audits, and risk mitigation plans must be developed with community input. The wider field of biosurveillance ethics underlines that conservation must adopt similar safeguards, ensuring that the benefits of monitoring do not come at the expense of privacy, rights, or justice for affected groups. Encryption, access controls, and data minimisation protocols should be implemented as standard practice.

The OECMs Guidance requires safeguards rooted in consent, and IUCN Global PCA Standard Criterion 3.1 (Woodley et al., 2026; Jonas and Woodley, 2024). Practitioners should evaluate whether the benefits of data collection outweigh the risks, and in some contexts, decide not to collect certain data at all (Sandbrook et al., 2021). Document roles and participation for these reviews under IUCN Global PCA Standard Criteria 1.1, 1.2, and 1.3, allocate budget and staffing for safeguards under Criterion 3.1, and record review cadence and indicators (e.g., incident response time, redactions, consent renewals) under Criterion 3.7; where a specific misuse risk is identified, log it under Criterion 2.4 and track management responses under Criterion 3.3.

In practice, this means assessing social, epistemic, and environmental harms together. Ethical reviews should consider not only privacy and misuse but also the risk of marginalising local knowledge or amplifying global biases. Data Protection Impact Assessments (DPIAs) and Data Management Plans (DMPs) can formalise these processes and build accountability.

2. Implement safeguards to prevent surveillance, misuse and unauthorised access

Follow the IUCN Biodiversity Monitoring Framework Sections 6.4 and 6.5 to document governance limitations, integrate diverse forms of knowledge, and plan for continuity in monitoring systems. The Target 3 '30x30' Guide reinforces that such risk assessments must be transparent and form part of regular compliance, ensuring that monitoring and reporting processes uphold equity, accountability, and knowledge integrity under KM-GBF Target 3 (WWF and IUCN WCPA, 2023).

Contracts should limit data re-use and require safeguards such as anonymisation, access restrictions, and encryption. When data or imagery travels along corridors or across borders, align contract clauses and standard operating procedures with the Guidelines for Conserving Connectivity so protections remain consistent across agencies and jurisdictions.

3. Involve communities in defining risks and overseeing safeguards

Risk governance should also include community participation. Local advisory boards can help identify what counts as harm in specific contexts, ensure that surveillance risks are rec-

ognised, and decide when technologies should not be used.

The KM-GBF Target 22 requires participation of rights-holders in governance, while the IUCN Global PCA Standard Criteria 1.1, 1.2, and 1.3 require legitimacy, inclusion, and transparency in governance structures (CBD, 2022; Woodley et al., 2026), which in practice means giving communities a formal role in defining and overseeing safeguards. For overlaps with Indigenous territories, record FPIC decisions and any community protocols that custodians choose to include in the formal agreements, consistent with the ICCAs guidance (Stevens et al., 2024). Referencing these arrangements in management planning helps ensure that custodians' governance authority and agreed benefit-sharing provisions are upheld in day-to-day operations.

4. Integrate environmental risks into technology governance

Environmental impacts must be integrated into risk reviews. Practitioners should assess lifecycle costs across the full AI and digital infrastructure chain, from mineral extraction and hardware manufacturing to energy use, cooling demands, and end-of-life disposal. Training and operating AI systems can be highly energy-intensive, often relying on data centres powered by non-renewable sources, while rapid hardware turnover contributes to growing e-waste. To reduce these impacts, mitigation measures include renewable-powered hosting, energy-efficient and smaller AI models, edge or local processing to reduce data transfer loads, and certified recycling or take-back systems for digital equipment (Zhuk, 2023). The KM-GBF Target 19 requires responsible management of digital infrastructure impacts, and the sustainability guidance specifies renewable hosting and circular economy approaches (CBD, 2022). Linking environmental accountability to data governance ensures that conservation technologies minimise unintended harms to both people and ecosystems. File sustainability clauses and supplier evidence in management plans under IUCN Global PCA Standard Criterion 3.1 and report simple indicators such as hosting energy mix, device replacement rates, and percentage of certified recycling under Criterion 3.7.

Relevant standards and guidance:

KM-GBF Target 3 (*Ensure and enable that by 2030 at least 30 per cent of terrestrial, inland water, coastal and marine areas are effectively conserved and managed through ecologically representative, well-connected and equitably governed systems of protected areas and other effective area-based conservation measures*), Target 19 (*Mobilise financial resources from all sources and strengthen capacity-building, technical and scientific cooperation and technology transfer*), Target 21 (*Ensure that knowledge is available and accessible to guide biodiversity action*), and Target 22 (*Ensure participation in decision-making and access to justice and information related to biodiversity for all*); IUCN Global PCA Standard Criterion 1.1 (Demonstrate supportive legal, policy or customary framework), Criterion 1.2 (Ensure *legitimacy and voice*), Criterion 1.3 (*Achieve transparency and accountability*), Criterion 2.4 (*Understand threats and challenges to major site values*), Criterion 3.1 (*Develop a long-term management strategy*), Criterion 3.3 (*Implement management strategies to maintain and restore site values*), and Criterion 3.7 (*Implement monitoring, evaluation and adaptive management*); IUCN Biodiversity Monitoring Framework Section 6.4 (*Combining forms of knowledge*) and Section 6.5 (*Continuity risks: Avoiding disruptions and gaps in data*); OECMs Guidance; Target 3 '30x30' Guide; ICCAs Guidance; Free, prior and informed consent (FPIC); Guidelines for Conserving Connectivity.

Practitioners should:

- [ ] Assess surveillance, misuse, and unintended harm risks before deploying any conservation technology, especially in sensitive or insecure contexts.
- [ ] Involve communities in identifying what counts as harm, risk, or unacceptable use in their specific social, cultural, and political setting.
- [ ] Apply data minimisation practices so only information that is genuinely needed for conservation is collected and retained.
- [ ] Use anonymisation, redaction, and encryption to protect sensitive information about people, species, and locations.
- [ ] Set clear access controls and limits on data reuse, including restrictions on secondary or commercial uses.
- [ ] Monitor for surveillance creep by regularly reviewing whether technologies are being used beyond their original purpose.
- [ ] Examine datasets and analytical models for bias that could marginalise local knowledge, communities, or underrepresented regions.
- [ ] Establish clear procedures for reporting, responding to, and learning from incidents of misuse or harm.
- [ ] Consider environmental risks alongside social risks by assessing energy use, resource extraction, and e-waste across the technology lifecycle.
- [ ] Prioritise lower-impact alternatives, such as renewable-powered hosting, efficient analytical models, and certified recycling or take-back systems.

Technology Overview and Strategic Considerations

Table 3.4. A structured overview of key technology categories and associated tools that outlines how each aligns with relevant global frameworks and highlights practical considerations for managers when assessing, selecting, and implementing technology within conservation contexts.

Category	Technologies	How the technology aligns with global frameworks	Considerations for managers
People / species detection systems	AI-powered surveillance, Camera traps	The IUCN Biodiversity Monitoring Framework (Section 7.3) recognises detection methods such as camera traps and AI-assisted systems, noting their operational, ethical, and regulatory requirements. The IUCN Global PCA Standard Criteria 1.3 and 1.4 require transparent, equitable, and adaptive governance processes with grievance and oversight mechanisms that manage potential harms and privacy risks. The KM-GBF Target 4 emphasises responsible monitoring practices that protect biodiversity and prevent misuse of surveillance technologies.	Define who can access raw media and detections; implement masking and access logs; publish non-sensitive summaries to maintain transparency.
Location-revealing tracking	GPS tracking, Biotelemetry, Acoustic telemetry	The IUCN Biodiversity Monitoring Framework (Section 5.2) lists these methods. The KM-GBF requires transparent reporting systems under Section J (16) that protect data integrity and privacy in location-based monitoring. The IUCN Global PCA Standard Criterion 1.3 requires transparent information management, and Criterion 3.7 calls for robust monitoring systems that safeguard data integrity and user privacy.	Anonymise coordinates for sensitive species and people; delay data release; document the rules in the monitoring and reporting protocol.
Air and space-based sensors	Drones, Remote sensing and Satellites	The IUCN Biodiversity Monitoring Framework (Section 7.3) includes aerial and satellite-based sensing methods, noting operator, regulatory, and infrastructure requirements for responsible implementation. The IUCN Global PCA Standard Criteria 3.1 and 3.7 require adequate planning, resourcing, and monitoring systems, including compliance with regulatory frameworks for aerial and satellite data. The KM-GBF Target 4 supports species and habitat monitoring within secure, regulated frameworks for aerial and satellite technologies.	Verify operator licences and permissions; publish flight policies; manage data securely with clear retention and deletion schedules.

Category	Technologies	How the technology aligns with global frameworks	Considerations for managers
In-situ sensor networks	IoT sensors, Acoustic sensors	The IUCN Biodiversity Monitoring Framework (2024, Section 7.3) highlights power, connectivity, and maintenance needs. The KM-GBF Target 4 reinforces species and threat monitoring with transparent and secure management of sensor-derived data. The IUCN Global PCA Standard Criterion 3.7 requires established monitoring systems, while Criterion 1.3 calls for transparency and accountability in managing sensor-derived data.	Plan servicing and power; restrict live feeds if they create risk; record who can access streams and how long data are kept.
High-impact analytics	Data mining and Predictive analytics	The IUCN Biodiversity Monitoring Framework (2024, Section 5.2) emphasises data standards, documentation, and management. The KM-GBF establishes transparency and accountability for analytical methods and reporting under Section J (16). The IUCN Global PCA Standard Criteria 1.3 and 3.7 require transparent data processes, documentation of analytical methods, and accountability in decision-support systems.	Document datasets, assumptions and model versions; provide plain-language method notes alongside outputs for review.

Question 5: How can women, youth, and Indigenous Peoples be empowered to govern conservation data systems?

Overview

Even where governance structures exist, decision-making over data is often dominated by external actors or technical experts. As a result, women, youth, and Indigenous Peoples are underrepresented in both institutional governance bodies and data system design. This limits the alignment of data practices with lived realities, cultural protocols, and intergenerational knowledge systems. Analyses of Indigenous data governance in open earth systems show that when authority is not embedded across all stages of the data lifecycle, control over data access, use, and interpretation remains with external institutions, undermining Indigenous sovereignty (Jennings et al., 2025).

The KM-GBF Target 22 requires equitable participation and leadership of underrepresented groups, while the IUCN Global PCA Standard Criteria 1.1 and 1.2 requires legitimacy and voice, meaning that governance must reflect the perspectives of women, youth, and Indigenous Peoples (CBD, 2022; Woodley et al., 2026). This imbalance is reinforced by the design of many conservation technologies. AI systems and biodiversity databases often rely on datasets that over-represent certain regions and species, while data from many biodiverse regions remain under-represented (Skaldina et al., 2024). Automated tools such as chatbots can unintentionally repeat colonial narratives or overlook Indigenous knowledge when they are built using mainly dominant or widely used data sources (Urzedo et al., 2025). The IUCN Biodiversity Monitoring Framework Sections 6.4 and 7.3 highlights the importance of documenting methodological limitations and addressing systemic dataset biases to ensure inclusive and transparent monitoring (Dalton et al., 2024). Furthermore, the OECMs Guidance requires monitoring to be culturally appropriate and inclusive of diverse knowledge systems (Jonas and Woodley, 2024). Without structural change, digital systems risk amplifying the very inequities conservation seeks to overcome.

Meaningful participation therefore requires moving beyond consultation to embed genuine authority in data governance. This includes enabling women, youth, and Indigenous Peoples to influence what data is collected, how it is categorised, and how it is used in decision-making processes. It also requires embedding cultural protocols and governance rules within digital infrastructures, so that community authority and conditions for use remain attached to the data as it is shared or reused (Jennings et al., 2025). The Target 3 '30x30' Guide requires inclusive governance systems that embed cultural authority as part of equitable implementation of KM-GBF Target 3 (WWF and IUCN WCPA, 2023). Tools such as Traditional Knowledge (TK) and Biocultural Labels demonstrate how Indigenous cultural authority, provenance, and permissions can be practically embedded within digital databases through metadata, ensuring that Indigenous interests remain visible and enforceable as data are shared and reused (Golan et al., 2022).

Capacity-building is critical but must be sustained over time. Training in data literacy, rights-based governance, and digital security provides foundational skills, but empowerment also requires mentoring, financial support, and long-term roles within governance systems. This ensures that women, youth, and Indigenous Peoples are not only invited into decision-making spaces but are able to influence them effectively (Carroll et al., 2020).

Action

1. **Invest in long-term capacity building and leadership development**

To ensure equity, conservation organisations should invest in long-term data governance capacity-building for women, youth, and Indigenous communities. This includes training in data literacy, rights-based governance, and digital security, alongside resourcing for participation in decision-making structures.

One practical approach is to design citizen science initiatives with clear, structured tasks and participatory digital elements that support learning through doing. Gamified and task-based approaches can build practical skills, confidence, and sustained engagement among community participants, creating pathways for deeper stewardship and participation in decision-making over time (Speelman et al., 2023).

Local data stewards and advisory boards should include diverse representation and be positioned to meaningfully shape data policies and governance practices, consistent with KM-GBF Target 22 and IUCN Global PCA Standard Criteria 1.1 and 1.2 (CBD, 2022; Woodley et al., 2026).

Building inclusive governance capacity strengthens legitimacy, accountability, and sustainability across conservation initiatives. Record these roles, selection processes, and decision powers in governance documents under IUCN Global PCA Standard Criteria 1.1, 1.2, and 1.3, allocate recurring budget lines and staff time for participation under Criterion 3.1. Define simple indicators such as the number of meetings convened, decisions taken, and actions implemented under Criterion 3.7, following the IUCN Biodiversity Monitoring Framework Sections 6.4 and 7.3 to ensure that monitoring remains inclusive, transparent, and adaptive over time.

2. Address barriers to participation and embed inclusion in governance systems

Empowerment requires addressing structural barriers that prevent meaningful participation. Digital platforms should be accessible, culturally appropriate and available in relevant languages. Participants should receive clear feedback demonstrating how their contributions are used and valued. This approach, used in Zooniverse, helps diversify participation and prepares community members to take on data stewardship roles in conservation projects (Zooniverse, n.d.). This means guaranteeing seats with decision-making authority on data stewardship boards, embedding collective rights and cultural protocols into governance frameworks, and creating accountability mechanisms to track inclusivity over time. Applying both CARE Principles and FAIR Principles ensures data systems balance technical usability with ethical responsibility.

3. Ensure women, youth and Indigenous Peoples have authority over data and knowledge governance

Tools such as TK Labels provide practical mechanisms for embedding Indigenous authority, provenance, and permissions into digital infrastructures, ensuring that Indigenous interests and protocols remain visible as data are shared and reused (Golan et al., 2022). A co-developed Statement of Shared Understanding on Indigenous data governance shows that empowerment includes establishing jointly agreed rules and protections, such as confidentiality provisions and safeguards for Indigenous knowledge, which are implemented through community-led governance structures (Drake et al., 2025). Cite OECMs Guidance for culturally appropriate mechanisms, the IUCN Global PCA Standard Criteria 1.1, 1.2, and 1.3 for legitimate, transparent governance safeguards, with inclusive participation and oversight. Follow the IUCN Biodiversity Monitoring Framework Sections 6.4 and 7.3 to establish governance safeguards that ensure transparency, inclusion, and accountability in monitoring and reporting systems. In ICCAs contexts, FPIC decisions and agreed benefit-sharing provisions should be documented in formal agreements approved by the appropriate customary authorities (Stevens et al., 2024). Referencing these arrangements in management planning helps ensure that custodians' governance authority is upheld in day-to-day practice, consistent with the ICCAs guidance.

Empowerment should not be limited to skills development. It must extend to shaping agendas, correcting systemic biases in datasets, and ensuring that underrepresented groups have interpretive authority over conservation outcomes. The KM-GBF Target 21 requires that Indigenous knowledge is fully integrated, while the Target 3 '30x30' Guide requires inclusive implementation that recognises women, youth, and Indigenous Peoples as decision-makers and leaders in conservation governance (CBD, 2022; WWF and IUCN WCPA, 2023). By position-

ing these groups as leaders rather than participants, conservation data governance becomes more legitimate, accountable, and effective. Establish co-authored data dictionaries and category standards. Require community-led interpretation workshops before publishing sensitive outputs. Institute redaction and take-down procedures that can be triggered by community stewards. Document these controls and their performance under IUCN Global PCA Standard Criterion 3.1 and Criterion 3.7.

4. Support intergenerational leadership and continuity

Finally, empowerment requires intergenerational continuity. Governance systems must resource youth leadership while also valuing elders' roles in knowledge transmission. The IUCN Global Indigenous Agenda calls for strengthening long-term Indigenous leadership and participation pathways, including sustained capacity building, institutional support, and access to decision-making spaces in conservation and natural resource governance (IUCN, 2021). In conjunction, the IUCN Youth Strategy calls for sustained investment in youth leadership development, capacity building, and intergenerational partnerships to support meaningful engagement over time (IUCN, 2022). Demonstrate resourced leadership pipelines and institutional capacity under IUCN Global PCA Standard Criterion 3.1, with progress tracked under Criterion 3.7. Create mentorship schemes that pair elders and youth as co-stewards, fund fellowships for young data custodians, and include succession plans and knowledge-transfer milestones in management plans. Track progress and report delivery through annual learning reviews under IUCN Global PCA Standard Criterion 3.7, aligning with the IUCN Biodiversity Monitoring Framework Sections 4.5 and 6.5 to ensure continuity, accountability, and intergenerational learning within governance systems.

Relevant standards and guidance:

KM-GBF Target 3 (*Ensure and enable that by 2030 at least 30 per cent of terrestrial, inland water, coastal and marine areas are effectively conserved and managed through ecologically representative, well-connected and equitably governed systems of protected areas and other effective area-based conservation measures*), Target 21 (*Ensure that knowledge is available and accessible to guide biodiversity action*), and Target 22 (*Ensure participation in decision-making and access to justice and information related to biodiversity for all*); IUCN Global PCA Standard Criterion 1.1 (*Demonstrate supportive legal, policy or customary framework*), Criterion 1.2 (*Ensure legitimacy and voice*), Criterion 1.3 (*Achieve transparency and accountability*), Criterion 3.1 (*Develop a long-term management strategy*), Criterion 2.1 (*Understand ecological, social and economic context*), and Criterion 3.7 (*Implement monitoring, evaluation and adaptive management*); IUCN Biodiversity Monitoring Framework Section 4.5 (*Ongoing monitoring cycles*), Section 6.4 (*Combining forms of knowledge*), Section 6.5 (*Continuity risks: Avoiding disruptions and gaps in data*), and Section 7.3 (*Technology-based approaches for biodiversity monitoring*); OECMs Guidance; Target 3 '30x30' Guide; CARE Principles; FAIR Principles; ICCAs Guidance; Free, prior and informed consent (FPIC); Traditional Knowledge and Biocultural Labels; IUCN Global Indigenous Agenda; IUCN Youth Strategy.

Practitioners should:

- [ ] Design data governance arrangements so women, youth, and Indigenous Peoples can actively participate and influence decisions.
- [ ] Clearly recognise Indigenous governance authority, including FPIC and agreed benefit-sharing, in data agreements.
- [ ] Set aside funding, staff time, and stipends so people can take part in governance in a realistic and sustained way.
- [ ] Offer ongoing training and mentoring in data use, governance, and digital safety so participants can engage with confidence.
- [ ] Include women, youth, and Indigenous Peoples in decisions about data collection and use.
- [ ] Reduce barriers to participation by using accessible, multilingual, and culturally appropriate tools and communication methods.
- [ ] Use the CARE and FAIR principles together to ensure data is useful while respecting rights, responsibilities, and ethics.
- [ ] Use tools such as TK and Biocultural Labels to clearly show Indigenous authority, provenance, and permissions in data systems.
- [ ] Regularly review who is involved in governance and how inclusive decision-making is, and make changes where gaps are identified.
- [ ] Support long-term governance by creating pathways for youth leadership and recognising the role of elders in sharing knowledge over time.

Technology Overview and Strategic Considerations

Table 3.5. A structured overview of key technology categories and associated tools that outlines how each aligns with relevant global frameworks and highlights practical considerations for managers when assessing, selecting, and implementing technology within conservation contexts.

Category	Technologies	How the technology aligns with global frameworks	Considerations for managers
Community & citizen-science platforms	iNaturalist, eMammal, Wildlife Insights	The IUCN Biodiversity Monitoring Framework (2024, Section 3.5; Section 4.5) states participation requires training and support. The KM-GBF promotes equitable participation (Target 22) and gender-responsive governance (Target 23) in community and citizen-science platforms. The IUCN Global PCA Standard Criteria 1.1, 1.2, and 1.3 require recognition of legitimate rights-holders and inclusive, equitable governance that ensures gender balance and participation of under-represented groups.	Provide training and feedback loops; assign review or moderator roles to women, youth and Indigenous contributors; record participation commitments in governance documents.
Field data capture apps	CyberTracker, Smartphone Apps	The IUCN Biodiversity Monitoring Framework (2024, Section 3.5) highlights accessible tools for community participation. The KM-GBF supports equitable participation (Target 22) and gender-responsive access (Target 23) in digital data collection and governance. The IUCN Global PCA Standard Criteria 1.3 and 1.4 require transparent, adaptive governance systems that enable equitable participation, learning, and feedback across user groups.	Configure local languages and icon-based interfaces; grant admin rights to community representatives to approve or correct records.

Category	Technologies	How the technology aligns with global frameworks	Considerations for managers
Open monitoring & transparency portals	Global Forest Watch, Global Fishing Watch, UN Biodiversity Lab	The Target 3 '30x30' Guide promotes transparent, accessible data systems that enable equitable participation and oversight by all stakeholder groups. The KM-GBF requires publicly accessible biodiversity information under Section J (16) to ensure transparency and equitable participation. The IUCN Global PCA Standard Criteria 1.3 and 3.7 require transparent, accountable governance and established systems for monitoring and reporting that enable equitable access and review.	Use platform permissions and public dashboards to enable community oversight; provide tutorials so under-represented groups can interpret and present results in decision forums.
Participatory mapping & dashboards	Participatory GIS, Site dashboards	The OECMs Guidance highlights the need for culturally appropriate and inclusive public information to support equitable participation in mapping and decision processes. The KM-GBF ensures informed participation (Target 22) and gender-responsive inclusion (Target 23) in participatory mapping and decision dashboards. The IUCN Global PCA Standard Criteria 1.1, 1.2, and 1.4 require recognition of rights-holders, inclusive participation, and adaptive governance processes to accommodate gender, youth, and cultural perspectives in decision-making.	Co-design indicators, legends and access rules; hide sensitive locations by default; document these settings in site governance records.

Relevant Standards, Tools and Templates

These resources support ethical, transparent, and rights-based governance of conservation data. They help clarify authority, consent, access, accountability, and inclusion across the data lifecycle, and support practical implementation and review of data governance arrangements in protected and conserved areas.

Relevant Global Standards

- **CBD Kunming–Montreal Global Biodiversity Framework (KM-GBF)** - The global agreement under the Convention on Biological Diversity that sets expectations for rights-based, inclusive, and accountable governance of biodiversity information. In this theme, it is particularly relevant through Target 21, which requires respect for Indigenous Peoples' knowledge and data, and Target 22, which promotes equitable participation and leadership in governance. The theme also contributes to the enabling conditions for Target 3 by strengthening equitable governance of data used in the management, monitoring, and reporting of protected and conserved areas.

- **IUCN Global Standard for Effective and Equitable Protected and Conserved Areas: Standard, Version 2.0.**- A global benchmark for good governance, effective management, and accountability in protected and conserved areas. In this theme, governance of conservation data is evidenced through Criteria 1.1 and 1.2 on legitimacy and voice, Criterion 1.3 on transparency and accountability, and Criterion 1.4 on adaptive governance. Resourcing and procedures for data governance are documented under Criterion 3.1, with performance, review, and learning related to consent, access, and safeguards recorded under Criterion 3.7.

- **IUCN WCPA Guidance on Other Effective Area-Based Conservation Measures (OECMs)** - Provides guidance on governance, equity, and management for conserved areas outside formal protected areas. In this theme, it reinforces the need for rights-based data governance, culturally appropriate monitoring, and governance arrangements that retain authority with rights-holders, particularly where data supports recognition, reporting, or management of OECMs.

- **IUCN A framework for monitoring biodiversity in protected areas and other effective area-based conservation measures** - Sets out concepts, methods, and technologies for monitoring biodiversity in protected and conserved areas. In this theme, it supports documentation of data roles, permissions, safeguards, and review cycles, particularly through guidance on combining forms of knowledge, continuity risks, and technology-based approaches to monitoring.

- WWF and IUCN WCPA A Guide to Inclusive, Equitable and Effective Implementation of Target 3 of the Kunming-Montreal Global Biodiversity Framework - Provides guidance on inclusive, equitable, and effective implementation of KM-GBF Target 3. In this theme, it reinforces the requirement that monitoring and reporting systems, including data governance arrangements, uphold rights-holder authority, equitable participation, and accountability as conditions for credible and legitimate area-based conservation.

- **IUCN Guidelines for conserving connectivity through ecological networks and corridors** - Provide guidance for governance and management across ecological networks and corridors. In this theme, they support alignment of data governance rules, permissions, and safeguards across sites and jurisdictions, ensuring that community authority and protections are not weakened as data moves across connected landscapes or seascapes.

- **IUCN WCPA Recognising territories and areas conserved by Indigenous Peoples and local communities (ICCAs) overlapped by protected areas** - Provides specific guidance for recognising and supporting territories and areas conserved by Indigenous Peoples and local communities. In this theme, it underpins requirements to document Free, Prior, and Informed Consent, custodians' governance authority, and agreed rights and responsibilities in data governance arrangements where conservation technologies intersect with Indigenous territories.

- **CARE Principles for Indigenous Data Governance** - Provide a foundation for collective benefit, authority to control, responsibility, and ethics. In this theme, they guide Indigenous data sovereignty, co-governance, consent, and benefit-sharing across conservation data systems.

- **FAIR Principles (Findable, Accessible, Interoperable, Reusable)** - The FAIR Principles provide guidance for making data technically usable and interoperable across systems. In this theme, they are applied alongside the CARE Principles to ensure that conservation data can be shared and reused responsibly, while respecting access controls, consent conditions, cultural protocols, and the authority of rights-holders.

- **United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP)** - UNDRIP establishes the collective rights of Indigenous Peoples to self-determination, governance, and control over their lands, territories, resources, knowledge, and data. In this theme, it underpins expectations around Free, Prior and Informed Consent, Indigenous data sovereignty, and the authority of customary institutions in decisions about conservation data collection, use, sharing, and interpretation.

- **CBD Nagoya Protocol on Access and Benefit-Sharing** - Applies where conservation data relates to genetic resources or associated traditional knowledge, reinforcing requirements for prior consent, mutually agreed terms, and fair benefit-sharing, including for eDNA and related data.

- **Free, prior and informed consent (FPIC)** - A core rights-based standard requiring that Indigenous Peoples and local communities can give, withhold, or withdraw consent for activities affecting their lands, knowledge, and data. In this theme, FPIC underpins ongoing, collective, and revocable consent for conservation data collection, use, and sharing.

Tools and Frameworks for Implementation

- **Governance and equity assessment tools (GAPA, SAPA, SAGE)** - Practical diagnostics for assessing governance quality, participation, equity, and accountability. In this theme, they support reflection on who holds authority over data, how consent and grievances are managed, and whether governance arrangements are inclusive and trusted over time.

- **Planning and documentation tools (Miradi)** - Support co-developed planning and documentation of data governance roles, decision authority, consent checkpoints, and review processes, helping translate co-governance agreements into operational and auditable practice.

- **Participatory governance mechanisms** - Structures such as data stewardship boards, community protocols, participatory audits, and dashboards that enable shared decision-making, oversight of data access and use, and transparency across the data lifecycle.

- **Risk and consent instruments (Data Protection Impact Assessments, Data Management Plans)** - Provide structured approaches for identifying and managing risks related to surveillance, misuse, bias, environmental impacts, and data continuity, and for documenting safeguards, responsibilities, and review cycles.

Templates and Learning Resources

- **IUCN GSAP SKILLS Platform** - Offers learning resources and practical templates to build capacity around ethical data governance, inclusive decision-making, consent processes, and monitoring of governance performance.
- **PANORAMA Solutions** - Provides real-world examples of rights-based and inclusive governance approaches that can inform conservation data, monitoring, and technology-enabled decision-making.

Additional Resources

- IUCN WCPA (2025). *IUCN World Commission on Protected Areas Impact Report 2024*. Gland.

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