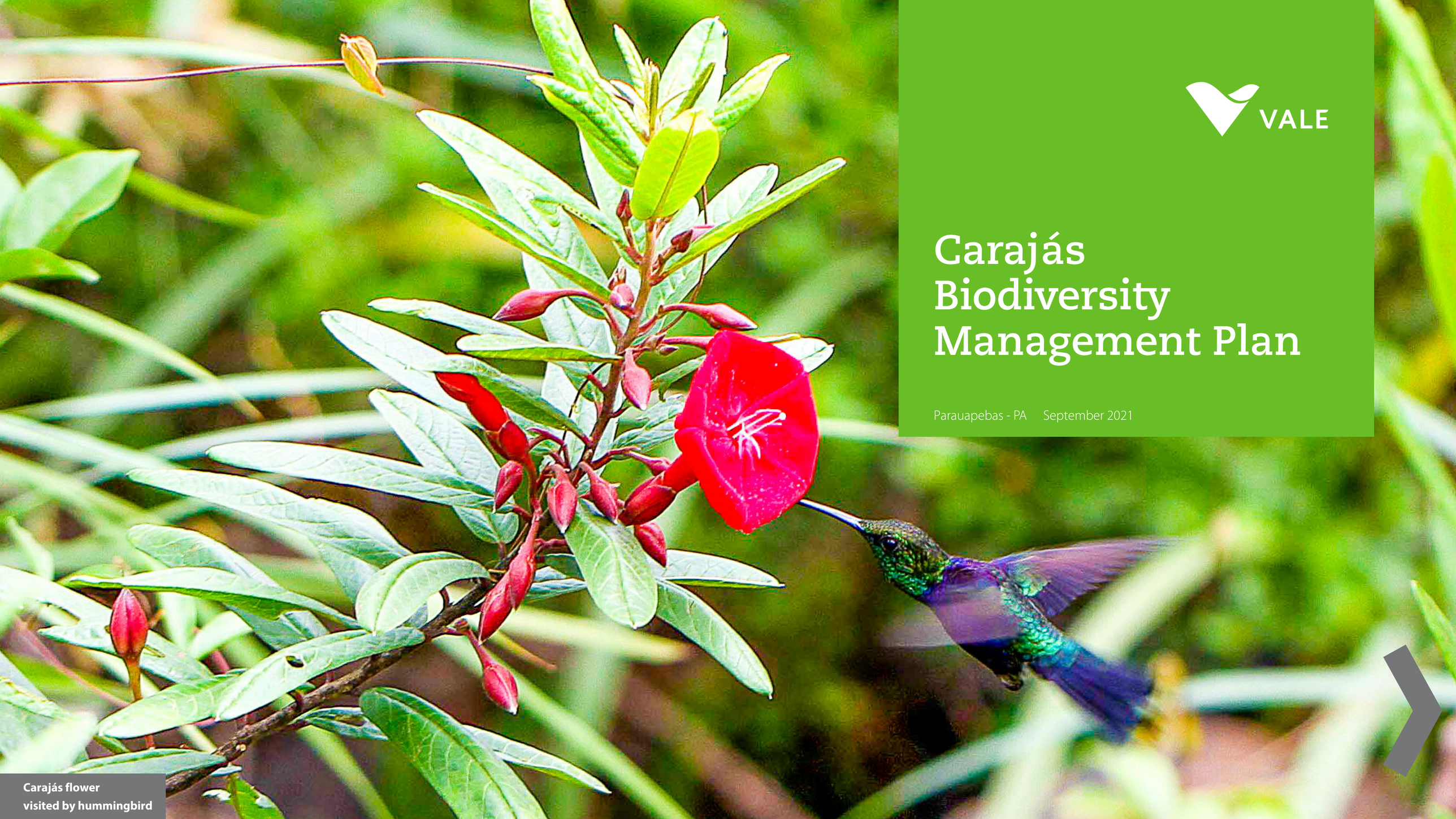

Carajás Biodiversity Management Plan

Parauapebas - PA September 2021

Carajás flower
visited by hummingbird

Project owner

Name of Project Owner: Vale S.A.

Est. Raymundo Mascarenhas, S/N Carajás

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Can mining and biodiversity coexist? The answer is a resounding yes, and more than 800,000 hectares of standing forests are there to prove it—a vast mosaic of protected areas in Carajás that have been well preserved over Vale's nearly four decades of operations in Pará. One of these areas, the Campos Ferruginosos National Park (PARNA), has been converted into a fully protected, no-mining area used exclusively for environmental education, tourism and scientific research.

Another illustration of how mining and conservation can work together is the Vale Institute of Technology (ITV), where extensive research has deepened scientists' understanding of Amazon fauna and flora, and has made these areas among the most well-studied in Brazil. This research can make an essential contribution to solving environmental issues, both big and small. Not to mention Vale's many initiatives to promote sustainable land use in the region, including several projects supported by the Vale Fund to integrate conservation with livelihoods.

But in this publication, I am pleased to present something that goes beyond these initiatives and legal requirements for our closely monitored mining operations. I am immensely proud to present the Carajás Biodiversity Management Plan, a living document setting out goals, initiatives and strategies to engage our mine operations team alongside environmental professionals in an enhanced biodiversity conservation program across our Carajás, S11D and Salobo mine operations, within the Carajás protected area mosaic .

Through the Plan, we will not only prevent, mitigate, remediate and offset potential impacts from our operations, but we will also reconcile conservation with local development priorities, with an increased focus on identifying and managing the risks from our operations to local biological diversity. I invite you to learn more about the Carajás Biodiversity Management Plan in the following pages.

We hope with this initiative to make an even greater contribution to balancing economic growth with environmental protection and social development, and to conserving Carajás fauna and flora and the ecosystem services that are essential for current and future generations.

Thank you!

Valeria Cristina Franco

Northern System HSE, Risk and Emergency Executive Manage

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PPA	Permanent Protected Area
ASV	Clearing Permit
ce BDS	Brazilian Business Council for Sustainable Development
c SI	Cement Sustainability Initiative
GBIf	Global Biodiversity Information Facility
GRI	Global Reporting Initiative
MH	Mitigation Hierarchy
Ic MBio	Instituto Chico Mendes de Conservação da Biodiversidade
Ic MM	International Council of Mining & Metals
Ifc	International Finance Corporation
IPS	IFC Performance Standards
MMA	Brazilian Ministry of the Environment
BeP	Basic Environmental Plan
PGBio	Biodiversity Management Plan
MLR	Mined Land Rehabilitation
eMS	Environmental Management System
PA	Protected Area
WBc SD	World Business Council for Sustainable Development

1 Introduction

Lagoon canga vegetation

Conserving biodiversity is essential to maintaining the natural capital and ecosystem services we all depend on. At Vale we recognize the importance of biodiversity and our environmental performance to achieving our vision, mission and values—including sustainable development, creating long-term value, and prizing our planet.

As part of our aspiration to become a leader for sustainability in the mining and minerals industry, we have undertaken several commitments to managing biodiversity in our operations, which include: building knowledge about local biodiversity; investing in research and development; managing risks and impacts; supporting national and international biodiversity goals; and working to achieve No Net Loss or Net Positive Impact on biodiversity in the long term, striving to leave a positive legacy wherever we operate.

These commitments reflect Vale's Sustainability Policy and have been incorporated into global sustainability objectives aligned with international agendas and goals (e.g. the Convention on Biological Diversity, the Aichi Biodiversity Targets and the Sustainable Development Goals as part of the United Nations' 2030 Agenda). As a member of the International Council on Mining & Metals (ICMM) and the Brazilian Business Council for Sustainable Development (CEBDS), and a signatory of the Brazilian Business Commitment to Biodiversity, Vale is committed to implementing good practices in biodiversity management and conservation and embedding them in our projects and operations, and to enhancing conservation knowledge and initiatives in the regions where we operate, in alignment with legal requirements and strategies recommended by environmental authorities.

Vale's Biodiversity Management Plan (BMP) aims to support biodiversity management and integration in the areas where the company operates, and minimize risks to mine planning, development and operation increasing reliability and competitiveness. Adhering to international standards on sustainable environmental performance and demonstrating compliance with related requirements not only strengthens our accountability to stakeholders but can also help to attract more investment and create value for the business. By integrating biodiversity conservation into our mining operations, we are creating two-way benefits—for both the environment and the business.

Flooded forest on the banks of the Rio Pacu

2
Reference documents

The dawn at foggy forest

2.1. Internal references

- Biodiversity Management Guidelines and Processes (PNR-000029).
- Guidelines on Managing Sustainability Indicators (PTP-000831).
- Mine Closure Guide (PGS-002828)
- Environmental Handbook for Project Management (MA-G-650)
- Vale Integrated Management System (IMS) Manual
- Sustainability Standard (NFN-0009).
- S11D Strategic Biodiversity Management Plan.
- Risk Management Policy (POL-0009-G).
- Global Climate Change Mitigation and Adaptation Policy (POL-0012-G)
- Social & Environmental Investment Policy (POL-0024-G)
- Sustainability Policy (POL-0019-G).
- Mineland Rehabilitation Management Procedure (PRO-003145)

2.2. External references

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- Brazilian Ministry of the Environment, Preservação da Natureza e Segurança Nuclear (BMU). Corporate Biodiversity Management Handbook, 2010.
- World Resources Institute, World Business Council for Sustainable Development, Meridian Institute. The Corporate Ecosystem Services Review: Guidelines for Identifying Business Risks & Opportunities Arising from Ecosystem Change, 2008.
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- Brazilian Ministry of the Environment. Office for Biodiversity and Forests. Diretrizes e Prioridades do Plano de Ação para implementação da Política Nacional da Biodiversidade (PAN-BIO), 2006.
- United Nations: Global Strategy for Plant Conservation (GSPC), 2002.

3

Biodiversity Management Plan Basics

Flight of the harpy eagle in the crown of the forest - *Harpy harpyja*

3.1. What Is a Biodiversity Management Plan (BMP)?

A Biodiversity Management Plan (BMP) is a document developed for projects in areas of high biodiversity concern in order to prioritize features, assess risks and impacts, and outline and monitor actions to prevent, mitigate, remediate and offset impacts throughout the project's lifecycle. Supplementing the scope of a Basic Environmental Plan (BEP), which sets out guidance on mitigating impacts identified by Environmental Impact Assessments (EIA) and on complying with legal requirements, a BMP outlines guidance and specific actions to maintain or improve the original biodiversity in the project area. The similarities and differences between an EIA, BEP and BMP are detailed in the table opposite (Chart 1).

Chart 1 – Comparison between key documents in an Environmental Management System (IMS).

Adapted from WBc SD/c SI (2014).

	ELA	BEP	BMP
PURPOSE	To evaluate the likely environmental impacts of a proposed project or development.	To specify the actions required to mitigate environmental impacts identified in the EIA and rehabilitate the site in accordance with legal requirements.	To set out and monitor actions needed on an on-going basis to preserve/increase biodiversity value during and after the completion of the extraction activities.
MAIN OU TPU TS	Predict impacts over different phases of the project.	Set targets and related actions for environmental programs, ensuring compliance with legal requirements.	Set targets and related actions to maintain or improve biodiversity values.
LEVELS OF BIO DIVERSITY MAN AGEMEN T INPUTS	Not applicable.	Minimum (e.g. control of invasive alien species) or medium (e.g. revegetation with native species, fauna and flora monitoring programs).	High input (targets set to ensure the preservation of species, habitats and ecosystem services, active monitoring).

A BMP is a practical and dynamic document that should reflect the specific local conditions of the project site and determine risks and opportunities related to biodiversity (WBCSD/CSI, 2014). It is focused on identifying, assessing and preserving priority biodiversity features, responding to regulatory requirements (compliance with applicable basic legislation), addressing biodiversity risks identified by EIAs and other assessments, and respecting the Mitigation Hierarchy (MH). A BMP provides a mechanism for monitoring and reporting on progress, and its strategy should be periodically revisited.

According to the Vale Biodiversity Management Guidelines and Processes Standard (PNR-000029), a BMP is an internal management document that provides greater detail on potential risks to and impacts on biodiversity features, its scope spanning from the early stages of design and planning to mine closure. A BMP can also be developed for brownfield projects, in which case the focus is on identifying priority biodiversity features in the area and reassessing and/or reformulating strategies to preserve those features (mitigating impacts and implementing remediation/restoration and offset measures).

3.2. Why is a BMP needed?

A BMP is developed and implemented to identify and recommend measures to address biodiversity risks prior to developing an environmental impact assessment (EIA). As mentioned in the previous section, highly sensitive areas require specific actions that are typically not included in a Basic Environmental Plan, and a Biodiversity Management Plan can also provide a range of opportunities for social and economic development. A BMP therefore serves to (adapted from WBCSD/CSI, 2014):

- Collect and disseminate information about biodiversity in the project area
- Identify risks to biodiversity
- Avoid or mitigate biodiversity losses (species, habitats, ecological functions)
- Contribute towards the remediation of significant biodiversity losses
- Facilitate new licensing processes and demonstrate the Company's contribution to knowledge about biodiversity and responsible stewardship of the environment
- Build trust and market value
- Secure access to investment funding—attracting the attention of socially responsible investment funds
- Reduce costs—finding environmentally sustainable options as a way to mitigate impacts helps to avoid unnecessary project costs and schedule overruns, and can make projects more efficient and economical
- Create economic benefits for the community—by supporting environmentally sustainable activities

Vale has supported the development of biodiversity management plans for its operations in order to act on risks before they materialize and create legal barriers or constraints on project development. Some of the added benefits from BMPs include enhanced compliance with the company's existing commitments, and the ability to raise new funding and attract new customers. consistently managing biodiversity also improves local community relations and stakeholder perceptions of the company, helping to safeguard its "license to operate" from the community. Below are examples of potential benefits from a BMP:

• Building trust and creating value

As a member of the International Council on Mining & Metals (ICMM), demonstrating adherence to environmental and governance best practices recommended by the ICMM helps to build trust and market advantage. ICMM Principle 7 calls for members to contribute to the conservation of biodiversity and integrated approaches to land-use planning, and accordingly to assess and address risks and impacts on biodiversity in project areas. At a national level, Vale's status as a signatory of the Brazilian Business Commitment to Biodiversity supports its goal to build trust in the environmental area. Vale has undertaken a commitment to develop and disseminate research about biodiversity in the regions where it operates, and to enhance conservation initiatives. Adhering to environmental practices recommended by national and international organizations is also a way of supporting global efforts such as the United Nations Sustainable Development Goals (SDGs).

• Raising new funding and attracting customers

The World Economic Forum's Global Risks Report 2020 shows that $44 trillion of economic value generation—more than half of the world's GDP—is dependent on nature and it services, and therefore there is a linkage between nature loss and economic impacts. Reflecting this, investors and customers are increasingly demanding practices and action to reduce and preserve biodiversity and ecosystem services. The International Finance Corporation (IFC)—a global development institution focused exclusively on the private sector in developing countries—has become an authoritative source on good practices in responsible investment. To qualify for investment from IFC's partner banks, a commercial project is required to demonstrate adherence to IFC's performance standards, which include building knowledge about the project area and managing biodiversity risks.

Sustainability reporting is another way to enhance accountability to stakeholders in general and to attract investment. Companies listed on the Dow Jones and BOVESPA sustainability indexes, for example, are required to demonstrate environmental compliance by reporting sustainability disclosures, and a commitment to managing biodiversity. The Global Reporting Initiative (GRI) Standards outline best practices and standard disclosures for reporting on a range of economic, social and environmental impacts, and help organizations understand and communicate their impacts across these dimensions. GRI disclosure MM2, for instance, requires organizations to report biodiversity management plans for areas of high biodiversity value, describing their approach to managing biodiversity in their operations in order to mitigate risks and impacts.

3.3. The BMP and its context in Carajás

Carajás is a region in the southeast of Brazil's northern state of Pará. One of the state's most prominent geographic features, the Serra de Carajás is a mineral resource-rich mountain range characterized by rugged slopes crowned by plateaus of ferruginous outcrops (AB'SABER, 1986).

The mountain range is contained in the municipalities of Água Azul do Norte, Canaã dos Carajás, Curionópolis, Eldorado dos Carajás, Marabá, Ourilândia do Norte, Parauapebas and São Félix do Xingu. Vale's S11D iron ore mine operations are located in the municipalities of Parauapebas, Canaã dos Carajás and Curionópolis. Part of the mine is within a sustainable-use Protected Area (PA) called the Carajás National Forest (MARTINS et al., 2018).

This area is bounded by other protected areas (table 2) including the Igarapé Gelado Protected Area, the Itacaiúnas National Forest, the Tapirapé-Aquiri National Forest, the Campos Ferruginosos National Park (PARNA), the Tapirapé Biological Reserve (REBIO) and the Xikrin do Catete Indigenous Reserve (IR). These PAs and the IR form what is known as the Carajás protected area mosaic, an area of approximately 1.3 million hectares containing species representative of Amazon vegetation in southern Pará and its ferruginous cangas (AMPLO, 2017; MARTINS et al., 2018).

The PA mosaic is encircled by anthropogenic landscapes created by demographic expansion, including an advancing agricultural frontier, vast smallholder settlements, and logging and small-scale mining operations, which have led to land-use conflicts. Amid these anthropogenic pressures, the protected area mosaic survives as a lone, vast island of native vegetation (ICMBio, 2016; SOUZA-FILHO, 2016).

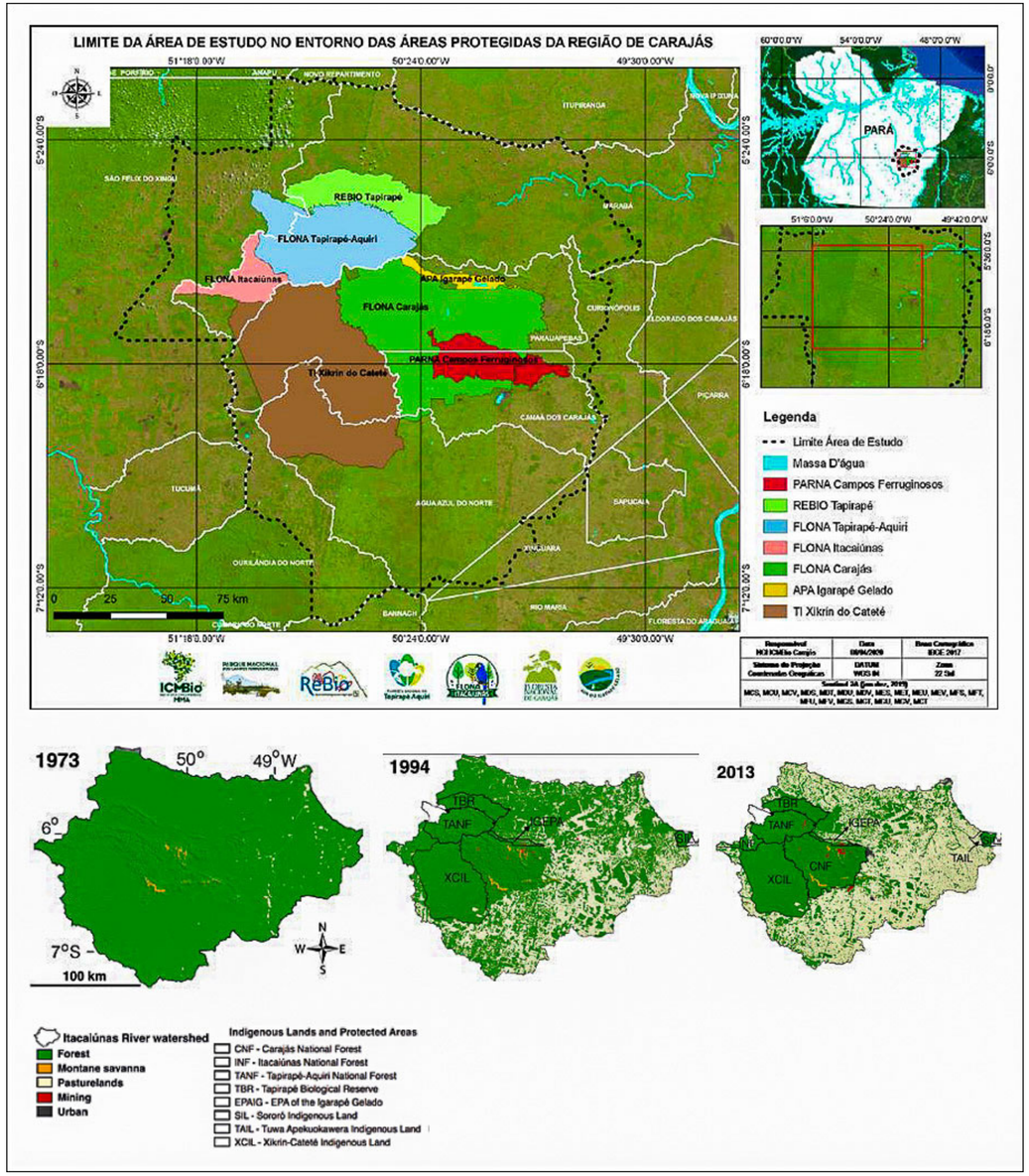

Chart 2 – Protected areas in Carajás

Protected area	Category	Municipalities	Created under	Managed by	Area (Hectares)
Carajás National Forest	Sustainable Use	Parauapebas	Decree no. 2 486, 2/2/1998	ICMBio	391263.04
Tapirapé-Aquiri National Forest	Sustainable Use	Marabá, São Felix do Xingu and Parauapebas	Decree no. 97 720, 5/5/1989	ICMBio	196503.94
Itacaiúnas National Forest	Sustainable Use	Marabá, São Felix do Xingu and Parauapebas	Decree no. 2 480, 2/2/1998	ICMBio	136698.91
Tapirapé Biological Reserve	Full Protection	Marabá and São Felix do Xingu	Decree no. 97 719, 5/5/1989	ICMBio	99271.75
Igarapé do Gelado Protected Area	Sustainable Use	Parauapebas	Decree no. 97 718, 5/5/1989	ICMBio	23285.09
Campos Ferruginosos National Park	Full Protection	Canaã dos Carajás	Decree dated 7/5/2017	ICMBio	79,086.04*
Xikrin do Catete IR	Indigenous Reserve	Água Azul, Marabá and Parauapebas	Decree no. 384, 12/26/1991	FUNAI	439150.54

*60,905 hectares overlapping the Carajás National Forest (MARTINS et. al, 2018).

Iron ore mines in Carajás (Serra Norte, Serra Sul and Serra Leste) operate in an environmentally sensitive setting with a large number of endemic species associated with the unique geology and vegetation in the region. In areas surrounding the iron ore mines, where altitudes range from 200-700 m, the vegetation forms a mosaic of hygrophilous forests interspersed with savanna formations typically associated with ironstone outcrops (AB'SABER, 1986). Because of this peculiar aspect, the biota occurring on these hills have a strong tendency to be rather specialized and even endemic, such that these communities can be defined as insular ecosystems—islands of canga within a landscape of ombrophilous forests.

In this context, attaining a goal of no net loss on biodiversity poses a significant challenge. To neutralize impacts or, more optimistically, achieve a net positive impact, efforts have been undertaken to manage risks by identifying and prioritizing critical biodiversity features, monitoring losses, and identifying and implementing actions to address prioritized features.

Vale's iron ore operations in the region have pioneered the development of plans specifically addressed to managing risks and impacts to critical biodiversity features (endemic, rare, restricted-range and threatened species, as well as endemic habitats) and implementing actions to avoid/mitigate these impacts, both from existing operations and from future expansions.

At the S11D mine, the consolidation of these biodiversity assessments into a BMP has helped to identify species in the area for which conservation actions have already been implemented, and plan future actions for species that could potentially be threatened by subsequent expansions. The initiative to develop and implement a biodiversity management plan for S11D, in the Serra Sul portion of the Carajás National Forest, is now being rolled out across the wider iron ore mining complex in Carajás. This report describes these integrated initiatives and how they align with biodiversity conservation strategies proposed by environmental authorities. This initiative by the environment team in Carajás has become a benchmark for the company's operations in Brazil and has provided a wide range of benefits as previously described. It is important to stress that identifying sources of risk should not be viewed as a constraint on the company, but rather as an opportunity to improve processes and find solutions before issues escalate into legal liability.

Vegetation transition of canga and forest

4 Goals

Flowering pink ipe in through the forest

4.1. Overarching goal

The Carajás Biodiversity Management Plan aims to integrate sustainability into Vale's operations in the Carajás protected area mosaic and in surrounding areas, providing guidance on biodiversity management throughout a mine project's lifecycle and on reconciling conservation with local development priorities, with a particular focus on identifying and managing risks from the Company's operations on biological diversity.

4.2. Specific goals

A set of eight specific goals have been developed to support the overarching goal of the BMP. In the table opposite, these goals are described and mapped to the pillars outlined in this document (Chart 3).

Chart 3 – Specific goals and related pillars under the Carajás Biodiversity Management Plan.

no.	Specific goals	Related BMP pillars
1	Assess the sensitivity of biodiversity features in the Carajás area.	• Risk assessment and Mitigation Hierarchy • Conservation Strategies for Threatened Species in Southeastern Pará
2	Prevent and mitigate risks and adverse impacts on the most sensitive biodiversity features.	• Risk assessment and Mitigation Hierarchy • Conservation Strategies for Threatened Species in Southeastern Pará
3	Rehabilitate habitats during and/or after mining operations.	• MLR in the context of biodiversity • Risk assessment and Mitigation Hierarchy • Conservation Strategies for Threatened Species in Southeastern Pará
4	Develop and implement offset initiatives to maintain environmental services.	• Integrated offsets • Conservation Strategies for Threatened Species in Southeastern Pará • Risk assessment and Mitigation Hierarchy
5	Conduct studies and research to identify species and preserve endemic, rare and threatened species.	• All pillars
6	Integrate initiatives for *in situ* and *ex situ* conservation of threatened species and their genetic variety.	• All pillars
7	Disseminate new knowledge about biodiversity to society.	• All pillars
8	Encourage local communities to participate in initiatives for biodiversity conservation and sustainable use.	• All pillars

5 Target audience

Parapara tree
flowering in the forest

This document is addressed to Vale—including operations managers, who are responsible for ensuring that biodiversity management and conservation are integrated into the c ompany's operations both during and after a project's lifecycle; and the teams engaged in BMP programs—and to environmental authorities and research and education institutes.

Male flowers of *Daphnopsis filipedunculata*

6
Action Plan

Jaguar melanin - *Panthera onca*

The carajás Biodiversity Management Plan comprises four pillars: (1) risk assessment and the Mitigation Hierarchy; (2) conservation strategies for threatened species in southeastern Pará; (3) MLR in the context of biodiversity; and (4) integrated offsets. Within each pillar, a strategic plan has been developed including an action plan outlining a set of goals, targets to achieve those goals, the individual steps in the process, and Key Performance Indicators (KPIs).

These strategic plans address the management and preservation of the biodiversity surrounding the mine sites in the c arajás PAs. Figure 1 provides a summary description of each pillar.

Figure 1 – Summary descriptions of the Carajás BMP pillars **(source of center diagram: freepik).**

A **6.1**

Obtaining an understanding of the local biodiversity context, identifying priority species and habitats for conservation and impacts on those species and habitats from mining operations; and planning measures to mitigate impacts based on the mitigation hierarchy (avoid, minimize, rehabilitate, offset)

B **6.2**

Strategic planning of actions to preserve identified priority species and habitats in the area (identifying knowledge gaps and recommending experiments, research, and *in situ* and *ex situ* conservation approaches)

D **6.4**

Measures to preserve species and habitats as part of environmental offsets and other supplementary activities to improve environmental quality and ecosystem services in the Carajás area

C **6.3**

Species conservation and habitat rehabilitation activities that can be integrated into the mineland rehabilitation plan to strengthen the program through proposed improvements

6.1. Biodiversity risk assessment and application of the mitigation hierarchy

6.1.1. Foreword

Until recently, biodiversity conservation was not always viewed through the lens of business risk or market opportunities, but largely as a regulatory requirement (SCHALTEGGER; BESTÄNDIG, 2010). However, as demand for accountability around sustainable performance increases, this mindset is being gradually replaced by efforts to achieve best practice in sustainability.

Vale has worked to make its operations increasingly sustainable by ensuring natural resources are used responsibly and risks and impacts are adequately managed, striving to leave a positive environmental as well as social and economic legacy in all areas where it operates.

The Mitigation Hierarchy framework is an important tool that Vale has used to identify and manage risks and impacts on biodiversity, and to inform its biodiversity management approach. This framework establishes a decision-making mechanism that balances conservation needs with development priorities, helping to achieve a net positive impact on biodiversity through a sequence of preventive and remediative actions (CCBI, 2015; VALE, 2020).

The mitigation hierarchy is a relatively new approach and is based on achieving No Net Loss or Net Positive Impact on biodiversity, with a focus on priority features. As a rule, preventive measures are always preferable to remediative measures—from ecological, social and financial perspectives (CCBI, 2015).

6.1.2. Rationale

The starting point in developing a BMP is identifying risks to biodiversity in the project area(s) through: local biodiversity assessments (baseline surveys, reviews of existing data, field investigations); sensitivity analysis and biodiversity risk classification to prioritize sensitive features (species and habitats); and structuring those risks/impacts to inform the optimal strategy to avoid or mitigate them.

These assessments are conducted using well structured and widely used methods. The Mitigation Hierarchy (MH) is an approach used by mining companies as a recommendation of the ICMM. The hierarchy is an excellent tool to frame impacts and allow the setting of targets in a way that promotes good practice and ensures optimal biodiversity protection within an operational context (WBCSD/CSI, 2014).

The MH framework is structured into four sequential steps (Figure 2): (1) as a first step, measures are taken to avoid impacts and locate operations in areas with minimal environmental sensitivity; (2) once the project site has

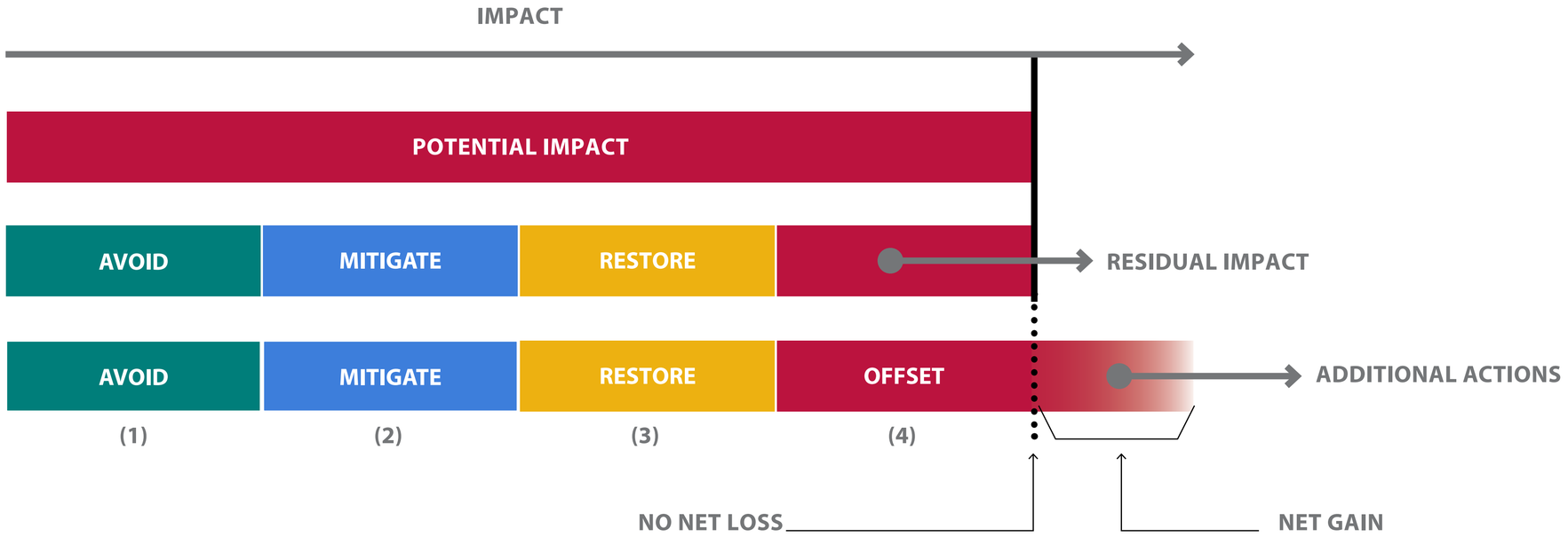

Figure 2 – Steps in the Mitigation Hierarchy.
Source: CBIS (2015), adapted.

been selected, the next step is minimizing/reducing impacts that cannot be avoided, through measures or practices to enhance the adaptability of local biodiversity and cause the least possible interference; (3) the third step is rehabilitating/restoring habitats and populations of affected species; and (4) the final step is offsetting residual impacts on biodiversity, i.e. those that cannot be avoided, minimized and/or remediated, ensuring no net loss or a net gain in biodiversity, whether by funding conservation initiatives or implementing additional, voluntary projects (WBCSD/CSI, 2014; ICMBio/MMA, 2018).

In the Carajás BMP, the "Risk Assessment and Mitigation Hierarchy" pillar relates to the steps involved in building knowledge on biodiversity, prioritizing biodiversity features and assessing risks, and identifying actions to address and/or mitigate those risks, applying the MH framework principles to the preservation of local biodiversity.

6.1.3. Strategic planning

This pillar is implemented in accordance with PNR-000029, a standard developed based on Guidelines on Biodiversity Management Plans prepared by The Biodiversity Consultancy (TBC) for Vale, and adapted from the World Bank's Performance Standard 6 (IFC, 2012).

The proposed plan for this pillar is shown in the diagram below (Chart 1).

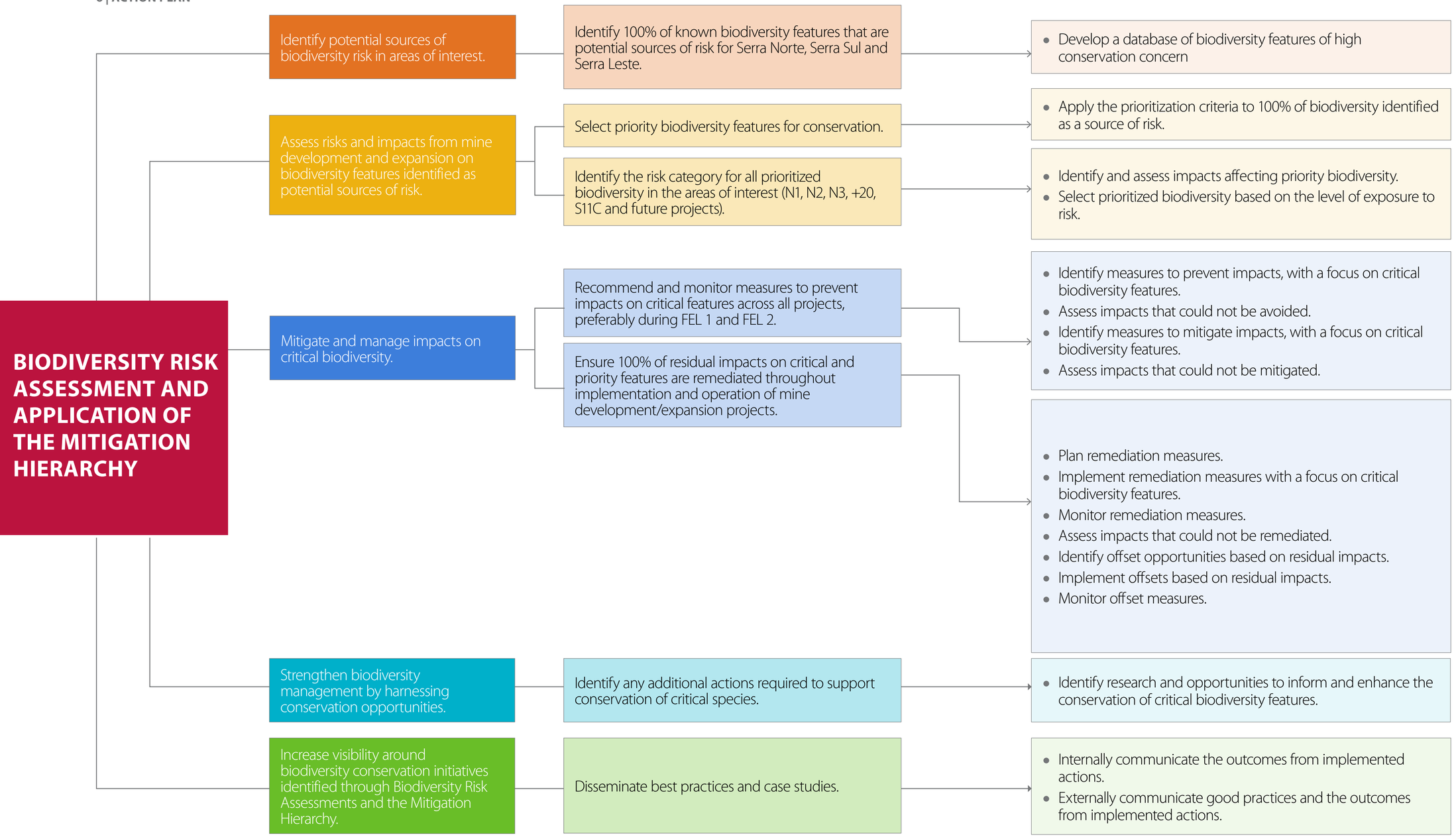

Chart 1 – Biodiversity Risk Assessment and Application of the Mitigation Hierarchy.

6.2. Conservation strategies for threatened species in southeastern Pará

6.2.1. Foreword

Brazil ranks at the top among the 17 megadiverse countries on Earth, hosting between 15% and 20% of the world's biological diversity (UN, 2019). Approximately 120,000 fauna species are known to occur in Brazil according to the Taxonomic Catalog of Brazilian Fauna (2020), and 50,000 flora species according to Brazilian Flora 2020 (under development). Brazil is home to major biogeographical regions of international importance in terms of biodiversity and ecosystem services, of which the Amazon is a notable example, covering 40% of the country's land area (ZAPPI et al., 2019). This creates huge potential for economic growth and social inclusion, but also an enormous responsibility.

Protected areas coexisting with and often enabling mining operations in the Carajás area have been implemented since the inception of mining activity in the area, as part of a strategy to protect biodiversity as well as the iron ore and other mineral resources in the area from an advancing development frontier. Reconciling mining with conservation, while perhaps seemingly incompatible, has been successfully achieved through the establishment of large protected areas that far exceed the areas directly affected by mining, as well as clearly articulated rules on environmental licensing and PA management (MARTINS et al., 2018).

This strategy has allowed the preservation of a significant portion of the forestland in the area under decrees creating protected areas and allocating effort and funding to the protection of local biodiversity (MARTINS et al., 2018). But while the approach taken to mining and conservation in Carajás has benefited biodiversity within these protected areas, they have become increasingly islanded by a surrounding landscape that continues to experience pressures from migration and extensive cattle ranching. For the sake of comparison, while these protected areas harbor a large expanse of virtually continuous forestland, the 39 municipalities in this portion of the state of Pará have lost more than 53% of their forests, and the residual native vegetation is now highly fragmented (SOUZA-FILHO et al., 2016).

Landscape diversity and species richness, including a wealth of endemic and threatened species, make the Carajás area among the most biologically diverse in the Amazon. Within the forest are islands of savanna growing on ironstone outcrops known locally as "cangas". In Brazil, these ecosystems also occur in the Iron Quadrangle in Minas Gerais, an on lateritic banks in Corumbá, Mato Grosso do Sul.

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6.2.2. Rationale

The Carajás ironstone outcrops are set within one of the largest mineral provinces in the world, hence the need to reconcile mining activities with conservation of regional biodiversity. Around 96.3 km^2 of Carajás cangas are contained within the Carajás National Forest, a sustainable-use protected area where

mining activities are permitted, and another 23.9 km^2 are located in the Campos Ferruginosos National Park, a fully protected area. The remainder of the ecosystem (approximately 75 km^2) is found outside protected areas on untitled lands and in legal reserves on private properties (SOUZA-FILHO et al., 2019).

The vegetation formations occurring on these ironstone outcrops harbor a specialized flora that has adapted itself to this unique environment, as well as endemic species (VIANA et al. 2006). Currently 38 species are considered endemic to the cangas of southeastern Pará, and seven taxa are found only in the Carajás National Forest. Of these, a single species is found in both the Serra Norte and the Serra Sul areas: *Peperomia pseudoserratirhachis* D.Monteiro. Three species are found only in the Serra Norte area: *Ipomoea cavalcantei* D.F.Austin, *Paspalum carajasensis* S.Denham and *Daphnopsis filipedunculata* Nevling & Barringer. Three species are exclusive to Serra Sul: *Carajasia cangae* R.M.Salas, E.L.Cabral & Dessein, *Parapiqueria cavalcantei* R.M.King & H.Rob. and *Isoetes cangae* J.B.S. Pereira, Salino & Stützel (MOTA et al., 2018; GIULIETTI et al. 2019, FONSECA-DA-SILVA et al. 2020).

Among the species endemic to southeastern Pará, *Axonopus carajasensis* M.Bastos, *Erythroxylum nelson-rosae* Plowman, *Hypolytrum paraense* M.Alves & W.W.Thomas, *Ipomoea cavalcantei* D.F.Austin, *Jacaranda carajasensis* A.H. Gentry, *Mimosa skinneri* var. *carajarum* Barneby, *Monogereion carajensis* G.M.Barroso & R.M.King and *Perama carajensis* J.H.Kirkbr are on threatened species lists (COEMA, 2007; MMA, 2014). While *Jacaranda carajasensis* is exclusive to forest ecosystems and *Hypolytrum paraense* occurs at the transition from forest to canga, the remaining species occur exclusively in canga ecosystems. In addition to the above, another 58 fauna species in the region are listed in national and international threatened species lists (COEMA, 2007; MMA, 2014; IUCN, 2020), although none of these are exclusive to canga. The Carajás National Forest is also recognized by the Brazilian Ministry of the Environment as a Brazilian Alliance for Zero Extinction site for cave fauna of the following target species: *Drymusa spelunca* (Bonaldo, Rheims & Brescovit, 2006), *Harmonicon cerberus* Pedroso & Baptista, 2014 and *Copelatus cessaima* Caetano, Benà & Vanin, 2013.

This pillar aims to integrate *in-situ* and *ex-situ* conservation strategies to prevent loss of genetic biodiversity and reverse the extinction threat to species in areas surrounding Vale's mine sites in Carajás.

6.2.3. Strategic planning

This pillar is being implemented in accordance with PNR-000029 – ***Biodiversity Management Guidelines and Processes***, a standard aligned with Vale's Sustainability Policy and a long-term strategic goal to achieve No Net Loss on biodiversity and leave a positive biodiversity legacy in the areas where the Company operates. The proposed execution plan for this pillar is shown in diagram form below (Chart 2).

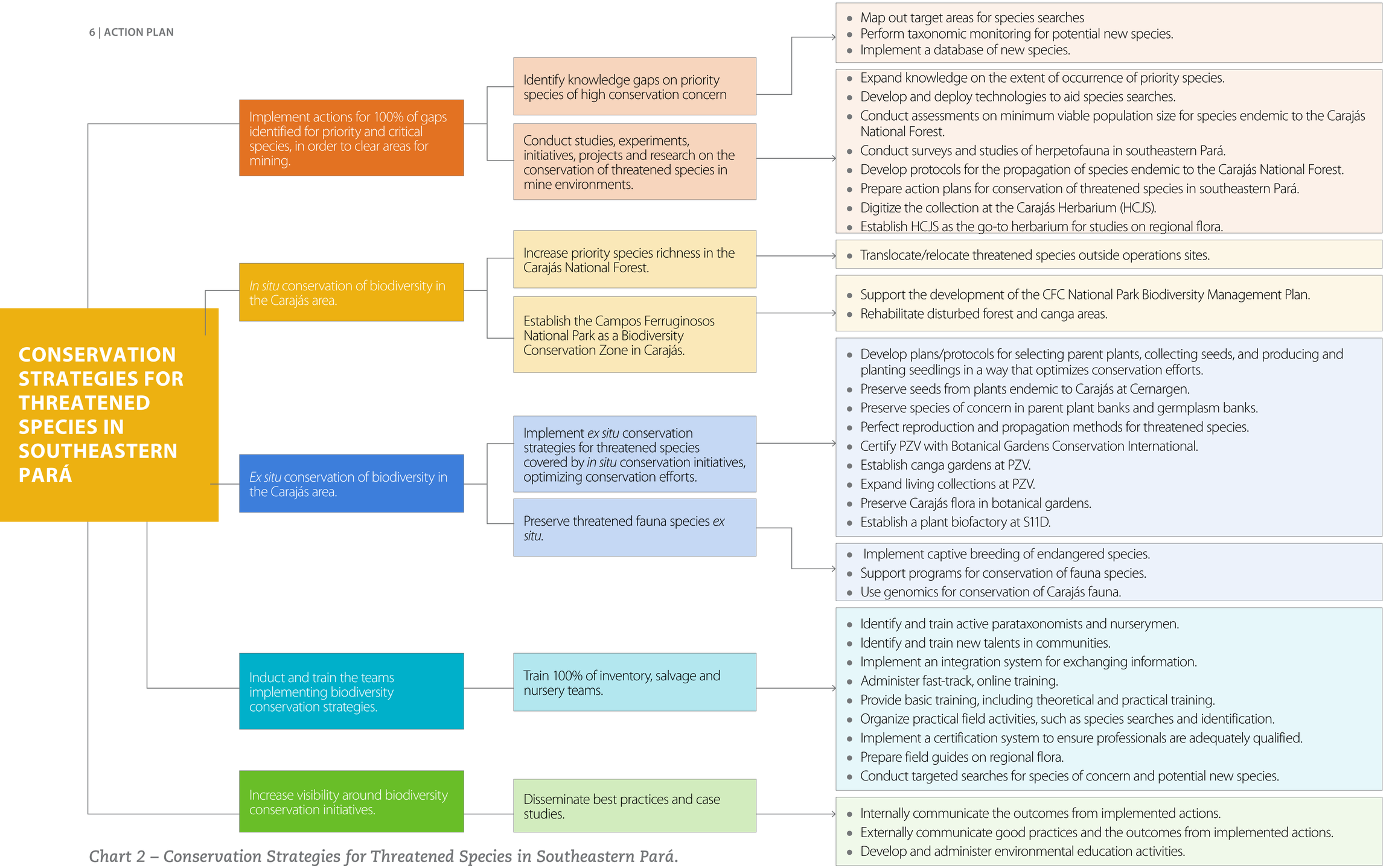


Chart 2 – Conservation Strategies for Threatened Species in Southeastern Pará.

6.3. MLR in the context of biodiversity conservation

6.3.1. Foreword

The purpose in rehabilitating disturbed land (land whose chemical, physical or biological integrity has been disturbed) is to restore the structure and function of these areas to a non-disturbed condition, irrespective of the baseline condition or future intended land use (RODRIGUES and GANDOLFI, 2001). In mining operations, Brazil's Constitution establishes that "those who exploit mineral resources are required to rehabilitate the disturbed environment using such methods as should be required by the appropriate government authorities and by law" (chapter VI, article 225, paragraph 2).

In order to remediate environmental impacts from mining operations, a Mineland Rehabilitation Plan is developed as an integral part of the Environmental Impact Assessment and submitted to the appropriate authorities in accordance with applicable legislation (Law no. 6 938/1981/ Federal Decree no. 97 632/1989). Under applicable Brazilian legislation, a disturbed site must be restored to an environmentally stable condition suited for a particular land-use, under a pre-established land-use plan.

A Mineland Rehabilitation Plan aims to stabilize the soil and create conditions supporting natural recolonization. When the basic goal is to restore some functions at the disturbed site, such as protection from erosion, flora composition is not a primary concern (MORAES et al., 2013). But when the purpose of rehabilitation—in addition to basic requirements—is to reestablish natural processes and restore vegetation as near as possible to its pre-impact condition, then measures need to be taken to promote ecological succession and enhance biodiversity and interaction with fauna. This is a fast-growing field of research in Brazil, in areas such as enhancing planting techniques for native species, revegetation strategies for ecological succession, and plant-animal interaction (Gastauer et al. 2018).

In mining operations in Carajás, despite knowledge gaps and the challenges faced in restoring canga vegetation, mineland rehabilitation methods have been consistently perfected and repopulation with native species has increased. Incorporating conservation-relevant species in MLR activities based on risks identified in the BMP is a step in the mitigation hierarchy that ensures populations of these species are restored and maintained in their original, natural condition.

The "MLR in the Context of Biodiversity Conservation" pillar aims to enhance mineland rehabilitation processes by incorporating conservation-relevant species in mineland rehabilitation activities and improving the effectiveness of mineland rehabilitation through applied research and collaboration with partner institutions.

6.3.2. Rationale

Mining is a vital activity in Brazil that contributes significantly to both state and national GDPs, as well as accelerating economic development. However, it also generates a complex set of adverse impacts that primarily affect the soil, fauna and flora (BORGA; CAMPOS, 2017).

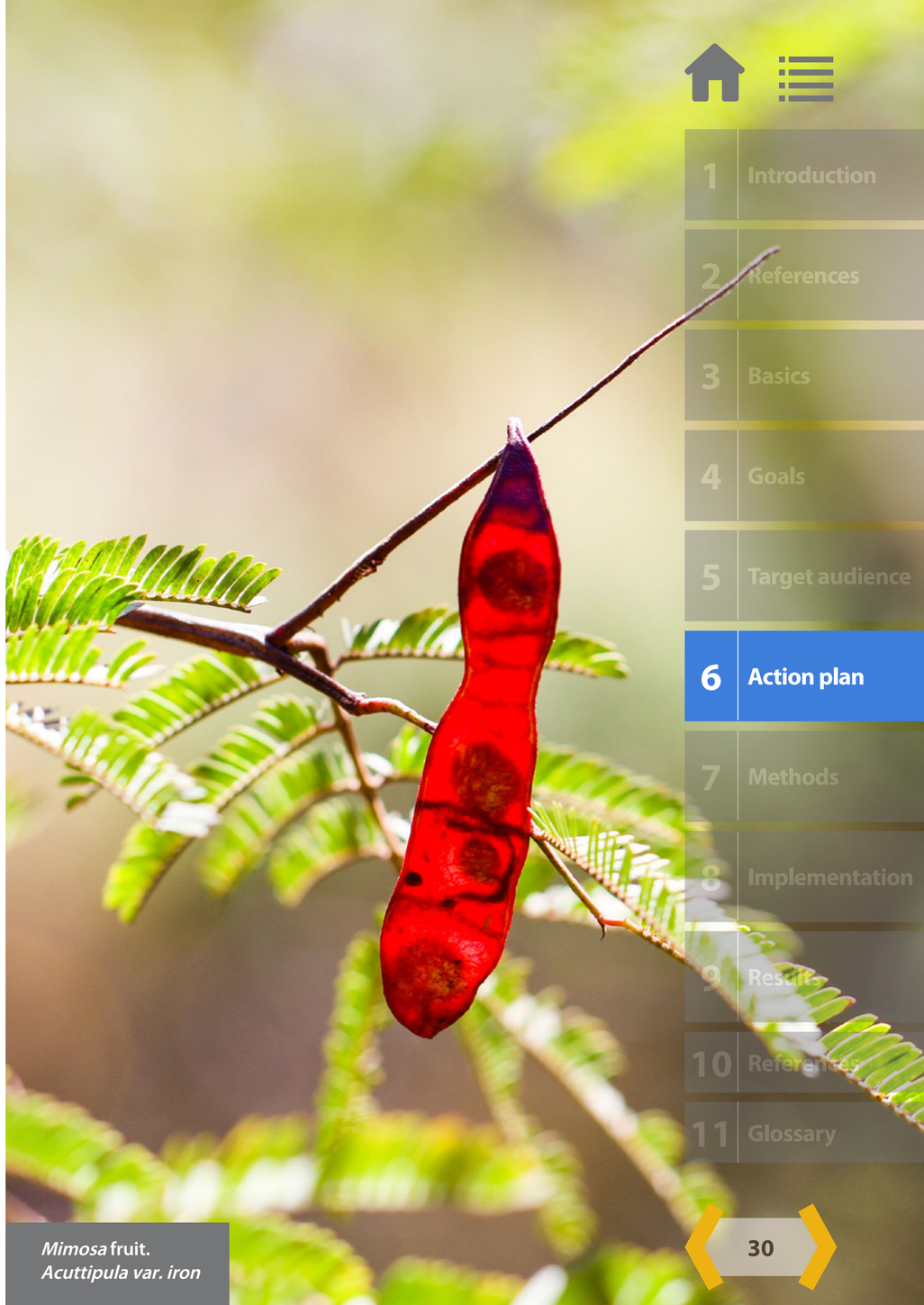
In Carajás, abundant mineral resources are found within areas of high conservation value. Mountain ranges hosting ferrous formations are the primary targets of Brazil's minerals industry. The unique geology of these mountains has given rise to a highly specialized and endemic flora, with many rare species listed in different threat categories (LIMA et al., 2016; SANTOS, 2010).

Land rehabilitation activities in these areas aim to remediate environmental impacts caused primarily by clearing and stripping for mine development. Incorporating priority species in MLR, including endemic, rare and threatened species, helps to establish new populations of, preserve and reduce the risk of extinction of these species (SANTOS, 2010).

This pillar involves implementing a rehabilitation model in Vale's operations to restore habitats and populations of priority flora species identified via the MH. The core focus is on preserving species of high biodiversity concern, including endemic, rare and threatened species—by using the latest technologies to salvage species, produce seedlings, build collections and translocate plants to rehabilitation sites, with the ultimate goal of maintaining biodiversity and ecosystem services.

6.3.3. Strategic planning

This pillar consists of embedding and integrating the biodiversity conservation activities described in 6.1 and 6.2 with activities already being carried out under Vale's mineland rehabilitation plan in Carajás. The strategic plan to achieve this objective is outlined below (Chart 6).



Mimosa fruit.
Acuttipula var. iron

MLR IN THE CONTEXT OF BIODIVERSITY CONSERVATION

- Preserve endemic and/or threatened fauna in the region in an integrated manner with the Mineland Rehabilitation Plan.
  - Expand the use of threatened species in mineland rehabilitation.
    - Prepare an updated list of species identified via pillars 6.1 and 6.2 and legally protected species, aligned with the teams involved.
    - Increase the number of Carajás flora species of concern in salvaging, relocation, seedling production and planting at MLR sites. (Related to pillars 61. and 6.2.)
    - Use the West waste pile area to repopulate legally protected canga species together with endemic canga species recommended for MLR.
    - Implement genetic monitoring of collected species, seeds and seedlings.
  - Develop a seed collection and seedling production network for the Carajás area (especially for species of conservation concern)
    - Expand the local seed collector and seedling producer network and provide capacity building for these activities.
    - Optimize the seed collection process rather than expanding the collector network (as the number of collectors is finite)
    - Encourage purchasing of native seeds for MLR and species of conservation concern (legally protected, endemic, restricted-range and/or threatened).
  - Increase production of seedlings, planting and relocation of endemic, restricted-range and/or threatened Carajás species.
    - Plan seedling production taking account of seasonality.
    - Establish parent plant areas for seed production.
    - Produce seedlings from seeds.
    - Plant seedlings of target species.
    - Relocate salvaged species.
- Improve MLR processes in Vale's operations to more effectively preserve habitats and ecosystem services.
  - Incorporate research findings into MLR activities to reduce required human effort, minimize water consumption, improve soil stability and plant composition, and otherwise optimize the process.
    - Improve methods for planting and establishing native, endemic, restricted-range and legally protected species at MLR sites.
    - Implement a mechanized MLR pilot.
    - Implement soil improvement experiments.
    - Implement a biocementation and iron ore agglomeration project.
    - Monitor rehabilitation sites.
  - Work to make MLR sites attractive to pollinators and dispersers.
    - Conduct research with species that are attractive to pollinators and dispersers.
    - Implement strategies to attract dispersers.
    - Salvage native beehives.
    - Bee biofactory at PZV.
- Increase visibility around conservation initiatives related to mineland rehabilitation.
  - Disseminate best practices and case studies.
    - Internally communicate the outcomes from implemented actions.
    - Externally communicate good practices and the outcomes from implemented actions.
    - Develop and administer environmental education activities.

Diagram 3 – MLR in the Context of Biodiversity.

6.4. Integrated offsets

6.4.1. Foreword

The history of PAs in Carajás is directly related to the discovery in 1967 and subsequent mining of large iron ore reserves in the area. In 1986, Vale was granted mining rights on Federal Government land (411,948.87 ha) in the mineral province of Carajás. These rights were conditional on certain obligations relating to the conservation of scenic and water resources, support for indigenous populations, forest surveillance, and mining methods.

The first PAs were created in 1989 (the Tapirapé Aquiri National Forest, the Tapirapé Biological Reserve and the Igarapé Gelado Protected Area). Following Vale's privatization, another two PAs (the Carajás National Forest and the Itacaiunas National Forest) were created in 1998 as a condition for the granting of mining rights to enable continued mine development. In 2017, the Campos Ferruginosos National Park was created as an environmental offset for the S11D mine project. These PAs are currently managed by Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio), a Federal Government agency created in 2007 under the Ministry of the Environment.

Conservation efforts in the Carajás National Forest began concurrently with the design and planning of the S11D mine project, following the creation of this Sustainable-Use Protected Area under Decree-Law no. 2 486/1998, which granted permission for Vale to establish mining operations in the area and an obligation for it to support the local environmental agency in surveillance and maintenance of this and other PAs in the area.

These plans also cover surrounding areas that are under significant pressures from migration and extensive cattle ranching.

Initiatives to integrate conservation efforts across the Carajás area as a whole have been undertaken jointly with environmental authorities in recent years as offsets. One example is the Carajás Long-Term Conservation Plan (PC-Carajás), developed in partnership with ICMBio and formalized under Reciprocity Agreement no. 14/2013. The Plan outlines measures to support development, identifies priority areas, and promotes biodiversity conservation in the Carajás area through integrated social and environmental management. The "Integrated Offsets" pillar aims to integrate offsets with territorial development in the region, and expand forest connectivity in areas surrounding the PAs.

6.4.2. Rationale

Vale has undertaken several commitments to further conservation efforts over the following decades, some of which have already delivered promising results, such as the Scenarios Project. The outputs from the Scenarios Project and an assessment prepared as part of the Carajás Long-Term Conservation Plan have provided inputs into the participatory development of a strategic conservation plan for Carajás, which will orchestrate initiatives within, and especially in the surroundings of, the PAs. In connection with the conservation plan for Carajás, Vale has signed a commitment with ICMBio (Terms of Commitment no. 02/2015) to promote the protection and sustainable use of the PAs, through a set of environmental protection, environmental education and sustainable production initiatives.

Also in connection with the plan, Terms of Cooperation (SEI ICMBio no. 02122.001002/2019-83) have been signed between ICMBio and Vale to establish mutual cooperation in advancing planned actions, in what has been dubbed the "Horizons Project". This project is the first step in implementing the Carajás Strategic Conservation Plan (PCE Carajás). Its core pillar of action is the diversification of sustainable land use in the Itacaiúnas river basin to expand sources of livelihood in the region through economic activities such as agroforestry systems and non-timber forest products.

One of the areas of action within the Horizons Project is the creation of ecological corridors to connect the PA mosaic to other forest landscapes—especially in the northeast, the Rio Negro PA, the Lindoeste area and the southeast of the mosaic—while advancing the social and economic development of the region through the implementation of agroforestry systems. Implementing these initiatives will benefit biodiversity conservation and can also support the achievement of important corporate goals, such as Vale Fund's target to rehabilitate 500,000 hectares of forests by 2030. The strategies that have been implemented to achieve this target include developing local actors and promoting more sustainable production methods, such as agroforestry systems.

Fragmentation and habitat loss from human activity cause a range of disturbances, including isolation of populations and loss of genetic variability in local flora and fauna. Efforts have been undertaken in Canaã dos Carajás to establish forest connectivity across the mosaic and surrounding areas through ecological corridors. Approximately 3,900 hectares of disturbed lands are being rehabilitated to reestablish connectivity between forest habitat fragments in the region. The corridors allow the free movement of wildlife and the natural dispersal of regional native plant species. In the period 2012-2013, Vale purchased all land surrounding the S11D mine and plant facilities. By 2020, forest cover had visibly expanded into former pastureland, although there is still room to further enhance restoration efforts to reestablish ecosystem services.

In this context, the Integrated Offsets pillar aims to integrate environmental offsets for the Carajás iron ore operations with other projects and collaborations in order to contribute to the conservation of biodiversity, the maintaining of ecosystem services, and sustainable regional development, with the ultimate goal of leaving a positive legacy in the Carajás area.

6.4.3. Strategic Planning

This pillar aims to integrate offset initiatives as part of Vale's Protected Area rehabilitation efforts in Carajás, the S11D and Salobo connectivity programs, the Horizons Project, and the Carajás National Forest Strategic Conservation Plan. The strategic plan to achieve this objective is outlined below (Diagram 4).

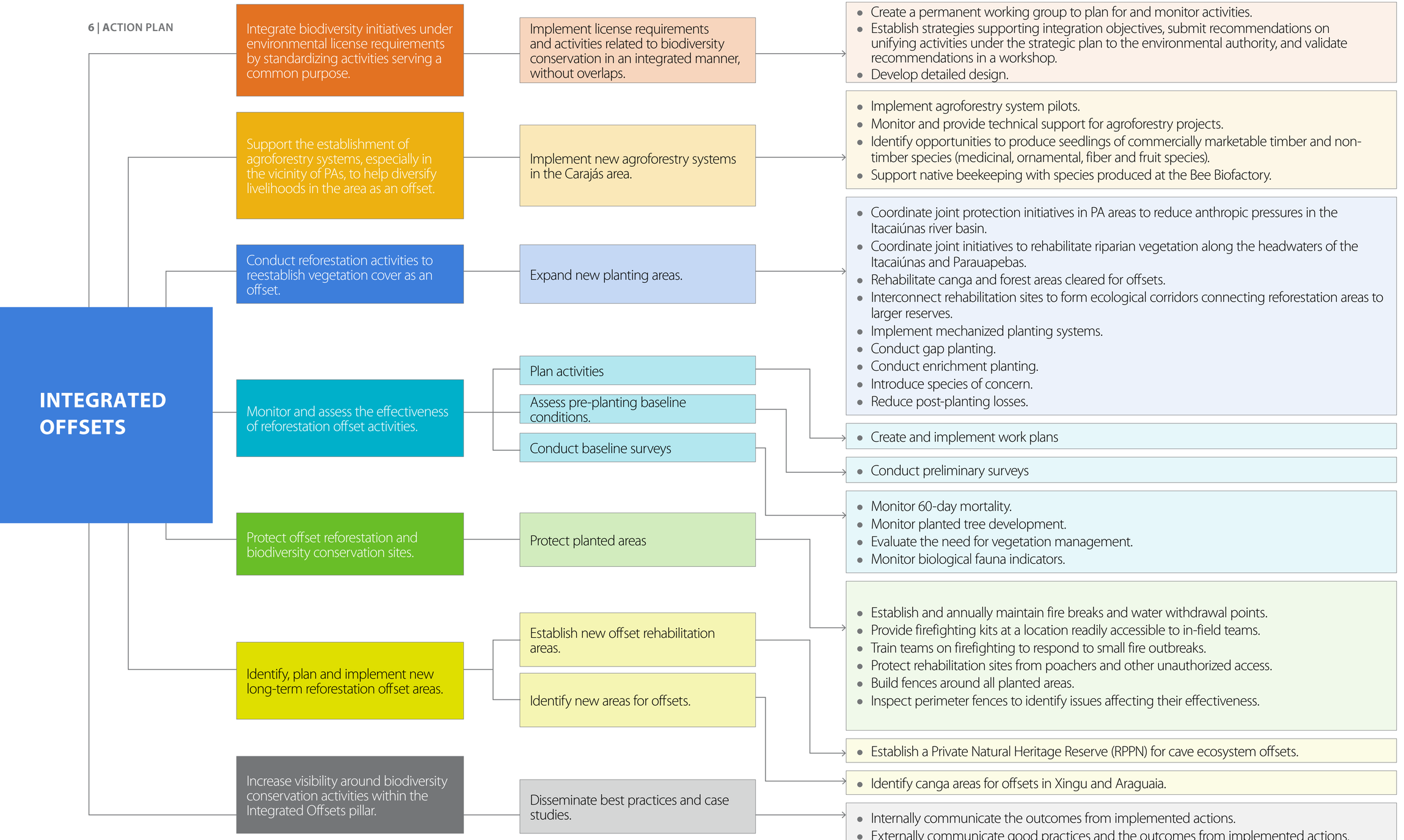


Diagram 4 – Integrated Offsets.

7 Management Methodology

Carajás seedling nursery

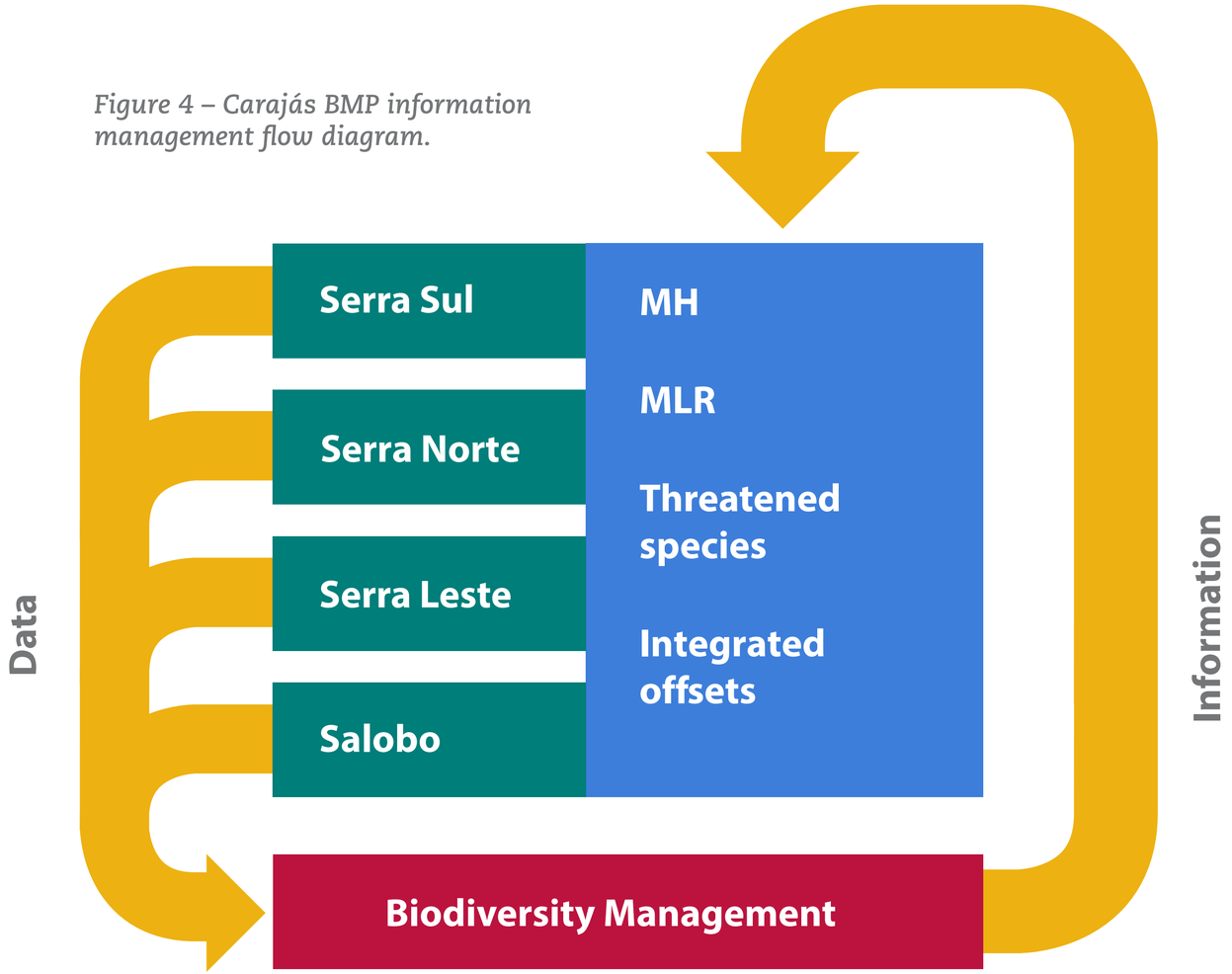
Working groups will be created for each pillar of the BMP to monitor adherence to plans and share good practices. These working groups will monitor a monthly schedule of actions and track key performance indicators (KPIs). Periodic meetings will be held to build alignment across functions and discuss results and training agendas.

The working groups will be appointed by the relevant functions and will necessarily include the key people involved in implementing activities, and optionally other team members looking to participate.

Risk assessment and mitigation hierarchy	Conservation strategies for threatened species in southeastern Pará	MLR in the context of biodiversity conservation	Integrated offsets
Operational Environment	Operational Environment	Operational Environment	Operational Environment
Biodiv. rehabilitation	Biodiv. rehabilitation	Communications	ICMBio
Communications	Communications	Engineering	IBAMA
Land development	Land development	Land development	Communications
Engineering	Environmental studies	Environmental studies	Land development
Environmental studies	Speleology	ITV	Vale Fund
Speleology, Ferrous Technologies	ITV	Mineland Rehabilitation & Mine Closure	ITV
ITV	Environmental Licensing		Environmental Licensing
Environmental Licensing	Mineland Rehabilitation & Mine Closure		
Mineland Rehabilitation & Mine Closure	ICMBio		

The teams from each function are responsible for implementing activities related to their function, ensuring adherence to the working plan, and reporting the biodiversity management team. This team acts as a moderator, compiling monthly data and processing it into meaningful information about progress achieved by each team. The biodiversity management team also provides feedback to the working groups and technical support to the different functions, including the development of team training protocols (Figures 3 and 4). Managers are responsible for monitoring teams' schedule performance, receiving and reviewing information and, when necessary, providing support to address issues.

Figure 4 – Carajás BMP information management flow diagram.



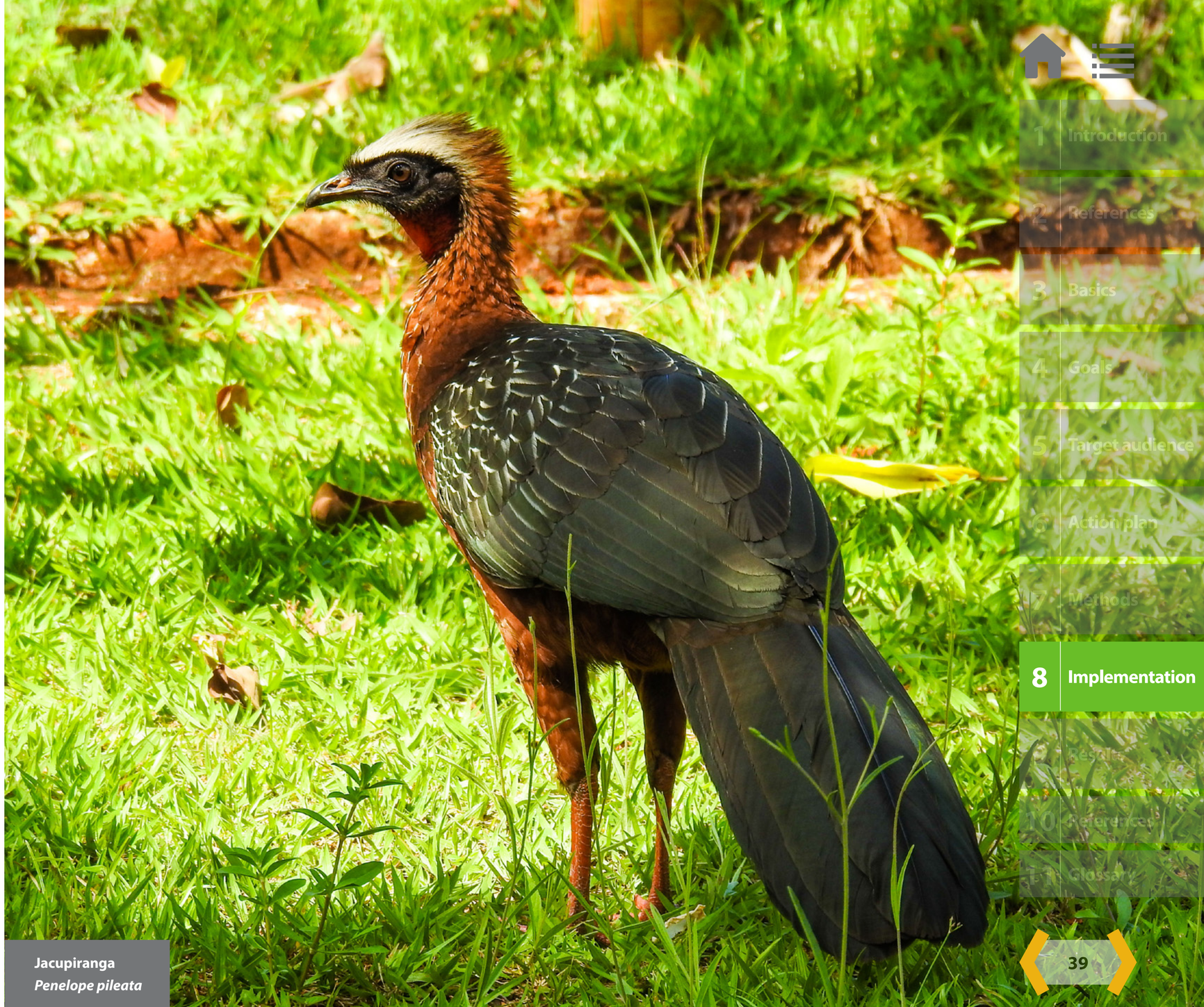
8 Implementation and monitoring

Erythroxylum nelson-rose flowers

To implement the planning recommendations above, working groups of key stakeholders will be established to align on objectives and actions. Different working groups may assign different values to biodiversity, and this exchange of knowledge will help to inform more actionable targets and metrics. This stage will involve bilateral meetings between the BMP development team and the working groups.

Progress toward the targets outlined in the BMP, following alignment among the groups involved and implementation of the relevant initiatives, will be regularly monitored against established indicators with technical support from collaborating teams in the event of any issues. Monitored items will include the impacts of measures on the environment and on threats to biodiversity features.

As described in PNR-000029 and its appendix, monitoring results should be compared against baseline data collected prior to implementing the project/expansion or before implementing actions within the BMP (for existing operations). It is equally important that the BMP is reviewed and adjusted to reflect changing conditions in the project area. It is recommendable that the frequency of these reviews be determined by stakeholders (annually or at most every 2 years).



Jacupiranga
Penelope pileata

9 Publishing and reporting on results

Jacaranda
Carajasensis

Monitoring results will be periodically reported in technical reports and scientific papers. These publications will inform assessments of benefits from implemented initiatives and any required planning adjustments.

Casal de mutum-de-penacho
Crax fasciolata

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11 Glossary

Axonopus carajasensis

Conservation targets: features of high conservation concern occurring in the study area and which represent the biodiversity on which conservation efforts will be focused (similar terms: conservation-relevant, biodiversity of high conservation concern).

Taxonomic aspects: aspects related to the classification of lifeforms into categories that allow a given organism to be identified down to the species, genus, or family level.

Critical features: biodiversity components, such as habitats or species, that have a restricted distribution and experience or will experience impacts from operations and/or projects that could affect their global/regional viability and survival (related terms: critical biodiversity, critical components, critical species).

Biodiversity features: components of biodiversity such as fauna, flora, specific habitats and ecosystems services (synonyms: biodiversity components, features).

Important features: biodiversity features (fauna, flora and habitats) of significant conservation concern (e.g. threatened, endemic and/or restricted-range species, areas of high conservation concern).

Priority features: the biodiversity features within a given area (such as species or habitats) that are deemed most important within the context of a project and are given priority in efforts to manage risks and impacts (related terms: priority biodiversity).

Biodiversity: the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (as defined in the Convention on Biological Diversity (CDB)). Synonymous of biological diversity.

Sensitive biodiversity: biodiversity features (fauna and flora species, specific habitats and ecosystems services) that have limited resistance and resilience to a given threat (related terms: sensitive features, sensitive species).

Biofactory: a laboratory producing biological agents at large scale under controlled nutrition, lighting and temperature conditions.

Phenology calendar: a calendar showing the phenological phases of plants, i.e. budburst, flowering, fruiting, leaf-fall, etc. From an operational perspective, knowing the flowering and fruiting periods, in particular, is important in planning seed collection, seedling production and planting activities.

Offsets: taking measures to offset residual impacts, i.e. significant impacts which, even after appropriate measures were taken, could not be avoided or mitigated.

***Ex situ* conservation:** maintaining genetic resources of high biodiversity value and high scientific, economic or social importance outside the natural habitat, including for research purposes, especially for research on genetic improvement (e.g. seed preservation, tissue cultures, in-field conservation, germplasm banks). As defined by the Brazilian Ministry of the Environment.

In situ **conservation**: the conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings (as defined in the Convention on Biological Diversity (CDB)).

Threatened species: species at a high risk of disappearing from nature in the near future, based on the best available scientific data and documentation (related terms: threatened biodiversity). As defined by the Brazilian Ministry of the Environment.

Species of high conservation value: species that are targeted for conservation and have been prioritized based on the level of project-related risks, including legally protected, threatened, endemic and restricted-range species.

Endemic species: species occurring only in a given country, area or geographic region (e.g. endemic to the Amazon, endemic to Brazil, endemic to southeastern Pará, endemic canga species).

Legally protected species: species that are listed by national and state environmental authorities as being officially threatened (Critically Endangered, Endangered or Vulnerable).

Restricted-range species: species whose extent of occurrence is less than 5000 km^2. As defined by Giulietti et al. (2019) based on IUCN assessment criteria.

Native flora: the flora species naturally occurring in a given country or region.

Degree of risk: the classification of a risk based on the likelihood of occurrence and the severity of potential consequences (related terms: level of risk, operations risk).

Habitat: a location/environment providing favorable physical and geographic conditions for the development of a given species.

No net loss: a desired condition in which impacts from a project on biodiversity are neutralized through measures to avoid, minimize, rehabilitate/remediate and/or offset those impacts.

Residual impacts: impacts that could not be avoided or mitigated, i.e. impacts that remain even after mitigation measures have been implemented.

Parent plants: individuals of a given species used as donors of reproductive material for producing seedlings.

Mitigation: working to reduce, neutralize and remediate impacts from operations on the environment.

Parataxonomist: a person who is able to recognize and identify tree species in the forest based on their traditional experience and expertise. Synonyms: parabotanist/botanical identifier.

Propagules: plant structures (branches, rhizomes, tubers, stolons, bulbs, leaves, etc.) that can give rise to a new plant in an asexual manner.

Rehabilitation: reestablishing the stability, safety and self-sustainability of disturbed land, harmonizing it with the natural environment and supporting future land uses.

Species richness: the number of species in a given community or area of interest, as a measure of biodiversity.

Biodiversity risks: actions/activities as part of a project which could affect environmental services and the viability or function of species or the environments in which they occur (e.g. local extinction, reduced genetic variability, loss of critical habitats).

Environmental services and goods: benefits that people derive from natural environments (e.g. drinking water, climate regulation, sources of food, energy sources, recreation).

Stakeholders: people, groups or institutions involved or having an interest in the relevant processes/activities.

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