

Indigenous involvement in Regional Cumulative Effects Assessment and Management

FINAL REPORT – PROJECT 4.7, STAGE 2

3 February 2026



Project partners



First Nations partner



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LEAD AUTHOR POSITIONALITY

Understanding and declaring positionality is the responsibility of professionals, practitioners, and researchers seeking to ensure effective and ethical cross-cultural collaboration, especially when collaborators – Indigenous and non-Indigenous – aim to promote self-determination by Indigenous communities.

Associate Professor Raquel Tardin-Coelho is a non-Indigenous researcher whose work focuses on integrating Indigenous and local communities' perspectives with scientific knowledge in the fields of Landscape Planning, Cultural Landscapes, Cross-cultural Collaborative Design, and Urban and Regional Planning. In this context, her work specifically addresses Regional Cumulative Effects Assessment and Management. The limited involvement of Indigenous peoples in shaping spaces for dialogue within these fields, alongside the under-recognition of Indigenous Knowledge as expressed through Indigenous voices, remains a significant gap. Addressing this gap is critical to advancing effective, sustainable practices in landscape and regional planning worldwide.

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ACRONYMS USED IN THIS REPORT

Aboriginal Cultural Heritage Assessments (ACHAs)
Aboriginal Cultural Heritage Committee (ACHC)
Aboriginal Cultural Impacts (ACI)
Acceptable Change Index (ACI)
Australian Institute of Aboriginal and Torres Strait Islander Studies (AIATSIS)
Community-based Monitoring (CBM)
Community-based Cumulative Effects Management Working Group (CEMWG)
Co-operative Research Centre for Transformations in Mining Economies (CRC TiME)
Cultural Heritage Management (CHM)
Culturally Significant Species (CSSs)
Cumulative Effects Assessment (CEA)
Cumulative Effects Assessment and Management (CEAM)
Cumulative Effects Management (CEM)
Cumulative Environmental Management Association (CEMA)
Cumulative Impact Assessment (CIA)
Department of Biodiversity, Conservation and Attractions (DBCA)
Department of Planning, Lands and Heritage (DPLH)
Department of Water and Environmental Regulation (DWER)
Ecosystem-based Management (EBM)
Environmental Assessment (EA)
Environmental Impact Assessment (EIA)
Environmental Impact Statement (EIS)
Environmental Protection Authority (EPA)
Free, Prior and Informed Consent (FPIC)
Impact Assessment (IA)
Impact Benefit Agreements (IBAs)
Indigenous Community-based Monitoring (ICBM)
Indigenous Cultural and Intellectual Property (ICIP)
Indigenous Impact Assessment (IIA)
Indigenous Land and Sea Management Programs (ILSMPs)
Indigenous Land Management (ILM)
Indigenous-led Impact Assessment (ILIA)

Indigenous-led Participatory and Cumulative Impact Assessment (IPCIA)

Indigenous Knowledge (IK)

Indigenous Regional Cumulative Effects Assessment and Management (I-RCEAM)

Inuit Qaujimajatuqangit (IQ)

Marine Plan Partnership for the North Pacific Coast (MaPP)

Metlakatla Cumulative Effects Management Program (Metlakatla CEM)

Nunavut Impact Review Board (NIRB)

Prescribed Body Corporate (PBC)

Puutu Kunti Kurrama and Pinikura (PKKP)

PKKP Aboriginal Corporation (PKKPAC)

Regional Cumulative Effects Assessment and Management (RCEAM)

Risk and Vulnerability (RAV)

The United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP)

Traditional Ecological Knowledge (TEK)

Traditional Owner (TO)

Valued Component (VC)

Yamatji Marlpa Aboriginal Corporation (YMAC)

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Executive summary

This study explores existing research and international best practices on Indigenous Involvement in Regional Cumulative Effects Assessment and Management (RCEAM), with a focus on its relevance to mine closure and sustainable regional planning in Australia. It undertook a comprehensive study examining Cumulative Effects Assessment and Management (CEAM) at a regional level and integrating Indigenous Knowledge (IK) in a structured manner, especially within the context of mine closure, which has yet to be undertaken.

A qualitative literature review was undertaken with the aim of outlining the necessary steps to address this gap, with a particular focus on the Australian context. It investigates key principles, criteria, and parameters that support an Indigenous RCEAM (I-RCEAM), thereby laying the conceptual groundwork for developing an I-RCEAM framework driven by Indigenous values set by the communities involved in the RCEAM process. The framework aims to guide mine closure planning and support decision-making during the transition from mining that incorporates Indigenous Knowledge (IK), values and expectations. Additionally, the study seeks to identify significant barriers and opportunities for enhancing I-RCEAM across Australia. This understanding of an I-RCEAM was achieved through the development of yarns with representatives of the Puutu Kunti Kurrama and Pinikura (PKKP) peoples, and through interviews with individuals from industry, government, non-governmental organisations, and research agencies. Whilst attempts were made to engage multiple Indigenous communities across different States by sharing the research proposal and exploring potential collaboration, most were unable to participate due to prior commitments. At the time, only the Puutu Kunti Kurrama and Pinikura (PKKP) peoples were able to contribute to the project.

RCEAM is the process of identifying, assessing and managing the combined effects of multiple developments at a regional scale over time. Despite global progress in recognising Indigenous authority in CEAM, notably in Canada and Norway, Australia continues to lack formal structures/frameworks that support RCEAM and, more specifically, Indigenous involvement in RCEAM. Indigenous involvement in CEAM is often limited to engagement mechanisms rather than key stakeholders/rightsholders in leadership, shared decision-making or co-governance. This report argues that a shift towards an I-RCEAM framework can enable inclusive, ecologically, socially, culturally and economically responsible outcomes for Indigenous communities and all parties involved, especially in the context of long-term regional planning towards sustainability. The findings highlight that Indigenous involvement in RCEAM is not merely about consultation but also involves the incorporation of IK and the creation of a 'shared space' where Indigenous and non-Indigenous assessments interact equally, rather than Indigenous assessments being integrated hierarchically or assimilated into Western scientific frameworks.

Background on Indigenous involvement in CEAM

Internationally, Indigenous-led CEAM frameworks demonstrate the effectiveness of culturally relevant and participatory assessment and management models in delivering more meaningful outcomes. Examples such as Canada's Guide to Effective Indigenous Involvement, Norway's Indigenous-led Participatory and Cumulative Impact Assessment (IPCIA), and the Metlakatla Cumulative Effects Management Program (Canada) highlight approaches that elevate Indigenous self-determination, prioritise spiritual and cultural values, and produce assessments rooted in holistic perspectives. By contrast, Australian regulatory systems, including the Environmental Protection and Biodiversity Conservation Act (EPBC Act, 2020) and Western Australia's mine closure guidelines, acknowledge Indigenous input primarily through engagement tools such as surveys, monitoring, and cultural heritage assessments. However, these mechanisms do not enable leadership or cumulative impact considerations. Whilst legislation nominally protects environmental and cultural values, it lacks cumulative definitions and fails to embed Indigenous views and aspirations. Structural reform is required to elevate Indigenous involvement to a central role in Australian RCEAM, particularly in regional and long-term planning contexts, such as those related to mine closures and other resource extraction activities.

Principles for Indigenous involvement in RCEAM

Indigenous leadership in RCEAM must involve Indigenous communities from the initiation stage through to implementation and beyond. Successful international Indigenous leadership models of Impact Assessment (IA) in Canada involve co-leadership (e.g., co-developed model) and independent assessments. The co-leadership model has been shown to be effective and depends on legislative support, dedicated funding, internal governance capacity, and trust-based partnerships. Voluntary corporate engagement has shown limited effect, highlighting the need for legal mandates. Guiding agreements, such as the Aashukan Declaration (2017), assert foundational principles: rights, relationships, processes, and outcomes. These anchor Indigenous involvement in data sovereignty, Free, Prior and Informed Consent (FPIC), and community-defined wellbeing. Indigenous assessments utilise local thresholds and cultural indicators, which contrast with the standard metrics of Western science. They emphasise relational worldviews, socio-ecological interdependence, and place-based perspectives. To avoid knowledge assimilation, effective RCEAM incorporates IK through approaches such as 'Two-Eyed Seeing' and co-produces knowledge with communities. Adaptive management, which is iterative, values-driven, and responsive to change, complements the dynamic nature of both IK systems and ecological realities.

Criteria and parameters for an I-RCEAM framework

The proposed I-RCEAM framework follows the four phases suggested by Gunn and Noble (2012), preceded by an introduced Initiation Phase: 1. Scoping Phase - scoping practices for Cumulative Effects Assessment (CEA), 2. Retrospective Assessment Phase - retrospective analysis of cumulative effects, 3. Prospective Assessment Phase - prospective analysis of cumulative effects, and 4. Decision-making and Implementation Phase - cumulative effects management measures. The I-RCEAM framework is presented as a conceptual circular model, guided by the above principles and shaped by Indigenous values. As a result, the development of each phase of the I-RCEAM process is proposed based on the following overarching criteria: 1. the conservation or restoration of the integrity of socio-cultural-ecological systems, 2. the systemic consideration of landscape scales (local and regional), 3. knowledge integration, and 4. contribution to sustainability. Although the I-RCEAM Framework is conceptually structured in a circular sequence, anchored in principles of Indigenous involvement and encompassed by Indigenous values, the phases and scales of analysis are intentionally dynamic rather than fixed. The Framework is designed to explore values, relationships, and processes, along with their associated attributes (such as spatial and functional dimensions), to guide outcomes aligned with the community's views and aspirations. As such, the phases are flexible, may overlap or be integrated, and do not require a strict linear progression.

The Initiation Phase involves setting shared principles and expectations, grounding projects in regional Indigenous values. Unlike conventional models that prioritise technical valued components (VCs), the I-RCEAM defines VCs from social, ecological, economic and cultural perspectives that are intertwined. The Scoping Phase shifts the assessment from narrow regulatory definitions to systems-based thinking. Indigenous perspectives define temporal and spatial boundaries, for example, based on kinship geographies and stewardship responsibilities. Indicators, triggers, and thresholds are developed from Indigenous views and aspirations, promoting proactive governance. Scientific thresholds do not measure significance, but Indigenous values. Yet, resistance to integrating existing data amongst the parties persists as a significant barrier. I-RCEAM recognises that Indigenous worldviews are central to sustainable futures, aligning with Indigenous continuity and place-based identities. The Retrospective Assessment Phase examines historical changes in VCs to contextualise current conditions. It moves beyond accepting present degradation as a baseline by acknowledging disrupted relationships and past cumulative impacts. The Prospective Assessment Phase focuses on predicting future changes using scenario modelling and participatory forecasting. This includes assessing the cumulative effects of multiple projects and setting limits for acceptable change. Decision-making and implementation frameworks must elevate Indigenous governance and cultural

legitimacy. Collaborative, multi-scalar governance supports equitable decision-making and capacity-building through long-term engagement and cross-sector partnerships.

I-RCEAM presents a significant opportunity to transform the regional landscape of mine closure in Australia. For this to occur, the development and implementation of an I-RCEAM framework represent an opportunity to make a step change in regional planning with genuine co-leadership, methodological equity between Indigenous and non-Indigenous methodologies, and long-term adaptive planning. Through this transformation, I-RCEAM can become a vehicle for cultural continuity, community development, ecological integrity, and sustainable development.

Most significant barriers and opportunities for an I-RCEAM in Australia

Indigenous perspectives on mining, according to PKKP, reveal a deep awareness of the cumulative, intergenerational impacts of large-scale industrial activities on Country, culture, and wellbeing. These impacts, compounded by climate change and historical land use, are experienced as layered disruptions to landscapes, including ecosystems and spiritual connections, resulting in the loss of sacred sites, traditional food and water sources, and cultural knowledge. Whilst smaller-scale mining is seen as less harmful, large-scale operations and associated infrastructure are viewed as major drivers of long-term change. The perceived contradiction of the energy transition was also noted as a future threat, raising concerns about continued environmental degradation under the guise of climate action. These insights underscore the importance of a community-led approach to RCEAM, centred on Indigenous values and decision-making, to address past harms, avoid future ones, and promote cultural continuity. Despite clear support for the incorporation of IK in RCEAM from PKKP, and as a result of the interviews, systemic barriers—including inadequate legislative frameworks, limited data sharing, siloed institutions, limited capacity, and inadequate industry engagement—continue to hinder meaningful Indigenous involvement. Current practices often marginalise Indigenous voices by relying heavily on Western legal and scientific systems, failing to reflect the relational and holistic nature of IK. Interview participants emphasised that these issues are deeply interconnected, resulting in reactive and tokenistic involvement of Indigenous groups, rather than meaningful participation and partnerships. The withholding of critical environmental data not only reduces technical accuracy but also erodes trust and limits Indigenous communities' ability to safeguard Country. Current legal and institutional frameworks largely exclude Indigenous perspectives from CEAM.

The transformative potential of IK incorporation in RCEAM hinges on early engagement, transparency, co-leadership, and shared governance. Examples of successful co-leadership, such as the heritage co-management agreement between PKKP and Rio Tinto, demonstrate what is possible when Indigenous authority is genuinely recognised. Whilst structural reforms remain necessary, the path forward is clear: embedding IK into RCEAM for mine closure planning through equitable power-sharing, long-term investment and capacity-building, and respect for cultural governance offers a powerful opportunity to protect Country and enable sustainable, community-driven futures that benefit all involved parties. Despite these challenges, there is a growing consensus amongst PKKP and interviewees that genuine transformation is both necessary and achievable. The evolution of RCEAM toward Indigenous-led, place-based governance models is seen as essential. This includes embedding Indigenous leadership structurally, not situationally, through legislative reform, long-term funding, and formal commitments to Indigenous data sovereignty and co-decision-making. Capacity building for stakeholders and rightsholders, whilst critical, must be paired with enforceable legal mandates that elevate IK to equal standing with Western frameworks. When supported by coordinated, regionally grounded strategies, I-RCEAM has the potential to drive environmental, social and economic sustainability, along with cultural recognition, and a more equitable governance model, benefiting not only Indigenous communities but all Australians. The findings from the literature review, yarns, and interviews are closely aligned. Overall, the implementation of an I-RCEAM grounded in Indigenous values was consistently supported as a promising approach to strengthen Indigenous involvement in RCEAM and promote more sustainable, resilient outcomes.

1 Introduction

Regional Cumulative Effects Assessment and Management (RCEAM) is the term given to the suite of processes and tools that enable the understanding and management of cumulative effects at a regional scale and facilitate the delivery of favourable long-term environmental, social, cultural and economic outcomes. RCEAM informs decision-making, including regional planning for post-mining futures.

1.1 Background and purpose

The Project ‘A Systematic Approach to Regional Cumulative Effects Assessment and Management to Support Transitions in Mining Economies’ is foundational to the Co-operative Research Centre for Transformations in Mining Economies (CRC TiME). The purpose of the Project is to contribute to the development of an agreed systematic approach to the assessment of cumulative social, cultural, economic and environmental impacts on the scale of regional landscapes.

Following completion of an initial literature review to develop an understanding of RCEAM and its context for mine transition (Sinclair et al., 2022), the Project is being undertaken in three stages:

- Stage 1 – Case Study Analysis
- Stage 2 – Developing Capacity
- Stage 3 – Pilot Study.

Stage 1 (Pope and Young, 2024) developed a typology of RCEAM practice from a review of Australian and Canadian case studies. This analysis informed the development of a decision guide to planning and scoping RCEAM in the context of mine closure and other transitions in mining economies.

Stage 2 builds on these preliminary findings to deliver a roadmap and toolkit to support RCEAM in transitions in mining economies. Key components of Stage 2 include:

- Work Package 1: Review of governance structures to support RCEAM (Rifkin et al., 2025)
- Work Package 2: Analysis of the potential for Indigenous involvement in RCEAM in Australia (Tardin-Coelho et al., 2026)
- Work Package 3: Scoping of a pilot RCEAM study (Murphy et al., 2026)
- Work Package 4: Identification and evaluation of analytical tools and methods for RCEAM (Maharjan et al., 2026).

The findings from Stage 2 Work Package 2 provide value for industry and other mining stakeholders in sustainable regional planning by investigating key principles, criteria, and parameters that support an Indigenous RCEAM (I-RCEAM), thereby laying the conceptual groundwork for developing an I-RCEAM framework driven by Indigenous values set by the communities involved in the RCEAM process.

1.2 Context and scope

The objective of this work is to understand avenues for effective Indigenous involvement in RCEAM for mine closure. Analysis occurs by viewing RCEAM through an Indigenous lens, incorporating Indigenous Knowledge (IK) in the process of assessing and managing effects as experienced by Indigenous people affected by them. Indigenous approaches to assessing and managing cumulative effects are becoming more common, mainly in Canada (Kwon et al., 2024; Arnold et al., 2024). However, it is still in its early stages in Australia.

Cumulative Effects Assessment (CEA), or Cumulative Effects Assessment and Management (CEAM), refers to assessing the combined effects of multiple development stresses on a landscape, which includes local communities, rather than evaluating each development individually. It involves proposing management measures to avoid or mitigate these stresses, keeping them within the environment's carrying capacity and within communities' social, economic, and cultural goals. It sets achievable goals, assuring the maintenance and/or restoration of environmental, social, economic and cultural parameters to thresholds that enable achieving sustainability (Blakley, 2021).

Cumulative effects in mining regions occur when the accumulation of effects of operations in multiple mines, for example, repeatedly overlap and/or have a significant functional and spatial extent, synergistically accumulating with the effects of other similar, or even unrelated activities (e.g., mining, forestry, and tourism), over time, both past or present (Franks, et al., 2009; Blakley, 2021). Cumulative effects become problematic when the combined magnitude of impacts is large, when the impacts occur relatively quickly, and when decision-making about responses is fragmented across different organisations (Rifkin, 2021).

RCEAM is referred to here in the context of multiple mine closure projects in a region on (or near) Indigenous lands, encompassing both disturbed and non-disturbed areas. Mine closure is understood as the “cessation of a mining operation” (Measham et al., 2024). However, mine closure is more than a point in time when a mining operation ceases. Closure can, and should, happen progressively and planning for it should occur throughout the life of a mine. Additionally, the term ‘landscape’ is considered the collective manifestation of the interactions between human beings and nature over time, including the intertwined tangible and intangible values, and elements and processes associated with them, where the physical landscape and communities interact (Berque, 2019). The term ‘Indigenous’, in the Australian context, refers to Aboriginal and Torres Strait Islander people in Australia, according to the Australian Institute of Aboriginal and Torres Strait Islander Studies (AIATSIS) Code of Ethics for Aboriginal and Torres Strait Islander Research (AIATSIS, 2020), which is informed by the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) (United Nations, 2007). Indigenous Knowledge is the “understandings, skills and philosophies developed by societies with long histories of interaction with their natural surroundings” (Nakashima et al., 2017, p.8), which vary from place to place and culture to culture.

Mining sites in Australia are located on Indigenous lands (whether formally recognised land, such as Native Title Determination Areas, or not). Mining on these sites can cause severe impacts on Indigenous communities, including socio-ecological-economic impacts (e.g., alterations or destruction of natural habitats, loss of landscape features, loss of access to the land, and social conflicts leading to loss of social cohesion) (Leyton-Flor and Sangha, 2024). The cumulative effects of multiple mine closures are related to the residual and latent effects from past mining (Franks et al., 2009). Hence, this often makes RCEAM about assessing and managing the effects of what was left over. For that, it is fundamental to recognise the regional landscape's past situations, the transformations it has undergone, and the future aspirations that envisage how this landscape should be in the future according to Indigenous perspectives and values (O'Faircheallaigh and MacDonald, 2022; Arnold et al., 2024).

The scale and nature of effects vary according to factors such as “the type of mining activity, the proximity of the mines to each other, the extent of other contributing activities in regions and the characteristics of the surrounding natural, social, cultural and economic environments” (Franks et al., 2009). Consequently, considering that the assessment and management of regional mine closure's cumulative effects will also encompass still undisturbed areas, taking the landscape as a whole is crucial, whilst focusing on maintaining or restoring its desired state according to the communities that live there, who face inevitable destruction.

Indigenous involvement in RCEAM for mine closure can offer an opportunity to incorporate IK into the RCEAM process by adopting the assessment and management of cumulative effects through an Indigenous-led lens and from a methodological perspective, whilst supporting greater degrees of leadership and self-determination. Indigenous self-determination is based on freely determining their political status and pursuing economic, social, and cultural development in accordance with their views and aspirations (United

Nations, 2007). Thus, Indigenous involvement in RCEAM represents the opportunity to consider Indigenous worldviews and values at the centre of the RCEAM processes to ensure that cumulative effects are addressed not only to restore past landscape values but to support a thriving future for the communities in their 'way' (Woodward et al., 2020), whilst establishing a fruitful dialogue with all parties involved.

The interconnectedness of nature-culture dimensions in IK dictates ways of knowing and doing that are founded upon a holistic perception of the landscape at broader scales (Woodward et al., 2020). It encompasses local and regional scales and emphasises shared responsibilities towards nature, culture, and people, favouring a comprehensive approach to assessing and managing regional cumulative effects with a goal of long-term sustainability (Gratani et al., 2016; Atlin and Gibson, 2017). Such an approach can benefit Indigenous communities directly and indirectly involved in mining or mine closure projects. It can also provide ways to establish criteria and parameters that are more strongly oriented towards a sustainability agenda for both Indigenous and non-Indigenous people and the landscapes involved. In other words, Indigenous worldviews have inclusive, relational elements (Woodward et al., 2020) that are often aligned with principles of sustainable development and multi-generational planning, favouring sustainable futures (Blakley, 2021).

1.3 Aim and objectives

This study aims to undertake a qualitative literature review¹ to investigate the key principles, criteria, and parameters that can support an I-RCEAM in an Australian context, thereby laying the conceptual groundwork for developing an I-RCEAM framework driven by Indigenous values set by the communities involved in the RCEAM process. It investigates significant barriers and opportunities for Indigenous Involvement in RCEAM in Australia through yarns with representatives of Puutu Kunti Kurrama and Pinikura (PKKP) peoples and interviews with individuals from industry, government, non-governmental organisations, and research agencies². For that, this study addresses the following research questions:

- What are the principles, criteria and parameters for Indigenous involvement in RCEAM for mine closure?
- What are the most significant barriers and opportunities to implementing it in Australia?

Important studies, mainly in the Canadian context, discuss how to involve Indigenous communities in an ethically and culturally sensitive way whilst incorporating IK to assess cumulative effects, ensuring Indigenous leadership and self-determination. Approaches vary from Indigenous Impact Assessment (IIA) (O'Faircheallaigh and Macdonald, 2022; Thompson-Fawcett, 2021) and Indigenous-led Impact Assessment (ILIA) (Gibson et al., 2018; Nishima-Miller et al., 2024) to forms of Cumulative Impact Assessment (CIA), such as Indigenous-led Participatory and Cumulative Impact Assessment (IPCIA) (Blom, 2023), Cumulative Effects Assessment (CEA) based on an Indigenous-led approach (Arnold et al., 2024), and Indigenous-led Cumulative Effects Assessment and Management (CEAM) (Tulloch et al., 2024; Kwon et al., 2024). Notably, the studies are often focused on impacts/effects, mostly addressing biophysical aspects, at the project level (Nishima-Miller et al., 2024), and fail to address effects at the regional landscape scale (Blakley, 2021). Few studies published in Australia address the topic (Godwin, 2016; O'Faircheallaigh and Macdonald, 2022; Holcombe, 2022; Sinclair et al., 2022; Pope and Young, 2024).

¹ Literature review methods are described in Appendix A.

² Yarn and Interview methods are described in Appendix B.

The study objectives are to identify:

- Background on Indigenous involvement in CEAM
- Principles for Indigenous involvement in RCEAM
- Criteria and parameters for an I-RCEAM framework
- Most significant barriers and opportunities for an I-RCEAM in Australia.

The findings of this study, along with the results from Work Package 1 – Governance models for RCEAM, Work Package 3 – Identification of potential pilot study, and Work Package 4 – Roadmap and toolkit, will support Stage 3 of this project, which is the development of a pilot study for implementing RCEAM.

2 Background on Indigenous involvement in CEAM

This section provides a background on Indigenous involvement in CEAM, introduces Indigenous-led approaches to effects assessment and management, discusses the regulatory requirements for RCEAM and Indigenous involvement in Australia, and provides an overview of Indigenous-led cumulative effects assessment and management frameworks.

2.1 Indigenous involvement approaches to effects assessment and management

Studies on Indigenous involvement in Impact Assessment (IA) are more prevalent than those on Indigenous involvement in CEAM, whether in case examples, principles, or prescriptive frameworks. The studies focus on Indigenous involvement as Indigenous leadership over the process, which can be shaped in different ways with distinct levels of involvement in CEAM, as discussed further below in section 3.1. Mainly, the studies call for Indigenous people to drive a CEAM process that reflects Indigenous values and considers Indigenous groups as active partners in decision-making and implementation processes.

In the Australian context, O'Faircheallaigh and Macdonald (2022) discuss IIA with the objective of enabling Indigenous peoples to determine what is assessed and how. Jolly and Thompson-Fawcett (2021) also discuss IIA, focusing on the New Zealand context and drawing on an Indigenous planning theory for IA. Both studies highlight the importance of IK and values guiding IIA, ensuring that Indigenous landscapes are safeguarded and proactively managed with a future orientation towards Indigenous self-determination.

ILIA is debated by Gibson et al. (2018), considering the Arctic context. The authors emphasise the importance of Indigenous communities having adequate control over the IA process and making well-informed decisions using a culturally appropriate decision-making framework. Nishima-Miller et al. (2024) used an ILIA approach to identify tools to enable the IA process based on an Indigenous-led approach, such as framework agreements, customised review panels, land use and consultation policy, impact and benefit agreements, and land use planning. IPCIA is discussed by Blom (2023), focusing on assessing impacts on traditional ecosystem services in Norway. Additionally, Arnold et al. (2024) explored how to improve the process of assessing cumulative effects based on an Indigenous-led approach that enables Indigenous communities to decide on their own future. Tulloch et al. (2024) and Kwon et al. (2024) also discuss

approaches to Indigenous-led CEAM. Regional approaches to CEAM are rare in the literature (see, for example, Halseth et al., 2016) and even more scarce from an Indigenous perspective.^{3,4}

Indigenous involvement in the current study follows the Gibson et al. (2018, p.45) definition of Indigenous leadership role over an IA process:

“A process that is completed prior to any approvals or consent being provided for a proposed project, which is designed and conducted with meaningful input and an adequate degree of control by Indigenous parties — on their own terms and with their approval. The Indigenous parties are involved in the scoping, data collection, assessment, management planning, and decision-making about a project.”

Gibson et al. (2018) recommend that an Indigenous IA shadows and uses the state process. They suggest a ‘willingness to shadow’ the existing requirements of legislated IA to avoid duplication, whilst incorporating existing information that can enhance the Indigenous IA, thereby reducing the effort and resources required. The authors suggest that parallel and collaborative impact assessments, which combine Indigenous and non-Indigenous Knowledge, have the potential to succeed, offering a hopeful outlook for the future. However, as stated by Blom (2023), scientific knowledge can provide valuable insights when integrated into Traditional Knowledge systems, not the other way around. This process allows for the creation of a ‘third space’, where Indigenous and non-Indigenous assessments equitably coexist (Jolly and Thompson-Fawcett, 2023).

Although Gibson et al. (2018) refer to Indigenous IA related to individual project impact, their perspective provides a valuable guide for the current study in recommending the adoption of an Indigenous-led viewpoint to approach RCEAM. This includes considering the effects of multiple mines and other developments at a regional scale from an Indigenous perspective before any approvals or consent are provided, influencing the establishment of completion criteria required to close the mines, along with the closure outcomes, which, as a set, should inform mine closure plans. This effort would require a regional orchestration involving multiple mine closure operations and, consequently, multiple corporations, communities, and government agencies. In this process, mine closure regulations play a crucial role in defining the steps to comply with and enable it.

Ultimately, those approaches to Indigenous involvement as Indigenous leadership in assessing effects raise the importance of deciding on the future of a shared landscape where the values addressed go beyond productive activities and abstract, quantitative metrics, to involve meaningful relationships between nature, people and the places they value, essentially enabling respectful co-existence of Indigenous ways of life with resource development activities.

³ The literature reviewed in this report encompasses studies that address a range of approaches with a common focus on the assessment and/or management of impacts/effects. These include, for example, Cumulative Effects Assessment (CEA), Cumulative Effects Assessment and Management (CEAM), Regional Cumulative Effects Assessment and Management (RCEAM), Cumulative Effects Management (CEM), Cumulative Impact Assessment (CIA), and Impact Assessment (IA). The corresponding acronyms are used consistently throughout the report in accordance with the terminology adopted in each cited study.

⁴ In Australia, an example of an Indigenous-led Monitoring, Evaluation, and Learning (MEL) framework is that developed by Kowa Collaboration (<https://www.kowacollaboration.com/>), a profit-for-purpose organisation. However, not directly related to CEAM, Kowa’s MEL framework is designed for initiatives supporting First Nations communities (such as a project or strategy). This framework emphasises the importance of First Nations leadership and ownership throughout every stage of MEL planning and implementation. MEL serves as a comprehensive tool to monitor project progress, evaluate its impact, and inform continuous improvement. In Kowa’s approach, the knowledge, perspectives, and cultural practices of local First Nations peoples, leaders, and knowledge custodians are central to guiding all place-based activities. Another initiative of interest is the Canadian Indigenous Centre for Cumulative Effects (<https://www.icce-caec.ca/>).

2.2 RCEAM regulatory requirements and Indigenous involvement in Australia

CEAM, particularly those involving Indigenous communities, are not yet well established in Australia, in contrast to Canada and Norway, where Indigenous involvement in impact assessment, encompassing cumulative effects, is mandatory by law (Canadian Impact Assessment Act, 2019, and Norwegian Planning and Building Act, 2008). The Australian Environment Protection and Biodiversity Conservation Act 2020 (EPBC Act 2020) - the reformed version of the EPBC Act 1999 - addresses the cumulative effects of a proposal on the environment (EPBC Act 2020, p. 8). However, it does not further develop the concept or its application. The Act refers to the protection, restoration, and management of Australia's environment. It encompasses the protection and restoration of biodiversity along with cultural values and significant natural and cultural places, such as heritage sites, water bodies, habitats for fauna and flora, and their associated connections. These impacts are evaluated through an Environmental Impact Assessment. The definition of 'environment', according to the Act, encompasses ecosystems, people and communities, and their wellbeing, including aesthetic, cultural, and economic aspects, as well as natural and physical resources. This scope means that the biophysical and social dimensions of the environment are recognised as intertwined. The extent to which physical and biological factors influence social surroundings must be considered for effective protection and management. Restoration measures are required for landscapes affected by the Act. However, it is worth noting that the EPBC Act is only triggered when an environmental factor (usually a threatened species or habitat) is affected by a project. Most projects are assessed under State legislation, which is similarly unclear on cumulative effects.

The infrastructure required for mining activities is significant, encompassing the placement of linear infrastructure (such as roads, rail, and airports), settlements (including villages and camps), the mine site itself, and renewable energy infrastructure to decarbonise operations. Each infrastructure project requires space for development, including construction sites and implementation. The interference of infrastructure construction and implementation with a landscape's local and regional biophysical and sociocultural aspects causes diverse effects that accumulate (such as vegetation clearing and water diversion). According to the EPBC Act (2020), mine closure plans must address the inherent past and present effects of a mine operation, as well as the complex situation of biophysically and socio-culturally altered Indigenous landscapes.

Each Australian State and Territory has their own regulations for conducting mining operations, including closure (Hamblin et al., 2022). According to the Western Australia State Government, for example, planning for closure should include an overall description of the operation at a regional scale concerning: "seasonal and climatic conditions and projected future climate profile; topographic relief and geomorphology; seismicity; historical and current land use and planning provisions; affected communities and social setting; heritage (including natural, cultural and historic); and any other potentially limiting factors for the mining operation (e.g., contaminated sites or reserve land)" (DMIRS, 2025, pp. 14-15). The closure plan should outline the significant effects of the mining activities, as identified in early agreements with the Traditional Custodians of the land, who are the parties responsible for the land. Relevant aspects of mine closure plans in Western Australia (WA) include Aboriginal heritage sites (such as sacred sites), current land uses (including tenures, Native Title Determination Areas, Parks, and Indigenous Protected Areas), environmental protection (such as threatened species), and social surroundings. Social surroundings consider the effects caused by biophysical alterations on a "person's aesthetic, cultural, economic or other social surroundings" (WA Environmental Protection Authority, 2024). Although the WA regulation mentions cumulative effects, it does not define the concept or delineate methods (DMIRS, 2025).

Indigenous involvement in CEA in Australia, in accordance with regulatory requirements, is often associated with 'engagement', regularly conducted through environmental and heritage surveys, information sharing, rehabilitation or restoration processes, and monitoring, including ranger programs. Those kinds of

‘engagement’ fall far short of the Indigenous involvement in leadership roles in the RCEAM process. Usually, CEA processes in Australia have the following characteristics:

- project-focused on a local scale, not involving a regional scale
- non-systemic
- focus on specific aspects, such as environmental, social or heritage issues, without a broader and integrated approach
- non-cumulative, indicating the assessment at a specific time
- not community-focused, with limited participation by local and Indigenous communities, and
- does not include assessment criteria derived from the views and aspirations of members of Indigenous communities.

This pattern of engagement and project-level focus, rather than a regional focus, highlights a regulatory gap in Indigenous involvement in RCEAM in Australia and underscores the need to address it.

2.3 Overview of frameworks for Indigenous-led CEAM

Four relevant frameworks for Indigenous-led CEAM (Table 1) were selected for analysis and presentation here to highlight key aspects and describe how they can inform principles for Indigenous Involvement in RCEAM for mine closure. Note that these frameworks were selected because they offer an extensive overview of Indigenous involvement in IA, CIA, CEAM, and CEM, and comprehensively represent Indigenous-led approaches to CEAM. Respectively, these are the frameworks discussed in the following sub-sections: Guide to Effective Indigenous Involvement in Federal Impact Assessment (Canada) (First Nations Major Project Coalition, 2020), Indigenous-led Participatory and Cumulative Impact Assessment (IPCIA) (Norway) (Blom, 2023), Framework for the Assessment and Management of Cumulative Effects on the North Pacific Coast (Canada) (Wilson, 2020), and Metlakatla’s Indigenous-led Cumulative Effects Management Program (Canada) (Metlakatla First Nation, 2019).

Table 1 – Indigenous-led assessment frameworks.

Indigenous-led Cumulative Effects Assessment and Management Frameworks				
Framework	Region / Community	Indigenous Involvement	Assessment Key Focus	Management Tools
Metlakatla Indigenous-led CEM Program	Metlakatla (BC, Canada)	Mandatory under the Canadian Impact Assessment Act (2019).	Values-driven CEA of priority values.	Tiered management triggers and mitigation actions.
Guide to Effective Indigenous Involvement in Federal Impact Assessment	Various Indigenous Groups (Canada)	Mandatory under the Canadian Impact Assessment Act (2019).	Step-by-step framework for meaningful Indigenous involvement in IA and CEA process.	Monitoring frameworks, collaborative agreements, and land use plans.
Indigenous-led Participatory and Cumulative Impact Assessment (IPCIA)	Various Indigenous Groups (Norway)	Mandatory under the Norwegian Planning and Building Act (2008).	Co-led assessment emphasising Indigenous methodologies and participatory decision-making.	Monitoring metrics, participatory monitoring and co-management tools.
Framework for the Assessment and Management of Cumulative Effects on the North Pacific Coast	Various Indigenous Groups (BC, Canada)	Mandatory under the Canadian Impact Assessment Act (2019).	Ecosystem-based CEA incorporating Indigenous values.	Thresholds and indicators based on ecosystem integrity and community wellbeing.

2.3.1 Guide to Effective Indigenous Involvement in Federal Impact Assessment

The Guide to Effective Indigenous Involvement in Federal Impact Assessment (First Nations Major Project Coalition, 2020) was designed to provide principles and practices for ensuring effective participation by Indigenous communities in Canada's Federal Impact Assessment process under the Impact Assessment Act (2019). The Impact Assessment Act is based on three mandates: to promote sustainability, to respect the government's commitments to the rights of Indigenous peoples, and to apply the precautionary principle, which involves acting with caution in the face of uncertainties in knowledge and information, as the impact of a new project or activity may be significant.

The Guide emphasises the importance of early, continuous, and respectful partnerships with communities, encouraging the co-development of assessment processes that incorporate Indigenous rights and knowledge, grounded in Indigenous values. Additionally, the Guide highlights the crucial role of capacity building, funding, and resources in supporting Indigenous participation, emphasising community-led data collection and assessments. Assessments are value-centred and integrate IK and scientific data to explore how impacts may affect Indigenous rights and interests, including traditional land use and associated values, such as the intertwined environmental, cultural, social, economic, and spiritual values, in accordance with the Indigenous people's holistic worldview. Regional cumulative effects assessments are encouraged. However, those should not disregard the specificities of each Indigenous community involved. In this regard, before a community decides to take its own CEA within the context of a significant project assessment, the guide recommends considering the need for a Nation-led CEA by analysing the current environmental, social, economic and cultural context, existing substantial adverse effects due to past and present interventions, and the limits the community considers acceptable. If issues arise and the proponent's Impact Statement does not address them, developing a Nation-led CEA is recommended. Notably, the guide stresses the commitment "to ensure that IK is not compartmentalised or treated as little more than a 'check box' to be filled" (p.67).

The Guide's management tools include Indigenous-led studies, terms of reference, monitoring frameworks, and collaborative agreements, such as Impact Benefit Agreements (IBAs), to ensure the achievement of desired outcomes through shared decision-making structures. The document recommends that the assessment process be flexible and based on Indigenous inputs.

2.3.2 Indigenous-led Participatory and Cumulative Impact Assessment (IPCIA)

The IPCIA (Blom, 2023) on indigenous cultural landscapes and traditional ecosystem services is a Sámi-led model (Norway) for broadly assessing impacts on Sámi livelihoods and cultural continuity, whilst integrating land use planning. It is based on IK and values, ensuring genuine participation that involves Elders, youth, and local organisations. It prioritises community control over the assessment process through data collection, management, and decision-making. The IPCIA emphasises the interrelationship of culture, land, and identity when assessing long-term impacts and non-linear changes that are very often overlooked in conventional IA.

The IPCIA defines Sámi indicators based on knowledge systems and culturally relevant metrics, ensuring that cumulative impacts are assessed not only biophysically, but spiritually, culturally and socially. For example, community wellbeing is linked to language and reindeer health, which should be considered when assessing an impact. These indicators guide the CIA process, inform negotiations, and influence project decisions and policy. Key to IPCIA is that Indigenous communities are not only consulted but also co-lead the assessment process according to their self-determination aspirations, using their own methods for assessment, such as Sámi-led mapping, storytelling and community workshops. It is worth highlighting that the assessment process must be continuous and requires ongoing monitoring, as well as community-led data collection.

2.3.3 Framework for Assessment and Management of Cumulative Effects on the North Pacific Coast

The Framework for the Assessment and Management of Cumulative Effects on the North Pacific Coast (Wilson, 2020), developed by the Canadian government and coastal First Nations (Marine Plan Partnership for the North Pacific Coast – MaPP), provides a collaborative, regionally designed approach that ensures shared leadership with Indigenous communities. The framework is grounded in values and principles of stewardship for ongoing monitoring and decision-making to ensure ecosystem integrity and community wellbeing. Community-driven priorities and regional governance are key aspects in environmental planning. The document addresses the cumulative effects of multiple land and marine uses on key ecological and cultural values, such as species habitats and human livelihoods, and highlights the use of Indigenous and Western scientific systems to define and assess impacts, both spatially and temporally.

The Framework utilises co-developed indicators, thresholds, and monitoring protocols that reflect Indigenous values and culture, thereby linking assessment outcomes to regional management actions and decision-making processes. Land and marine use plans are encouraged to be developed, followed by cumulative effects monitoring, supported by scenario modelling. Additionally, it promotes the integration of local and regional efforts, guiding cross-scale and co-governance, whilst emphasising Indigenous leadership.

2.3.4 Metlakatla Cumulative Effects Management Program

The Metlakatla Cumulative Effects Management Program (Metlakatla CEM) (Metlakatla First Nation, 2019) is a resource management system, based on Metlakatla's worldview and values – understood as everything that matters to the community – developed to monitor, proactively manage, and improve crucial interconnected values of the Metlakatla over time in the face of industrial developments.

This program, which was initiated in 2014, integrates Metlakatla's knowledge into a comprehensive, community-driven framework for monitoring and managing cumulative effects. The program's community-based research on values approach is designed to monitor the community's ten priority values, across four pilot values based on environmental, social/health, economic prosperity and cultural identity (such as food, social, ceremonial activity, housing, butter clam, and employment). Trade-offs are an essential component of the program. For instance, a certain level of change in one value may be tolerated if it improves another connected value.

Management triggers encompass marks that indicate levels of concern about the effects on a value and suggest that actions to restore or improve the conditions of such a value must be implemented. Decisions regarding values and value-related subjects are made collectively through a structured decision-making process involving a Metlakatla member-based working group. Being value-focused, implementable, interdisciplinary, and embracing uncertainty are core to the program.

The Metlakatla CEM Program is a pioneering, Indigenous-led model that facilitates informed decision-making in environmental assessments, treaty negotiations, and regional planning. The program has also led to increased employment opportunities within the community and secured funding for long-term stewardship initiatives. However, building internal capacity for data management and addressing concerns about data sharing and confidentiality remain challenges to overcome.

According to Gibson et al. (2018), several specific factors are crucial for enabling the success of an Indigenous-led impact assessment: legislation requirements, the capacities of the Indigenous community, and the willingness of the proponent and government to support the Indigenous initiative. A shared foundation across the examined Indigenous-led frameworks lies in the legislation's mandatory requirements,

suggesting that legislation is essential to address Indigenous involvement in CEAM. An exception is the Metlakatla independent CEM Program, which was developed before the enactment of the existing Canadian Impact Assessment Act (2019). The frameworks' value-driven and participatory approaches, founded in IK, Indigenous rights, and relationships, as well as community-driven indicators, guide meaningful effects assessment and management. Holistic worldviews are emphasised, valuing not only biophysical outcomes, but also spiritual, social, cultural, and economic ones, based on place-based approaches. Co-governance, long-term stewardship, and shared decision-making are key management strategies supported by Indigenous-led research and monitoring programs, as well as agreements such as Impact Benefit Agreements (IBAs). In this context, collaborative management and governance are not only about Indigenous participation. Still, they are structured based on Indigenous priorities, ensuring that Indigenous parties participate actively in a structured and co-led decision-making process. Adaptivity is key in all frameworks, ensuring the approaches remain responsive to contextual changes, evolving priorities, and new information. Feedback loops, scenario analysis, and modelling are methods utilised to keep the frameworks relevant over time. As a set, those frameworks offer insights into meaningful Indigenous involvement in RCEAM to achieve sustainable land use, effective and adequate management of resources significant to Indigenous communities, and ultimately, to the collective landscape from which resource developments benefit.

3 Principles for Indigenous involvement in RCEAM

Understanding the principles of Indigenous involvement in RCEAM for mine closure is a foundational step towards a meaningful I-RCEAM. This section identifies key principles (Table 2) for I-RCEAM for mine closure, namely: co-leadership with Indigenous communities; a focus on Indigenous peoples' rights, relationships, processes, and outcomes; values-driven and place-based approaches; systemic and holistic assessments; and knowledge integration and adaptive processes.

Table 2 – Principles identified for a meaningful I-RCEAM.

Principles for Indigenous Inclusion in RCEAM	
Principles	Main Aspects
Co-leadership with Indigenous Communities	- Co-leadership tends to lead to effectiveness. - Levels of Indigenous involvement vary. - Three co-leadership models are suggested: <i>Co-developed</i>: Partnership with the proponent. <i>Co-managed</i>: Joint process with the government. <i>Independent</i>: Full control by the Indigenous community. - Resources and capacity are essential.
Focus on Indigenous People's Rights, Relationships, Processes and Outcomes	- Indigenous rights as a foundation (e.g., Free, Prior and Informed Consent (FPIC), mutually agreed terms, access and benefit sharing). - Centrality of relationships. - Culturally-aligned processes. - Community-defined outcomes.
Values-driven and Place-based Assessment	- Holistic and community-defined values. - Place-based and context-specific approaches. - Community goals and thresholds. - Interconnected human and environmental values.
Systemic and Holistic Assessments	- Interconnected socio-cultural-ecological systems. - Systems thinking, landscape resilience and community wellbeing as a foundation.

Principles for Indigenous Inclusion in RCEAM	
Principles	Main Aspects
	• Indigenous values as human values for sustainability. • Towards proactive, integrated effects assessment and management approaches.
Knowledge Integration	• Equal integration of knowledge systems and capacity building. • Knowledge system integration requires structural reforms. • Models of knowledge integration (such as 'Two-Eyed Seeing' and 'Two-way science'). • 'Ongoing' process of documenting, assessing and managing the landscape.
Adaptive Management	• Adaptive nature of IK and living frameworks. • Culturally appropriate decision-making that incorporates lived experiences and evolving data. • Adaptive management for long-term monitoring of the landscape.

3.1 Co-leadership with Indigenous communities

Co-Leadership with Indigenous communities in RCEAM processes has been demonstrated to lead to effectiveness. Many studies highlight the importance of co-leadership with Indigenous communities in IA and CEA throughout the process (Ho-Tassone et al., 2023; Jolly and Thompson-Fawcett, 2021, 2023; Larsen, 2018; Larsen et al., 2018; Larsen et al., 2022; Peletz et al., 2020; Adams et al., 2023). Specifically, Larsen et al. (2022) explore how mining activities have been disregarding IK and livelihoods, mainly in the Swedish context, leading to dispossession rather than collaboration, and highlight that Indigenous participation in mine closure plans is minimal. The same has been observed in the Australian context (O'Faircheallaigh, 2017).

When Indigenous involvement in CEA is not mandatory under existing regulations, Larsen et al. (2018) found that companies' voluntary inclusion of Indigenous concerns had little influence on the final report, concluding that only voluntary will is not enough to build meaningful partnerships and assessment processes. Larsen (2018) proposed a scalar framework to include Indigenous participation in IA, aiming to transition from token inclusion to shared decision-making, which is essential for ensuring Indigenous self-determination. The author concludes that the appropriate level of influence should be proportional to the level of impact a project has on Indigenous cultures, highlighting two key variables: the level of Indigenous influence and the phase of the IA process in which it occurs (scoping, evidence generation, significance determination, and follow-up). The levels of influence are described by Larsen (2018) as:

- Notification (no influence)
- Consultation (limited influence)
- Co-management (shared influence)
- Community-owned (total influence).

In this regard, Ho-Tassone et al. (2023) state that to be considered a 'partner', an Indigenous community representative should be involved in all phases of the assessment and management processes of cumulative effects. Gibson et al. (2018, p.47) identify how Indigenous parties increasingly lead/co-lead IA in the Canadian context according to leadership models (Table 3) proposed by the Guide to Effective Indigenous Involvement in Federal Impact Assessment (First Nations Major Project Coalition 2020). The author highlights the three models that can be adopted when a project is being developed in an Indigenous territory (please refer to Boxes 1 and 2):

1. **Co-developed** – "Team up with the proponent to assess the project before filing for a formal environmental assessment certificate or other authorisations".

2. **Co-managed** – “Engage within the existing Crown system (federal or provincial), with more collaboration with the Crown during the project assessment than in the past”.
3. **Independent** – “Go it alone and make your own final, independent decision on whether a project should proceed and under what conditions.”

Table 3 – Models of co-leadership with Indigenous Communities. Source: Guide to Effective Indigenous Involvement in Federal Impact Assessment (First Nations Major Project Coalition, 2020).

Models of IA Co-leadership with Indigenous Communities			
Model	Description	Benefits	Considerations
Co-developed	The proponents and the Indigenous group(s) co-lead the IA based on an agreement.	Greater project influence, better relationships, improved environmental protections, often fully funded.	Requires effective collaboration, relies on trust and/or legally binding documents, and well-designed/agreed-upon procedures are necessary.
Co-managed	Joint assessment by Indigenous group(s) and the Agency under a formal agreement.	Inclusion in the process of development and shared responsibility.	Limited influence on outcomes, with difficulty integrating Indigenous input due to potential weakened enforcement power.
Independent	Entirely controlled by the Indigenous Nation, from design to decision.	Full autonomy, strong rights protection, and long-term empowerment.	Resource-intensive, most viable when the Nation has high leverage, and the project is high-impact.

According to the Guide to Effective Indigenous Involvement in Federal Impact Assessment (First Nations Major Project Coalition, 2020), the co-developed model is characterised by a partnership between the proponent and the Indigenous community(ies) affected by a development through a formal agreement. Proponents benefit from this model by reducing uncertainty, increasing the potential for community acceptance, and building more substantial, long-term relationships. By adopting this model, Indigenous communities may benefit from greater influence over projects, protection of Indigenous values, such as environmental values, and often complete funding from the proponent. However, as it requires effective collaboration, it also relies on mutual trust and/or legally binding documents. This model can enable Indigenous communities and proponents to develop mutually beneficial solutions, reducing impacts and increasing benefits if well implemented. The co-managed model is a joint initiative between the Indigenous community(ies) and the Agency (State) based on a formal agreement. The Guide states that some communities face challenges participating in this model, primarily due to their ability to influence assessment outcomes and ensure that proponents comply with agreement requests. This is due to the limited integration of Indigenous inputs and the enforcement of consent conditions. The Independent model is fully controlled by the Indigenous community(ies) under a consent-based process, which demands significant human or financial resources. It is recommended for high-stakes projects in Indigenous areas. It denotes high Indigenous empowerment and protection of rights. However, it might not always be feasible due to a high demand for limited resources. Although the independent model requires significant resources, all models necessitate resources and capacity from the involved community(ies) to be co-leads/leads and sustain the assessment processes. In this regard, Gibson et al. (2018) emphasise the importance of negotiating financial resources through Impact Benefit Agreements (IBAs) to enable communities to effectively partner in IA, develop their studies and research, and build internal capacity for long-term assessment development and implementation. The authors highlight that enabling factors contributing to success involve (Figure 1):

1. External context – legislation, project size and complexity, and strategic location
2. Community context – connection to place, Indigenous leverage, high internal capacity, high internal unity, funding, and willingness to ‘shadow’
3. Crown/proponent – existing contractual relationship, willing proponent or government, and funding capacity and willingness.

Amongst these factors, legislation that makes Indigenous involvement mandatory, high internal capacity, ongoing funding, and willingness to collaborate are crucial components.

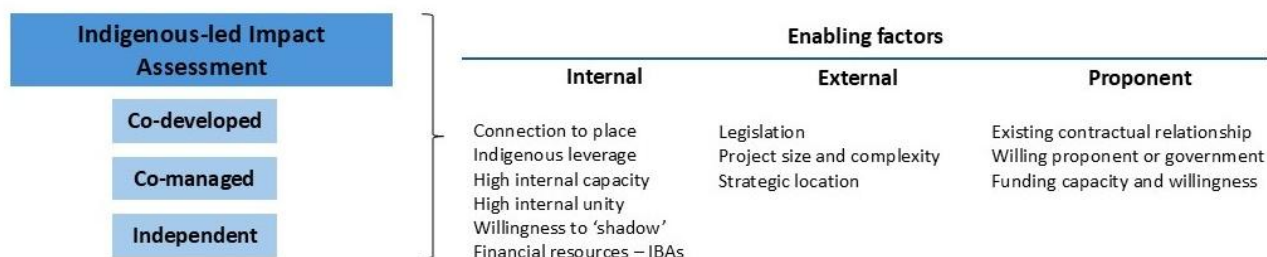


Figure 1 – Indigenous-led Impact Assessment models and enabling factors. Source: Gibson et al. (2018).

For this study, co-leadership with Indigenous communities in RCEAM (Figure 2) requires the involvement of multiple communities and mine closure projects – consequently, multiple proponents – around shared and agreed values, as well as parallel Indigenous-led RCEAM and Conventional RCEAM, and a Collaborative RCEAM carried out in a ‘shared space’, where Indigenous and non-Indigenous knowledge equally interact. This situation requires a coordinated effort amongst proponents and communities willing to participate in a cross-cultural collaboration process, necessitating institutional and community flexibility, methodological equity, innovative technical resources, and co-created governance arrangements that incorporate community resourcing and capacity building.⁵

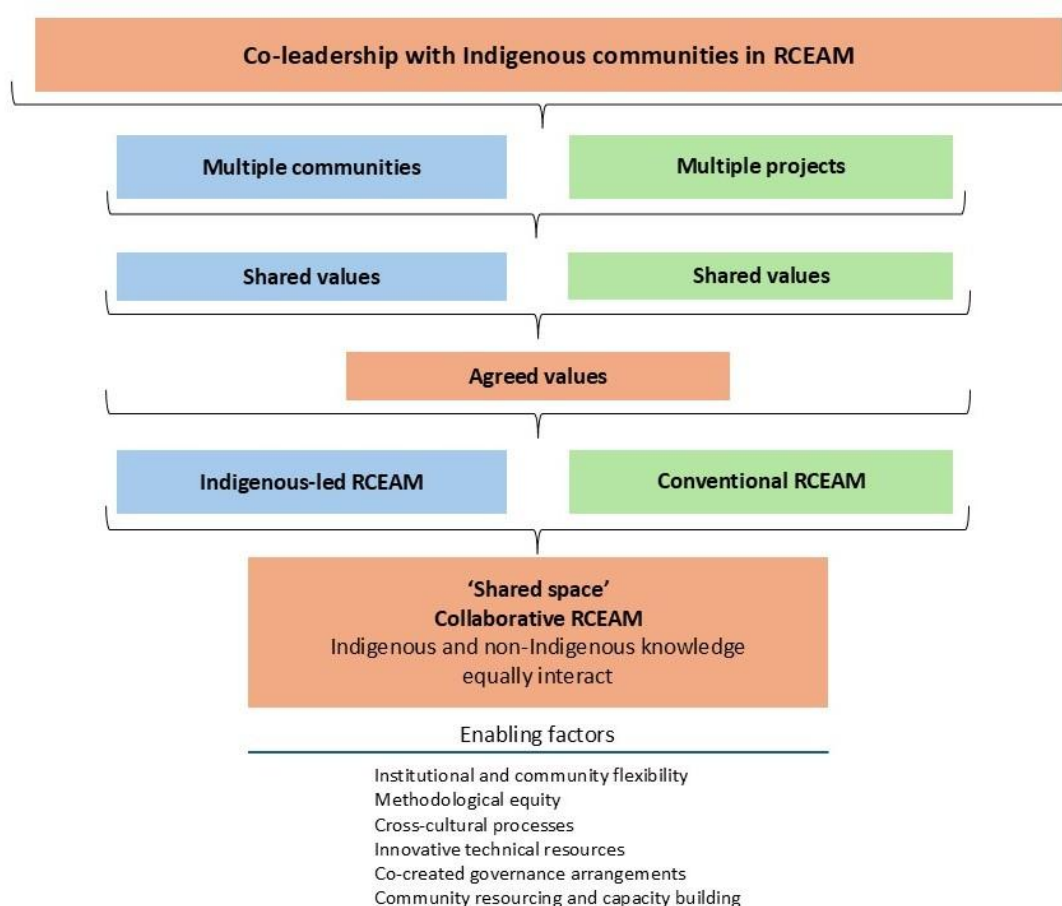


Figure 2 – Co-leadership with Indigenous communities in RCEAM.

⁵ Please, refer to Work Package 1 report – Governance Models for more details (Rifkin et al., 2025).

Examples for considerations and capacity to develop an independent IA can be found in Boxes 1 and 2 below, respectively.

Box 1 – Considerations on Independent IA (First Nations Major Project Coalition, 2020).

The Guide to Effective Indigenous Involvement in Federal Impact Assessment recommends that each Nation consider the actual need to undertake an Indigenous-led cumulative effects assessment before developing it (First Nations Major Project Coalition 2020, pp. 72, 73): *“It is recommended that your Nation leads its own cumulative effects assessment if your Nation is already dealing with substantial adverse effects to the environment and community well-being caused by past and present industrial projects and activities, and especially if these effects already surpass the limits of what your Nation considers to be acceptable change. To determine whether your Nation requires its own cumulative effects assessment, consider the following questions:*

- *CURRENT CONDITIONS OF YOUR NATION’S VALUES (“Values” refers to what matters most to your Nation): Are your environmental, cultural, social and economic Values already at risk or have been impacted beyond acceptable levels?*
- *REASONING FOR CURRENT STATE OF VALUES: What pressures are these Values under (e.g., oil and gas expansion, fragmentation, industrial infrastructure development, loss of traditional lands, etc.)? Are these activities likely to continue to put pressure on your Values?*
- *PROJECT IMPACT: How might the proposed project add to these pressures? How would these changes impact your Nation’s rights and culture? Who would be impacted (i.e., any specific groups within your Nation)?*
- *THE SEVERITY OF THE IMPACT: How long would the impacts last? Are the impacts reversible? What (if at all) do you consider an acceptable change to each of these Values?*

If your Nation reviews these questions and believes the project is likely to have cumulative effects, and the proponent has not committed to fully capturing these issues in the Impact Statement, it may be a good idea to conduct your own cumulative effects assessment.”

Box 2 – Considerations on Capacity to Develop an Independent IA (First Nations Major Project Coalition, 2020).

Reflecting on a Nation’s needs and capacity to undertake the IA is also recommended (First Nations Major Project Coalition 2020, pp. 65, 66):

- *“What is the internal capacity of your Nation, especially the lands departments (strong to weak)? This can mean both your staff’s experience, expertise and time to undertake a study; and alternatively, your staff’s availability to oversee and coordinate studies being undertaken by external consultants hired by the Nation. The level of internal capacity will decide the number and depth of studies your Nation will want to conduct, and how it will conduct them.*
- *How much funding do you have available to undergo the study(ies) (high to non-existent)? To estimate the funding that your Nation would need to undertake its own studies, refer to the “costing estimator” tool that will be available to download from the FNMPC website in 2021.*
- *How much time does your Nation have available? This connects to question 1 and 2, if you are understaffed and limited on time, the type of study and the depth of the analysis might be impacted. If your Nation is engaged properly and your Nation follows the time limits of the project from the outset, then the study timeline can match the assessment timeline.*
- *What is your Nation’s leverage in relation to the project (strong to weak)? This means, how strong is your position (e.g., through legal action) to stop the project by withholding your Nation’s consent, and how open is the proponent to working with your Nation and supporting whatever involvement your Nation identifies as necessary? Is the proponent open and do you have the backing of the Agency? This will help identify the amount of resources and support available to your Nation to carry out the project.*
- *What are the likely impacts (e.g., ecological, rights-based, food security-related, cultural, health)? This will help identify the type of research that will need to take place to identify the type and level of impacts.*
- *How concerned is your Nation about the project (very concerned vs. slightly concerned)? The greater the potential severity of the project on your Nation’s rights, community well-being and the environment, the greater the potential for concern — e.g., Is the project proposed in a cultural and ecologically important area? Are the possible project impacts reversible? How long will the project last?*
- *What is your Nation’s desired priority relationship (e.g., with the Agency, the proponent, or both)? This will help identify how your Nation wants the study undertaken — is it in collaboration with the Agency, the proponent, both, or independently with funding supports from proponent or Agency?”*

3.2 Focus on Indigenous people's rights, relationships, processes and outcomes

According to the Aashukan Declaration⁶ (Table 4) (Watson et al., 2022) – which was developed during the 2017 International Association for Impact Assessment conference in Montreal and signed by several global Indigenous representatives, including Australians – Indigenous peoples' rights must be the foundation and starting point of any discussion concerning development on Indigenous lands. Those rights encompass the right to say 'Yes' or 'No' when facing a project proposal, Free Prior and Informed Consent (FPIC), recognition and respect for territorial rights to Indigenous lands, the right to self-determination, as stated in The United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) (United Nations, 2007), and Indigenous Cultural and Intellectual Property (ICIP) and data sovereignty⁷ to ensure IK remains in the domain of Indigenous peoples.

The Aashukan Declaration states that 'relationships' are the foundation of Indigenous ways of knowing, being, and doing and must guide development. These considerations relate to the long-term and ongoing relationships between mining companies, the government, and communities, as well as the willingness to understand and embed the intricate web of life and its connections, based on a value system prioritising responsibility towards oneself, nature, and community. According to this reasoning, understanding and building relationships are crucial to framing any development.⁸

The Declaration also emphasises how 'processes' related to a project must be grounded in Indigenous worldviews by incorporating IK. Processes refer to the development of a project, from the early phases of engagement through to project planning, design, implementation, operation, closure, and handover. Those worldviews should guide the project life cycle, the evaluation of impacts, and their mitigation.

⁶ Aashukan means 'bridge' in Eastern Cree (Cree Nation of northern Québec, home to development of mineral resources, forests and hydroelectricity). The Aashukan Declaration had two main objectives: 1. to address development to protect Indigenous cultures and lands; and 2. to convey an Indigenous-led message about what is expected from developments on their lands. The Declaration also emphasises IA as a pedagogical process involving mutual learning and multi-way dialogue amongst the parties based on agreed-upon processes and outcomes. To this end, Indigenous communities and proponents are invited to come together to transparently exchange information whilst addressing their visions and aspirations and acknowledging different cultures and constraints (such as cultural beliefs and operational issues). This partnership throughout a resource project's life cycle is key to achieving short and long-term goals. Here, partnerships with Indigenous communities extend beyond engagement or monetary compensation, encompassing an active role for Indigenous peoples in designing and monitoring IA processes through tailored, shared-value systems that incorporate innovation where needed and create outcomes desired by the involved parties.

⁷ The AIATSIS Code of Ethics (2020) and its Guide to Applying the Code (AIATSIS, 2020a) set out clear guidelines for protecting ICIP, emphasising the importance of Indigenous ownership, control, and management of their knowledge systems. The CARE principles (Collective benefit, Authority to control, Responsibility, and Ethics) are essential for safeguarding Indigenous data sovereignty and knowledge (<https://www.gida-global.org/care>). Developed within Indigenous data governance frameworks, CARE aligns with Australian standards, including the AIATSIS Code of Ethics (2020) and the National Health and Medical Research Council (NHMRC) guidelines (2018), which emphasise the need for Indigenous communities to retain ownership over their data and research outcomes. In addition, the FAIR principles (Findable, Accessible, Interoperable, and Reusable) are widely recognised in scientific data management (<https://force11.org/info/the-fair-data-principles/>), but their application in Indigenous contexts requires cultural sensitivity. Whilst the FAIR principles aim to improve data transparency and usability, the AIATSIS Code of Ethics (2020) cautions that, without proper adaptation, these principles can inadvertently violate community rights. Ensuring the ethical use of Indigenous data requires careful consideration of both the scientific goals and the cultural rights and needs of the Indigenous communities involved.

⁸ In this regard, two previous reports from CRC TiME, which set the foundations for partnering with Indigenous Australians, serve as references (Maclean and Woodward, 2021; Miller-Sabbioni et al., 2023).

In the document, ‘outcomes’ are described as multifaceted and oriented towards mutually beneficial partnerships. Outcomes must reflect the vision and aspirations of Indigenous communities and comply with pre-established agreements between communities and developers, ensuring accountability for the projects. Outcomes encompass a commitment to the wellbeing of Indigenous peoples, based on their own parameters and criteria, allowing for capacity building and addressing their interests.

Table 4 – The Aashukan Declaration Principles (Watson et al., 2022) and possible contributions to I-RCEAM.

The Aashukan Declaration Principles		
Components	Principles	Contributions to I-RCEAM
Indigenous Peoples' Rights	Indigenous Rights to Say Yes or No	Ensure that Indigenous communities have their say (yes or no) regarding RCEAM proposals and how they are undertaken.
	Free Prior and Informed Consent (FPIC)	Ensure that FPIC is in place before any RCEAM process starts and is continuously reaffirmed through proper information and negotiation processes.
	Territorial Rights to Indigenous Lands	Respect land ownership and rights, including rights to natural resources.
	The Right to Self-Determination	As stated in UNDRIP (2007), support Indigenous authority over their future and decision-making in RCEAM.
	Indigenous Cultural and Intellectual Property (ICIP) and Data Sovereignty	Ensure IK remains within the control and domain of Indigenous peoples.
Relationships	Community Empowerment	Recognise Indigenous communities as proactive partners in assessing and managing impacts.
	Respect, Humility, and Integrity	Commit to understanding and valuing other cultures to preserve integrity and align with specific worldviews.
	Shared Values and Knowledge	Establish mutual learning and shared aspirations for collaborative progress.
	Reciprocity	Balance different visions, aspirations, and ways of knowing and doing.
	Sustained and Long-Term Partnerships	Commit to maintaining partnerships throughout the project lifecycle and beyond.
Processes	Timelines	Respect Indigenous cultural timelines and governance in planning, decision-making, and implementation.
	Clear Communication	Build trust through early, ongoing, culturally appropriate communication that includes community feedback and input.
	Being Founded on the Worldview of the Indigenous People Impacted	Integrate IK and Indigenous methodologies in assessment and management practices.
	Ongoing Monitoring, Assessment, and Management	Restore and monitor the landscape based on criteria co-developed with Indigenous communities.
	Practising Inclusive and Transparent Decision-Making	Involve communities directly in decision-making processes aligned with their governance and cultural protocols.
Outcomes	Considering the Transition After a Project Ends	Plan and commit to post-project actions and relationships with Indigenous communities.
	The Prevention of Harm	Incorporate precautionary measures valued by Indigenous communities to safeguard the land and knowledge transmission.
	Multi-Faceted Outcomes	Ensure outcomes address interconnected biophysical, social, and cultural dimensions that Indigenous communities value.
	Be Oriented Towards Mutual Benefits	Ensure all parties benefit equitably based on pre-established, partnership-based agreements.

The Aashukan Declaration (Watson et al., 2022) highlights the IA process as a “pedagogical process that involves mutual learning” and long-term relationships. The Declaration provides a robust foundation for RCEAM, significantly strengthening it according to the following:

1. Ensuring that Indigenous communities can reject or accept a project, ensuring that their knowledge remains their property.

2. Addressing RCEAM beyond pure technical assessments and towards processes that consider the interconnections between people, nature, and culture, which are essential for evaluating long-term and systemic cumulative effects.
3. Integrating IK and worldviews across the project lifecycle through culturally appropriate methodologies whilst legitimating assessments and management strategies, including mitigation.
4. Supporting community-defined visions and aspirations to ensure long-term wellbeing and accountability upon agreed and multi-criteria metrics.

3.3 Value-driven and place-based assessments

The literature endorses the transformative nature of value-driven and place-based Indigenous-led IA and CEA processes, as these approaches reframe how effects are evaluated, moving beyond regulatory frameworks to methodologies grounded in IK and the territorial context. Value-driven assessment processes raise the concept of a value system that shapes individuals' and communities' lives and decision-making, underpinning meaningful development effects assessment and setting specific goals with accessible outcomes (Joseph et al., 2017; Gratani et al., 2016; Adams et al., 2023; Davies et al., 2020; Gibson et al. 2018). In value-driven approaches, the condition of values and significance thresholds for acceptable changes, regardless of the prior harm, and as defined by a community, guide decisions and reinforce the necessity of a cumulative context in assessment decisions (Joseph et al., 2017). Arnold et al. (2024), in a study concerning the T̓silhqot'in Nation in IA (British Columbia, Canada), state that these values and goals raise a vital criterion based on how much a project contributes to healthier land and people and supports Nation-defined objectives. It further identifies adverse effects and mitigates harm, considering long-term sustainability from the community's perspective, values, and goals.

Similarly, Gratani et al. (2016) discuss Indigenous values as human values, linking those values to sustainability and the common good, highlighting Indigenous environmental values as human values that care for an intertwined relationship between people and nature, supporting ecological stewardship through spiritual and respectful connections with the environment. The authors argue that the restoration of Indigenous environmental values through the assessment and management of their integrity fosters not only the ecosystem health associated with them, but also cultural bonds and beliefs, aligned with social systems and livelihoods.

The same is true for cultural heritage values, which are cultural conceptions aligned with social constructs, as explored by Sutton et al. (2013). These values are grounded in people's values and associated with places and objects, but not limited to them. It involves considering Indigenous cultural specificities, which are deeply rooted in their territory and environment and are linked to tangible and intangible aspects such as stories, ceremonies, cultural practices, and lived experiences from a place-based perspective (Muir, 2022). A value-driven, place-based assessment informs not only impact identification but also ongoing management, ensuring that cumulative effects management responds to specific local realities and needs (Joseph et al., 2017; Davies et al., 2020). Thus, effects assessment and management models should be contextualised (Nishima-Miller et al., 2024; Peletz, et al., 2020), whilst 'one-size-fits-all' models are fated to fail because they do not account for existing differences (Muir, 2022).

Thus, understanding the contextual political, social, cultural, economic, and environmental history is essential for evaluating cumulative effects, emphasising territorial and cultural significance over regulatory thresholds that often lack contextual relevance and are abstract and transactional (Arnold et al., 2024).⁹

3.4 Systemic and holistic effects assessments

Systemic and holistic effects assessments founded in IK and relational values reinforce the perspective that social-cultural-ecological systems are at the core of a landscape and sustain life (Berque, 2019). In Australia, for example, Indigenous values refer to the intrinsic relationships between kin (people), Country, language, lore, spiritual beliefs, cultural practices, family, and kinship systems that ensure identity, social cohesion, subsistence, responsibilities and stewardship founded in intergenerational knowledge (Martin and Mirraoopa, 2003; Dudgeon et al., 2014; Poelina et al., 2023; Woodward et al. 2020; Gee et al., 2014; Goolmeier et al., 2024). Country is a complex living matrix of intertwined connections amongst people, plants, animals, Dreamings, spiritual entities, earth, water, ether, and cosmological relations (Somerville, 2014; Dudgeon et al., 2014). This socio-cultural-ecological system and its values would set the basis for assessing and managing multiple interventions on Country according to diverse Indigenous communities' perspectives, whether at a local or a regional scale, considering that both are holistically interlinked and collectively shared. Conventional effects assessments often fail to consider the spiritual and ceremonial dimensions of Indigenous culture, thereby compromising their legitimacy, as they are not methodologically inclusive (Muir, 2022). This oversight results in a lack of comprehensive, culturally relevant impacts (Tulloch et al., 2024). In this direction, Sangha et al. (2015) propose an integrated model that frames Indigenous relationships with Country as a reciprocal, holistic system. This model differs from conventional ecosystem services frameworks by emphasising a two-way relationship involving 'duty of care' rather than one-way benefits extraction.

This approach points to the interactions of landscape systems, such as socio-ecological systems, according to the local communities' perspectives and the system dynamics parameters (e.g., landscape ecological resilience) (Gunn and Noble, 2011; Mackay et al., 2024) with a special focus on community wellbeing (Grace and Pope, 2021) that can support Indigenous communities' perspectives on cumulative effects. A systems-thinking perspective argues that action changes the environment, and its effects are not linear. They propagate across interlinked systems as feedback to the actions that vary over time (Grace and Pope, 2021). Those consequences may be unpredictable and/or unintended, as side effects that might also be essential components of the system, responding to the action at different timings, adding uncertainty to future predictions (Grace and Pope, 2021). Considering multiple projects in a region, those effects are interrelated, collective, and systemic (Ehrlich, 2022).

Regarding Indigenous communities, Gratani et al. (2016) explore human interdependence with ecosystems through an eco-centric perspective, in contrast to anthropocentric views, thereby making reductionist assessments based on species-by-species comparisons seem too narrow and inappropriate. The authors emphasise that shared human values aimed at achieving sustainability can bridge cultural gaps and foster co-governance and management structures in pursuit of the common good, which are key to decision-making negotiations.

Community wellbeing and connection to Country are closely related, and a healthy Country influences a healthy community (Gee et al., 2014), highlighting the importance of the integrity of the Indigenous socio-cultural-ecological systems towards meaningful and sustained livelihoods. Cultural systems are an essential

⁹ It is worth mentioning the previous CRC TiME report and paper on how 'values' differ between the regulatory and planning regimes, having different implications for IA and CEA (Foran et al., 2022; 2024).

part of the landscape and intrinsically related to socio-ecological systems, forming a socio-cultural-ecological system (Berque, 2019). In this regard, cultural systems embed the environment and its processes, being multi-sited and referenced at diverse scales, whose values are defined by the people who belong to and live in them, and might change over time (Sutton et al., 2013; Sangha et al., 2015; Peletz et al., 2020; Muir, 2022; Adams et al., 2023), indicating that cultural values and biodiversity, for example, deserve an integrated approach (Heiner et al., 2019; Muir, 2022). These considerations highlight the inadequacy of considering cultural 'sites' in isolation as elements to be included in Environmental Impact Assessment (EIA), as is the case in Australian regulations.

Qualitative indicators are relevant in this reasoning and serve as key parameters for assessing and managing effects. They also influence values, significance, and impact attribution according to community-defined goals (how much a project contributes to existing issues or creates new ones) (Muir, 2022; Arnold et al., 2024), determining the 'effectiveness' of effects assessments (Jolly and Thompson-Fawcett, 2021). In this regard, Godwin (2016) argues that decision-makers and regulators should be culturally educated to appreciate the value of qualitative methods. The author argues that applying a rigorous, quantitative approach, such as the Acceptable Change Index (ACI), to cultural heritage is fundamentally limited due to the inability to define critical elements, including baselines, thresholds, and exceedance criteria. Therefore, qualitative, culturally informed indicators remain the preferred choice. This calls for decision-makers and regulators to avoid the inappropriate adoption of ill-fitting quantitative tools, reinforcing the need for management strategies to align with the cultural and qualitative nature of heritage values rather than be imposed by scientific metrics.

This systemic approach has the potential to combine IK and Western science, proactively driving RCEAM for mine closure and, consequently, regional planning and mine closure planning. It allows for replacing a very common reactive position with CEA and its mitigation by focusing on landscape values and objectives to proactively assess the landscape transformations over time and propose not only mitigation measures but also improvement actions to achieve improved outcomes (Gunn and Noble, 2011; Grace and Pope, 2021; Mackay et al., 2024). However, this systemic and holistic approach also has challenges, which involve inclusive and transparent partnerships, the construction of shared visions across a region, cross-scale and principles-based approaches, conceptual tools from systems analysis, the use of diverse data sources, cross-disciplinary collaboration, and adaptive programs (Davies et al., 2020; Ehrlich, 2022; Mackay et al., 2024). Additionally, a systemic, holistic methodological approach to CEAM that encompasses the socio-cultural-ecological system and aligns with economic considerations is still missing.

3.5 Knowledge integration

CEAM have increasingly integrated Indigenous and non-Indigenous knowledge systems to create evidence to support Indigenous perspectives (please refer to Box 3). This shift enables the incorporation of IK into broader assessment and management processes, contributing to inclusive decision-making and collaborative partnerships. Scholars and Indigenous-led CEAM frameworks, such as those mentioned above, have demonstrated the necessity of a structural shift in the methodological procedures for CEAM. For example, the lack of understanding of Indigenous cultural knowledge in water management in Australia is a significant barrier to effective Indigenous involvement, as integrating Indigenous water knowledge requires shifting commodified views of water to consider it through its cultural and spiritual values, as outlined in Indigenous ontologies (Somerville, 2014).

Incorporating Indigenous perspectives is not merely about consultation but must involve shared authority, rather than Indigenous assessments being integrated hierarchically or assimilated into Western scientific frameworks (O'Faircheallaigh, 2007; Ho-Tassone et al., 2023). This approach would allow for mutual learning and avoid tokenism, where Indigenous communities are involved in data collection but excluded from decision-making (O'Faircheallaigh and Corbett, 2005; Nakamura, 2013; Gondor, 2016; Gustafsson and

Schilling-Vacaflor, 2022; Muir, 2022; Adams et al., 2023; Vine et al., 2023; Urzedo and Robinson, 2023; Nishima-Miller et al., 2024; Tulloch et al., 2024).

Box 3 – Considerations on Indigenous Knowledge Plan (First Nations Major Project Coalition, 2020).

The Guide to Effective Indigenous Involvement in Federal Impact Assessment (First Nations Major Project Coalition 2020) suggests that each nation should develop a project-specific Indigenous Knowledge Plan prior to commencing an assessment to ensure that “IK is not compartmentalized or treated as little more than a ‘check box’ to be filled”. “An IK Plan is a tool to help direct how IK will be collected, treated, and considered during an IA based on the Nation’s governance systems, laws, norms, and approach to IK protection” (First Nations Major Project Coalition 2020, pp. 67). The following questions are proposed for consideration (First Nations Major Project Coalition 2020, pp. 67, 68):

- “What kind of knowledge would your Nation like included in the assessment?”
- When should Knowledge Holders be engaged to ensure that they are able to both frame and help to answer questions related to the effects of a proposed project?
- For what parts of the IA should IK be considered?
- How should your Nation’s IK be protected?
- How will your Nation’s involvement be funded?
- What will your Nation’s knowledge contribute to the IA? How will IK contribute to understandings of baseline conditions and cumulative effects?
- How will IK be collected and how will the studies be conducted?
- When should this knowledge be collected and considered in an IA?
- How should this knowledge be collected, analyzed and used in decision-making?
- What resources are available to your Nation and how best can you use these resources to ensure IK collection and analysis is carried out to the same extent as Western knowledge collection and analysis?
- How will your Nation ensure that its IK is considered by the proponent and the Agency during each step of the IA?”

Ho-Tassone et al. (2023) recommend an approach to CEA based on consent and the full implementation of distinct knowledge systems. In Nunavut (Canada), for example, the Nunavut Impact Review Board (NIRB) refer to a process that treats Inuit Qaujimajatuqangit (IQ) and Western science as complementary and equally valued systems, where one does not supplement the other (Peletz et al., 2020). In Nunavut, there is growing recognition that meaningful integration occurs when distinct knowledge systems are developed from the start of the assessment process, with Knowledge Holders represented in assessment bodies (Peletz et al, 2020). However, the authors also note that limited data access, unequal respect, and consultation fatigue hinder full inclusion. Furthermore, scaling up IK may lead to decontextualisation and homogenisation, suggesting that true collaboration must be locally driven and bottom-up, tailored explicitly to the distinct contexts of Indigenous communities (Austin et al., 2019). Also, at the individual and organisation level, capacity building is essential to integrate different knowledge systems, enhancing the assessment process to be more effective and legitimate (Darling et al., 2022).

The Blom report (IPCIA) (Blom, 2023), the Framework for the Assessment and Management of Cumulative Effects on the North Pacific Coast (Wilson, 2020), and the Metlakatla CEM (Metlakatla First Nation, 2019) are initiatives that integrate Western scientific knowledge into IK, not vice versa, across cultural, environmental, social, and governance pillars to enhance CEAM outcomes. Concepts that align with Indigenous worldviews, like Traditional Ecological Knowledge (TEK), are introduced as part of the assessment frameworks. Other approaches that intend to integrate Indigenous and Western science knowledge are ‘Two-eyed Seeing’ (Bartlett et al., 2012; Jeffery et al., 2021), and ‘Two-way Science’ (Deslandes et al., 2019), successfully applied in Health and Education, for example, which highlight the synergistic potential of different knowledge systems in Canada and Australia, respectively¹⁰.

¹⁰ See also Johnston and Forrest (2020) ‘Working Two Way’ on cross-cultural collaborative relationships through an action research approach in Noongar Country.

Similarly, Indigenous Community-based Monitoring (ICBM) indicates a pathway towards Indigenous-led data collection and environmental stewardship, integrating IK with Western science (Beausoleil et al., 2022). Shields et al. (2024) develop an Indigenous-led research model that promotes equal and shared interaction between Indigenous and non-Indigenous knowledge systems, as well as co-governance in environmental research, aiming to improve economic opportunities.

Knowledge system integration requires structural reforms, capacity building, methodological equity, and respectful partnerships that recognise IK and methodologies in assessment and management frameworks. These partnerships must influence decision-making and transition from consultation to an 'ongoing' co-production of knowledge and co-governance, extending beyond specific project demands at a particular time and embracing multiple project locations and communities to achieve culturally legitimate and scientifically robust outcomes. It would enable the building of long-term partnerships, primarily with communities with whom proponents have established long-term commitments, by relying on understanding and monitoring regional landscape processes, and ensuring communities are prepared for CEAM when necessary.

3.6 Adaptive management

Austin et al. (2019) emphasise the adaptive nature of IK, which is highly context-specific, iterative and dynamic, and evolves through local experience. Indigenous Knowledge incorporation and Western science integration require adaptiveness. This reasoning is consistent with the systemic nature of cumulative effects, their interactions, and uncertainties that emerge over time across a region. Embracing the adaptive nature of IK enables new inputs into the assessment and management processes, grounded in lived experiences, which may bring new solutions to the problems faced, minimising risks and facilitating risk mitigation through culturally appropriate data collection, measures, and shared decision-making.

The Guide to Effective Indigenous Involvement in Federal Impact Assessment (First Nations Major Project Coalition, 2020) reaffirms this approach, stating that cumulative effects should evolve in response to new information and dynamics specific to each community, including its values and protocols. It requires adaptive management for long-term monitoring. In this process, partnerships that recognise and respect Indigenous self-determination are crucial to building trust and achieving effective outcomes from Federal impact assessments in Canada.

The IPCIA (Blom, 2023) also adopts an adaptive approach, considering community feedback, socio-political developments, and seasonal conditions, whilst encouraging long-term relationships, community resilience and governance. Likewise, the Framework for the Assessment and Management of Cumulative Effects on the North Pacific Coast (Wilson, 2020) is a living framework that emphasises adaptive management and learning-by-doing, allowing revisions to indicators, thresholds, and processes in response to changing priorities and outcomes.

Similarly, the Metlakatla CEM (Metlakatla First Nation, 2019) embraces uncertainty as the core of the Program, defining its adaptive nature. The Framework for the Assessment and Management of Cumulative Effects on the North Pacific Coast (Wilson, 2020, p.13) suggests the following steps to conduct adaptive management: "1. Formalising our current knowledge of systems as testable models; 2. Developing forecasts of future conditions that provide management hypotheses; and 3. Monitoring system inputs and outputs over time and using results to improve estimates of conditions and the reliability of forecasts."

4 Criteria and parameters for an I-RCEAM framework

As a methodological approach, this study adopts the framework of Gunn and Noble (2012) for assessing and managing cumulative effects. This framework was adopted in Stage 1 of this research project (Pope and Young, 2024), providing a parallel to the present study. The Gunn and Noble's framework enabled the analysis of the current literature included in this study to propose content for each I-RCEAM phase that is conceptually and methodologically meaningful for Indigenous peoples, encompassing¹¹:

1. Scoping practices for cumulative effects assessment
2. Retrospective analysis of cumulative effects
3. Prospective analysis of cumulative effects
4. Cumulative effects management measures.

The literature analysis followed the four phases proposed by Gunn and Noble (2012), preceded by an 'initiation' phase. The result is the I-RCEAM framework (Figure 3). This is a conceptual value-system framework conceived as a circular model, guided by the principles above and shaped by Indigenous values as reported in the reviewed studies. Ultimately, the I-RCEAM framework proposed offers a suite of IK-based criteria and parameters to scope the I-RCEAM process, guiding mine closure planning for mining transitions and informing decision-making. Note that the set of criteria and parameters presented is not exhaustive. The development of each phase of the RCEAM process is proposed according to the following overarching criteria derived from the principles discussed above:

1. Conservation or restoration of the integrity of socio-cultural-ecological systems
2. Systemic consideration of landscape scales (local and regional)
3. Knowledge integration
4. Contribution to sustainability.

Whilst the I-RCEAM framework is conceived in a circular sequence – centred on the principles for Indigenous involvement and surrounded by Indigenous values – the phases and scales of analysis are not static. The framework aims to understand values, relationships, processes, and all associated attributes, such as functional or spatial dimensions, to achieve desired outcomes. In this context, some dynamics may require revisiting past landscape conditions or anticipating future ones, and 'zooming in' or 'zooming out' across different scales. Therefore, the phases may overlap or be combined as necessary, and do not need to be developed sequentially.

¹¹ Work Package 4 report – Process Roadmap and Toolkit of Methods (Maharjan et al., 2025) presents a complementary perspective on conducting RCEAM concerning the current report.

I-RCEAM FRAMEWORK

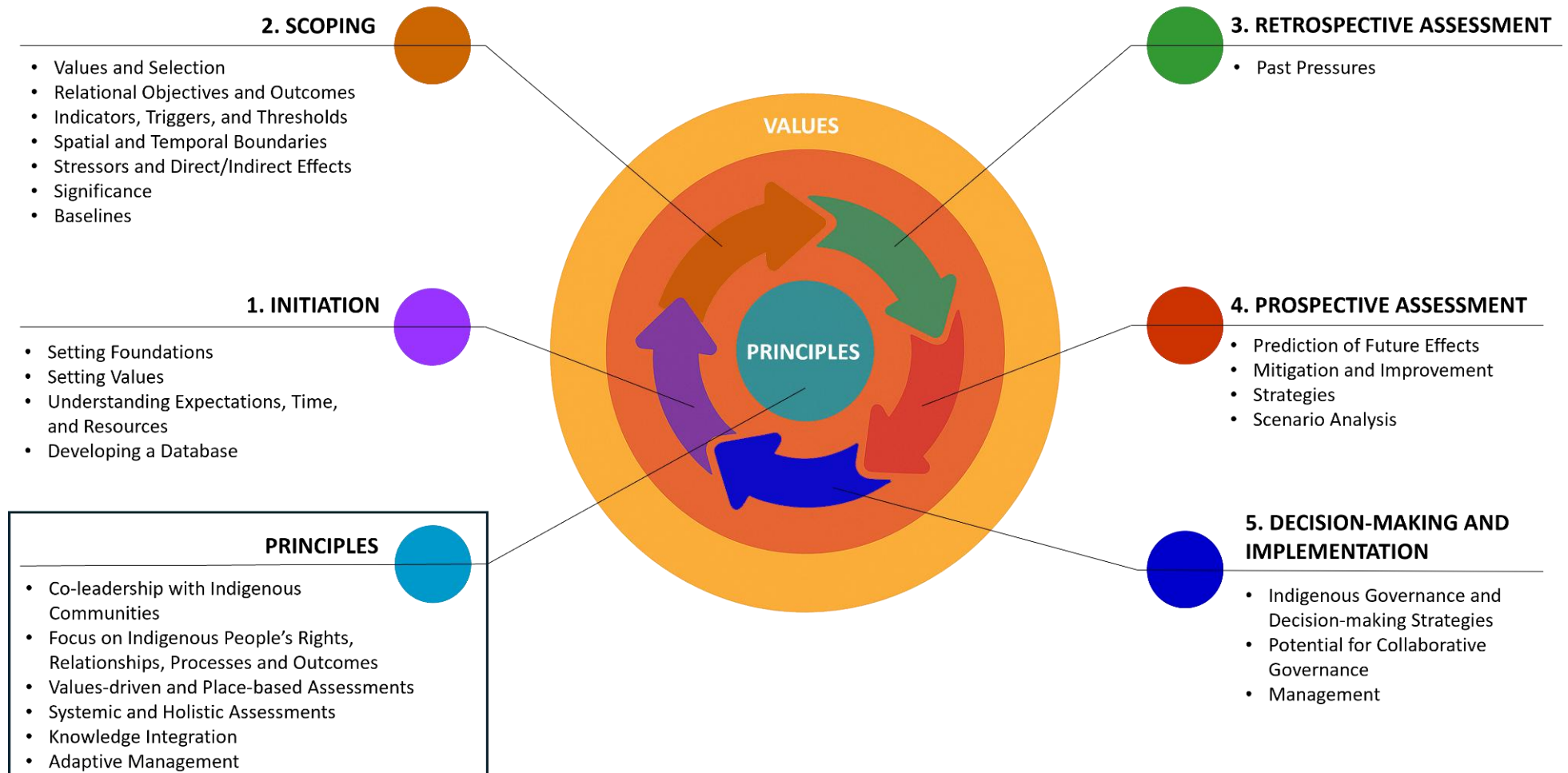


Figure 3 – Indigenous RCEAM – I-RCEAM framework. Source: Raquel Tardin-Coelho.

4.1 Initiation phase

The Initiation phase of I-RCEAM encompasses four key components (Table 5): setting foundations; setting values; understanding expectations, time, and resources; and developing a database.

Table 5 – I-RCEAM Initiation phase criteria and parameters.

Initiation Phase Criteria and Parameters		
Components	Criteria	Parameters
Setting Foundations	Common Values and Objectives	All communities in a region must set common values and objectives.
	Indigenous Decision-Making Authority	Indigenous governments must be recognised as authorities in decision-making and management.
	Informing Projects	Outputs from assessment and management must inform major and minor projects across multiple spatial scales.
	Feasibility of Values Selection	A limited set of values most affected by cumulative effects should be selected to make the process feasible.
	Use of Best Available Information	When setting values, indicators, and triggers, the best available information, including IK and monitoring results, should be considered.
	Ongoing Monitoring	Ongoing value-monitoring is crucial for supporting decision-making, creating evidence, and achieving desired objectives.
	Precautionary Principle	The precautionary principle should guide mitigation strategies for unintended impacts, even in the face of scientific uncertainty.
	Adaptation and Interaction in Management	Management must incorporate adaptation and interaction as knowledge evolves.
	Proactivity in Addressing Impacts	Proactive management is encouraged to address unintended impacts before they occur.
Setting Values	Accommodating Sub-regional Priorities	Sub-regional priorities should be accommodated whilst maintaining a consistent regional structure.
	Indigenous Community Involvement in Setting Values	Indigenous communities must establish their own values and priorities, rather than relying on conventional Western scientific frameworks.
	Focus on Land, Water, Social Wellbeing, and Cultural Values	Emphasis should be placed on land, water, social wellbeing, and cultural values as per Indigenous stewardship.
	Holistic, Goal-based Approach	The approach should prioritise long-term community goals rather than isolated technical analysis.
	Holistic Approach	The values and impacts assessed should align with the Indigenous governance systems, planning processes, and lores.
	Alignments Between Indigenous Values and Conventional CEAs	Indigenous values may not align with conventional resource development, requiring a more holistic approach.
	Addressing Cultural and Social Impacts	Social and cultural impacts, such as mental health and cultural losses, should be integrated into CEA alongside environmental impacts.
Understanding Expectations, Time, and Resources	Integrating Cultural and Ecological Values	Cumulative effects assessments should integrate ecological and cultural values, particularly those related to provisioning services and cultural significance.
	Clear Expectations and Definitions of Cumulative Effects	At the start of the process, a clear, shared understanding of what 'cumulative effects' means must be in place.
	Capability, Limitation, and Data Standards	Clearly addressing capabilities, limitations, methods, protocols, and data standards is necessary for all stakeholders and rightsholders.
	Clear Engagement Process and Data Output Expectations	Set clear expectations for when and how engagement occurs and what data outputs are expected (e.g., maps, infographics).
	Community Engagement and Ownership of Data	Community engagement is time-intensive but necessary to establish ownership, like in the case of the Metlakatla community.

Initiation Phase Criteria and Parameters		
Components	Criteria	Parameters
	Realistic Timeframes and Avoidance of Consultation Fatigue	Time constraints should be addressed to avoid consultation fatigue whilst maintaining a meaningful process.
	Cultural Sensitivity and Understanding of Time	It is essential to recognise that cultural perceptions of time may differ from Western linear timelines in forming realistic timelines for CEA.
	Accessibility Constraints of Indigenous Knowledge	Accessibility to IK (e.g., IQ) may be limited and should be factored into the assessment process.
	Acknowledging Differences in Methodologies	Indigenous and non-Indigenous knowledge systems must be recognised and integrated despite methodological differences.
Developing a Database	Data Integration and Knowledge Systems	Integration of IK with quantitative scientific data is essential but challenging due to IK's qualitative and sensitive nature.
	Data Gaps and Incompleteness	Existing datasets often lack comprehensive information, especially for Indigenous social and cultural values.
	Data Accessibility and Sharing	With secure and equitable access to cultural data, data sharing should be facilitated across projects and agencies.
	Ethical Governance of Data	Ethical governance is needed for sensitive cultural data (e.g., sacred sites), respecting Indigenous rights and knowledge ownership.
	Community-based Monitoring (CBM)	CBM initiatives are key to building a more robust and accessible data collection system.
	Technological and Ethical Innovations	Developing spatial databases integrating ecological and cultural data can aid in proactive land use planning.
	Knowledge Integration	Combining IK systems and scientific data strengthens understanding of cumulative effects and fosters intercultural decision-making.
	Secure and Adaptive Data Management	To protect sensitive cultural and ecological data, databases must be adaptable and securely governed.

4.1.1 Setting foundations

The Assessment and Management of Cumulative Effects on the North Pacific Coast Framework (Wilson, 2020) clearly states that, for an RCEAM, key criteria must be taken to ensure the ongoing development and interaction amongst the RCEAM phases, such as:

1. All communities along the Coast that use coastal and marine resources are required to set common values and objectives.
2. Indigenous governments should be recognised as authorities in decision-making and management.
3. Outputs from assessment and management should inform major and minor projects across multiple spatial scales.
4. A limited set of values that can be most affected by cumulative effects should be chosen to make the process feasible.
5. The best available information (whether IK or results from monitoring) should be considered when setting values, indicators, and triggers.
6. Ongoing monitoring of values is crucial for creating evidence, supporting decision-making, and following up on the achievement of desired objectives.
7. The precautionary principle should guide the implementation of mitigation strategies for unintended impacts, despite scientific uncertainty.
8. Adaptation and interaction should be considered in management as knowledge evolves.
9. Be proactive rather than reactive in addressing unintended impacts before they occur.

10. Accommodate sub-regional priorities whilst providing a robust and consistent structure throughout the region.

These criteria serve as examples of how to establish a collective foundation for a more inclusive, effective, and adaptive approach to assessing and managing regional cumulative effects, as proposed in the I-RCEAM framework. They enable responsiveness to anticipated and unforeseen cumulative impacts through robust regional frameworks adaptable to local contexts over time.¹²

4.1.2 Setting values

The literature highlights the essential role of Indigenous communities in setting values and priorities. This concept challenges conventional Western science frameworks, which are often based on legislative requirements and/or external priorities.

Arnold et al. (2022; 2023) prioritise Indigenous vision and stewardship aspirations, focusing on land, water, social wellbeing, and cultural values. The authors propose a focus on impacts that align with the Nation's goals and are associated with its governance systems, planning processes, and lore. This goal-based approach promotes long-term community objectives, rather than isolated technical analysis. It also (re)addresses how responsibility and outcomes are assessed. Gondor (2016) also identifies misalignments between Indigenous communities' values and current resource development CEA, particularly in the Inuit reality. This is especially important as Indigenous communities are increasingly related to industrial economies, highlighting the need for a holistic approach. Similarly, Nakamura (2013) and Measham et al. (2021) emphasise the importance of meaningful CEA that recognises the diversity of Indigenous values within or across communities. Nishima-Miller and Hanna (2022) discussed how establishing consistent decision-making criteria that integrate environmental, cultural, social, and economic conditions provides a strategic foundation for Indigenous-led impact assessments (ILIA). The T̓silhqot'in and Tla'amin Stewardship Policies exemplify this by requiring projects to meet Indigenous stewardship obligations as a precondition for approval, diverging from conventional EIA trade-off approaches that weigh environmental versus economic considerations (Nishima-Miller and Hanna, 2022; Atlin and Gibson, 2017; Arnold et al., 2023).

Kwon et al. (2024) and Tulloch et al. (2024) emphasised the importance of avoiding the selection of valued components (VCs) based solely on regulatory requirements and instead embracing Indigenous values, as regulations often fail to address local Indigenous priorities and limit Indigenous influence on outcomes. This echoes recent CRC TiME findings by Foran et al. (2022; 2024) on stakeholder values, which are set in the Australian context. This point highlights the need to redefine VC selection as a value-based process grounded in IK and priorities, representing a significant shift in perspective. In this regard, Arnold et al. (2023) outline the complexity of including social and cultural impacts (such as mental health and cultural damage and losses) into CEA in addition to and in interaction with environmental impacts, since those are diffuse and historically rooted and cannot be managed through the narrow lenses of project-based assessment models.

Similarly, in Australia, Boldy et al. (2023) emphasise that mining assessments often overlook ecosystem services with cultural significance to Indigenous peoples. Their study in Western Cape York (Queensland) shows how regulatory systems focusing on biodiversity fail to capture the full spectrum of Indigenous values, particularly provisioning services from culturally significant plants. They argue for integrative assessments that recognise and manage landscapes for both ecological and cultural values, echoing calls for Indigenous-led methodologies in environmental governance.

¹² Refer to Work Package 1 report – Governance Models (Rifkin et al., 2025) for complementary findings on setting foundations for RCEAM and how it evolves over time.

The literature calls for a transformative shift in CEA centred around Indigenous values at local and regional scales. This can foster the livelihoods of Indigenous communities whilst contributing to more socially, culturally, and environmentally sustainable realities.

4.1.3 Understanding expectations, time and resources

Developing a meaningful I-RCEAM requires established and realistic expectations, resource planning, and time commitments¹³. To initiate the process, it is essential to have a clear and shared definition of ‘cumulative effects’ or ‘cumulative effects assessment,’ as suggested by Ho-Tassone et al. (2023). Additionally, the authors emphasise the need to clearly address capabilities, limitations, methods, protocols, and data standards for stakeholders and rightsholders. Establishing expectations early in the process is also highlighted by Adams et al. (2023), such as how and when engagement will occur, the type of data outputs expected (e.g., maps, shapefiles, infographics), and agreements regarding data ownership, control, and access. For instance, Kown et al. (2024) highlight that establishing management triggers is a time-intensive process that requires significant community engagement. This process was beneficial for the Metlakatla, as it increased capacity and fostered a sense of ownership. Efforts to reduce time requirements whilst keeping a meaningful process may reduce communities’ consultation fatigue whilst maintaining consistency.

In this regard, Larsen et al. (2017) note that unrealistic expectations, particularly regarding participation and documentation provision, may lead to exclusion from decision-making processes. Partal and Dunphy (2016) also reinforce the challenges of limited timescales, which hinder effective impact measurement in CEAs. Measham et al. (2024) add that cultural perceptions of time differ. Linear Western timelines may not align with Indigenous understandings based on place, ancestry, and cultural practice. Such differences must be considered when forming agreements and timelines for post-mining or CEA processes.

Another topic that deserves attention is raised by Peletz et al. (2020), who discuss that accessibility constraints of IK (e.g., Inuit Qaujimaningit) often limit the usability of the knowledge. This necessitates setting realistic expectations for information availability during the IA process. Additionally, Partal and Dunphy (2016) and Nakamura (2013) call for cultural sensitivity and the recognition of IK systems, acknowledging that methodological differences can challenge data integration unless properly resourced and planned. In this direction, Shields et al. (2024) advocate for ‘right-way science’, where Indigenous and non-Indigenous participants collaborate at all project phases, from design to dissemination, grounded in FPIC and mutual benefit.

4.1.4 Developing a database

The literature highlights the crucial need for robust, inclusive, and ethically governed databases as foundational tools to support CEA and collaborative management, particularly in Indigenous contexts where cultural and ecological values intersect.

Key challenges in developing a database include data integration and knowledge systems, data gaps and incompleteness, and data accessibility and sharing. Data integration and knowledge systems issues refer to IK that often remains qualitative, culturally sensitive, or not easily translatable into standardised databases, limiting integration with scientific data (Ho-Tassone et al., 2023; Partal and Dunphy, 2016). Another point is

¹³ Refer to Work Package 1 report – Governance Models (Rifkin et al., 2025), and Work Package 4 report – Process Roadmap and Toolkit of Methods (Maharjan et al., 2025) for complementary findings on how understanding expectations, time and resources contribute to RCEAM readiness.

that sensitive cultural information, such as sacred sites or oral histories, requires secure access and ethical governance to protect Indigenous rights and knowledge. This necessitates strict ethical procedures (Heiner et al., 2019), which are often not in place. Ensuring ICIP and data sovereignty is fundamental (AIATSIS, 2020). Besides, Western scientific frameworks can dismiss Indigenous methodologies, creating tensions that limit equitable data sharing and recognition (Austin et al., 2019).

Data gaps and incompleteness issues in existing datasets frequently exclude large, unsurveyed regions and lack data, thereby impairing the ability to identify true knowledge gaps (Heiner et al., 2019). For instance, Davies et al. (2020) mention that marine and terrestrial ecosystems in Tasmania (Australia) have insufficient large-scale, long-term datasets, especially for Indigenous social and cultural values, which remain unquantified or restricted. Likewise, according to Godwin (2016), cultural heritage baseline data is often incomplete or non-existent, undermining CIA reliability. Data accessibility and sharing issues indicate that data usually remain siloed within specific projects, agencies, or Indigenous groups, limiting regional integration and broader collaborative use (Kidd et al., 2024), and legal and policy frameworks sometimes restrict the sharing of cultural data, complicating coordinated cumulative effects analyses (Godwin, 2016). Ethical data governance models based on Indigenous principles (such as respect and equity) can ensure secure, consensual, and equitable data use, building trust and shared ownership (Ho-Tassone et al., 2023).

Key opportunities in developing a database include Community-based Monitoring (CBM), technological and ethical innovations, and knowledge integration. CBM programs enhance frequent and consistent data collection, promoting transparent and accessible databases (Kidd et al., 2024). Localised data initiatives, like the Metlakatla Membership Census, demonstrate how community-specific databases fill critical gaps and support culturally relevant CEA (Metlakatla First Nation, 2019). Technological and ethical innovations allude to developing spatial databases that integrate biodiversity, cultural heritage, and development pressures, which can guide proactive land use planning and threat mitigation (Heiner et al., 2019; Boldy et al., 2023). Additionally, databases that accommodate quantitative data and intangible cultural values (e.g., language and oral histories) allow for adaptive, evolving knowledge management (Partal and Dunphy, 2016). Knowledge integration refers to the integration of IK systems alongside scientific data, providing a more comprehensive understanding of cumulative effects and strengthening intercultural decision-making (Austin et al., 2019). Tools such as 'document banks' in Aotearoa New Zealand compile Mātauranga Māori for intergenerational knowledge transfer and cultural resilience (Jolly and Thompson-Fawcett, 2023). Likewise, Ho-Tassone et al. (2023) note that coordinated watershed-scale monitoring and data sharing frameworks facilitate two-way knowledge exchange and enhance understanding of cumulative effects. Those examples stress that developing comprehensive, secure, and adaptive databases is indispensable for effective CEA.

4.2 Scoping phase

Ehrlich (2022) addresses the apparent tension between issue scoping (prioritising specific issues for efficient assessment) and systems thinking (considering interconnected systems and cumulative effects). The author clarifies that good scoping is not about limiting perspective but about identifying the direction of inquiry, zooming in or panning out as needed based on the nature of the issues and values identified. Considering the systemic nature of IK, adopting a systems thinking approach should be more appropriate, although not necessarily exhaustively encompassing. Indeed, considering the systemic nature of cumulative effects, adopting a systems thinking approach to Western science RCEAM or Indigenous-based RCEAM should be more suitable. Thus, the conservation or restoration of the integrity of socio-cultural-ecological systems, the systemic consideration of landscape scales (both local and regional), knowledge integration, and contributions to sustainability come together as criteria for scoping. The scoping phase of I-RCEAM encompasses key components as follows (Table 6): values and selection; relational objectives and outcomes;

indicators, triggers and thresholds; spatial and temporal boundaries; stressors and direct/indirect effects; significance and baselines.

Table 6 – I-RCEAM Scoping phase criteria and parameters.

Scoping Phase Criteria and Parameters		
Components	Criteria	Parameters
Valued Component Selection	Identify What Matters Most	Comprehensive issues scoping (review of planning materials and scientific literature); initial filtering (selection based on community relevance and preliminary feasibility); in-depth engagement with community and experts.
	Prioritise for Implementation	Implementation criteria: Level of priority, mandate, ability to influence, capacity/resources; selection of pilot VCs: Using collaborative scoring and deliberation, including socio-economic and cultural VCs; long-term implementation planning: Ongoing incorporation of additional VCs based on evolving community values.
	Relevance	Values must align with the interests of Indigenous peoples and stakeholders in environmental, social, cultural, and economic matters.
	Comprehensiveness	Understanding past, present, and foreseeable future effects.
	Representativeness	Consider both natural and human attributes that may be affected.
	Responsiveness	Ability to respond to potential human or nature-related events/developments.
	Conciseness	Avoid redundant analysis and strive for clarity in the relationships between value-stressor interactions and their causal pathways.
Relational Objectives and Outcomes	Indigenous Wellbeing	Indigenous wellbeing is deeply connected to the land, spiritual knowledge, and traditional practices.
	Species and Biodiversity Management	Incorporating social, spiritual, economic, cultural, and environmental values into species management.
	Legal and Procedural Safeguards	Ensuring legal robustness and effectiveness through clearly integrating Indigenous objectives and respect for cultural heritage.
Indicators, Triggers, and Thresholds	Indicators	Metrics are used to measure the condition and trends of values. Must be relevant, measurable, and responsive.
	Triggers	Specific levels of indicators signal when management actions are needed. Multiple indicators can apply to a single value.
	Thresholds	Defining the unacceptable level of change for a VC that necessitates mitigation actions. Must be legally recognised and culturally grounded.
Spatial and Temporal Boundaries	Spatial Boundaries	Boundaries must reflect IK, governance, and the ecological scale of values. It can vary based on the development's scope and project type.
	Temporal Boundaries	Temporalities must be grounded in Indigenous worldviews, considering cycles, ceremonies, and the interconnectedness of humans, nonhumans, and land.
	Regional and Local Context	Boundaries should be regionally coordinated and should integrate Indigenous and ecological priorities.
Stressors and Direct/Indirect Effects	Source Impacts	Changes to natural, social, human, or economic capital; broad regional impacts (e.g., increased regional health demand); contamination (e.g., lead, radiation).
	Sink Impacts	Localised effects (e.g., dust, greenhouse gases; destruction of sacred and cultural sites; destruction of customary harvest areas).
	Direct Effects	Immediate impacts on Indigenous land, water, culture, and wellbeing (e.g., direct harm to sacred sites, disruption of spiritual and cultural practices, loss of access to sacred sites, ritual and traditional harvesting sites; stress from environmental degradation affecting physical and mental health).
	Indirect Effects	Direct contamination of resources or the environment; long-term, cumulative impacts on culture, socio-economic conditions, and health; indirect disturbances to intergenerational knowledge transfer and social cohesion; effects that are often spatially and temporally displaced, requiring a dynamic approach to assessment (e.g. impact on intergenerational knowledge and cultural resilience).

Scoping Phase Criteria and Parameters		
Components	Criteria	Parameters
	Management Strategies	Thresholds, limits, and allocation for source impacts; market-based instruments, such as trading schemes and offsets; addressing interactions between different stressors at multiple scales; culturally grounded cumulative analysis that addresses indirect effects beyond the project footprint; and ecological, cultural, and social systems viewed as part of a larger whole (systems thinking).
Significance	Indigenous Definitions of Significance	Indigenous-led assessment of significance from cultural, spiritual, and social perspectives; non-scientific knowledge and qualitative assessments of heritage and cultural resources; regional, local, and broader impacts considered simultaneously; significance of Indigenous systems of interconnected ecological, cultural, and social values; significance of places through relationships, values, and lived experience, not solely scientific terms; IK systems for determining significance, including intangible cultural heritage.
Baselines	Baseline Condition	Indigenous communities' current ecological, social, and cultural status and resources; quantitative and qualitative baseline data on environmental and social health; integration of Indigenous ecological knowledge to define baseline conditions and trends; consider historical and living knowledge of ecosystems and socio-cultural patterns; CBM to fill knowledge gaps; integration of TEK with Western scientific data for baseline validation according to desired outcomes.

4.2.1 Valued component selection

Selecting Indigenous valued components (VCs) is an essential part of I-RCEAM process. Kwon et al. (2024) present an Indigenous-led method for selecting VCs developed through the Metlakatla CEM (Metlakatla First Nation 2019). The initiative prioritises Indigenous perspectives, knowledge, and values, integrated with scientific data, in designing a deliberative, community-led process to identify and manage cumulative effects in Environmental Assessment (EA) and planning. The Metlakatla CEM Program is a six-step methodology for VC selection and prioritisation (Metlakatla First Nation 2019):

Phase 1: Identifying what matters most

- **Step 1 – Comprehensive issues scoping** – Review of documents (such as planning materials and scientific literature) to collect a list of potential VCs. The focus was then narrowed to marine biophysical resources, a priority given expected regional development impacts.
- **Step 2 – Initial filtering** – Candidate marine VCs were selected based on community relevance and preliminary feasibility.
- **Step 3 – Community and expert engagement** – In-depth engagement with Metlakatla leaders, Knowledge Holders, scientists, and practitioners culminated in a community workshop to validate the previous selections and add more VCs if necessary.

Phase 2: Prioritising for implementation

- **Step 4 – Implementation criteria development:**
 1. Level of priority
 2. Mandate
 3. Ability to influence
 4. Capacity/resources.
- **Step 5 – Selection of Pilot VCs** – A second workshop applied the criteria using a collaborative scoring and deliberation process, selecting pilot biophysical VCs and key socio-economic and cultural VCs (e.g., housing and employment).

- **Step 6 – Long-Term Implementation Planning** – The Metlakatla CEM Program incrementally incorporates other VCs based on evolving community values, environmental change, and increased capacity. Expansion into terrestrial and freshwater systems is anticipated.

Although designed for a CEA framework, the approach is adaptable to project-specific IAs. It offers a model for incorporating Indigenous values early in the scoping phase (Kwon et al., 2024). The process reinforces Indigenous governance capacity and asserts rights-holder leadership in setting the boundaries and frameworks of environmental decision-making.

The Assessment and Management of Cumulative Effects on the North Pacific Coast Framework (Wilson, 2020) suggest that valued components are selected based on:

- **Relevance** – to Indigenous and stakeholders’ environmental, social, economic, health or cultural interests.
- **Comprehensiveness** – to enable the understanding of past, present, and foreseeable future effects combined.
- **Representativeness** – to consider important natural and human attributes that can be affected.
- **Responsiveness** – to potential human or nature-related events/developments.
- **Conciseness** – to avoid redundant analysis by clearly considering the articulation between the value stressor interactions, their nature, and the causal pathway. The framework emphasises that considering an excessive number of values can introduce high complexity to causal pathways, limiting attempts to maintain clarity. It highlights that keeping value interactions and protection at broader scales may ensure that the exact value is protected at a closer scale. However, some further studies at local scales might be necessary for validation.

Setting Indigenous VCs as the basis for CEA transforms how environmental, social and cultural effects and change are understood, evaluated, and governed. By legitimising Indigenous-defined VCs, applying community-driven methods, and adopting relational, systems-based approaches, RCEAM can become more inclusive, culturally relevant, and ecologically effective. This represents not just a methodological enhancement but a structural reorientation.

4.2.2 Relational objectives and outcomes

Relational objectives are a crucial component of I-RCEAM. It is worth noting that this concept was specifically developed in this study, emphasising that objectives and outcomes are inherently related to relational values. From a broader environmental management perspective, setting objectives at a regional scale is critical to effectively addressing cumulative effects (Halseth et al., 2016). Recognising sustainability through interconnected environmental, economic, social, and health dimensions requires large-scale spatial and temporal assessments that incorporate Indigenous relational values and enable strategic regional planning, thereby avoiding fragmented, project-by-project analyses (Halseth et al., 2016).

The Assessment and Management of Cumulative Effects on the North Pacific Coast Framework (Wilson, 2020) states that, when defining VC, it is essential to identify regional objectives as desired outcomes, or VC desired conditions, enabled by the entire CEA process. It highlights that a well-defined objective is crucial for determining appropriate indicators and triggers, as well as for providing a basis for further monitoring. The Framework states that objectives should include: a measurable result and a standard. “For example, an objective for a harvested species might be to ‘maintain’ sufficient populations in areas of community interest [the result] to meet community needs [the standard]. Optionally, timeframes can be added for objectives that imply a directional improvement, e.g., instead of ‘maintain’ the objective could be to ‘restore by 2027’” The Assessment and Management of Cumulative Effects on the North Pacific Coast Framework (Wilson,

2020, p.8). Furthermore, the Framework states that VCs and objectives should not compete against each other, meaning that all objectives should be achieved simultaneously. When competing objectives are inevitable (i.e., one must be accomplished before the other), the Framework suggests separating them in space, time, or ranking them, allowing for trade-offs and optimisation.

Indigenous objectives for CEA must encompass relational dimensions to accurately reflect Indigenous conceptions of health and the environment. Sangha et al. (2015) highlight Indigenous wellbeing as fundamentally connected to land, spiritual knowledge, and traditional capabilities, dimensions often excluded from Western wellbeing metrics. Indigenous-led objectives also extend to species and biodiversity management, as demonstrated by Goolmeer et al. (2024), who developed objectives that incorporate social, spiritual, economic, and cultural values alongside environmental monitoring measures. As Che and Hickey (2021) and Godwin (2016) caution, inadequate instructions and procedural shortcomings undermine the effectiveness and legal robustness of assessments. Ensuring that directives explicitly require integrating Indigenous objectives and safeguarding cultural heritage against superficial or compliance-driven assessments supports Indigenous-led governance of cumulative effects.

4.2.3 Indicators, triggers and thresholds

The Assessment and Management of Cumulative Effects on the North Pacific Coast Framework (Wilson, 2020) defines indicators as metrics used to measure the condition and trends of values, particularly in assessing the effects of projects or stressors. According to the Framework, effective indicators should be relevant, practical to evaluate, measurable, responsive to potential effects, accurate, and predictable. Their selection should be supported by causal models that map relationships between values, indicators, stressors, and receptors. These models (e.g., conceptual models or means-ends networks) help formalise understanding of systems, illustrate causal pathways, and may be expanded into mathematical representations. Though understanding causal relationships is rare, models can incorporate current knowledge, including traditional and expert input, and account for uncertainty, supporting decision-making, forecasting, and management planning (Wilson, 2020).

For example, Weber et al. (2012) emphasise the importance of IK in developing social indicators for CEA and monitoring. Christensen et al. (2010) illustrate how community collective memory can help articulate desired wellbeing indicators, enabling communities to backcast from past developments to identify how industrial and land management practices affect community conditions. This participatory approach can be used to inform threshold setting beyond maintaining the status quo, embedding Indigenous values into management decisions. Indigenous perspectives often reject any level of impact on sacred landscapes, emphasising a relational and non-compensable view of cultural heritage (Godwin, 2016). Effective CEA should incorporate these qualitative dimensions to avoid perpetuating colonial impacts through technocratic metrics.

The Metlakatla CEM (Metlakatla First Nation, 2019) highlights the central role of values, as things that Indigenous communities care deeply about and wish to protect or restore, and the use of indicators as measurable expressions of those values. The focus is placed on ‘condition indicators’, which measure the overall state of a VC over time, rather than ‘stressor indicators’ linked to individual development projects. This approach ensures that the CEA centres on the sustained condition of VCs that are important to the community, rather than transient project impacts. A ‘condition indicator’ provides a direct measure of a VC’s state (e.g., the prevalence of hypertension as a health condition indicator), helping track trends over time. These condition indicators often require the complementary use of ‘stressor indicators’ to pinpoint underlying causes of change. For example, the stressor indicator physical exercise levels can influence the condition indicator of hypertension prevalence, isolating pressures affecting the VC’s condition. According to the Metlakatla CEM (Metlakatla First Nation, 2019), selecting appropriate indicators is both critical and complex, as there are potentially an unlimited number of indicators for any given VC. The Metlakatla approach adapts indicator selection criteria from the BC Environmental Assessment Office’s guidelines

(2013) to ensure alignment with best practices. Key criteria must be accurate (accurately reflecting changes in the VC and appropriate to its spatial scale), sensitive to development or mitigation efforts, practical (feasible to monitor and clear for users), and relevant (informative to Metlakatla organisations and consistent with community context). ‘Influence diagrams’ were developed for each priority Metlakatla value to facilitate indicator selection and understanding of cumulative effects. These conceptual models map cause-and-effect relationships between development activities in Metlakatla Territory and the community’s priority VCs, illustrating linkages between condition and stressor indicators. This participatory and iterative process strengthens the connection between Indigenous VCs and the CEAM metrics. The diagrams are revisited throughout the program to educate new participants, maintain community communication, and update the understanding of impacts as development activities evolve.

The Assessment and Management of Cumulative Effects on the North Pacific Coast Framework (Wilson, 2020) defines triggers as specific indicator levels that signal when management action is needed. They help identify when a VC’s condition requires attention, using zones of concern and trajectories to illustrate potential changes. Multiple indicators and triggers can apply to a single value, including ‘precautionary triggers’ that prompt early intervention. Effective management aims to maintain indicator conditions within acceptable zones, thereby avoiding the exceedance of critical triggers (Wilson, 2020). Their development should be informed by science, traditional knowledge, and community values, acknowledging that acceptability is subjective (Wilson, 2020). Setting triggers also requires avoiding considering deteriorating conditions as usual. Triggers should be based on future desired outcomes rather than degraded past baselines. Iterative assessments and community consultation are essential for setting meaningful and effective triggers (Wilson, 2020). For example, Metlakatla’s tiered management triggers for fishing, hunting, and gathering activities explicitly reflect Indigenous goals to protect cultural practices and facilitate intergenerational knowledge transfer, prioritising youth participation and community continuity (Kwon et al., 2024).

In EA, thresholds guide the identification of acceptable changes in VCs and trigger mitigation actions before systems reach undesirable states (Joseph et al., 2017). Indigenous-led threshold setting reorients CEM towards justice, accountability, and place-based sustainability, indicating that environmental, social, or cultural changes are no longer acceptable beyond a certain point (Kwon et al., 2024). It addresses implementation gaps in existing frameworks by clearly articulating when, why, and how actions should be taken to prevent or reverse harmful trends, thereby helping to avoid irreversible impacts on community wellbeing, cultural continuity, and ecological integrity. Triggers differ from targets or thresholds in that they imply a need for action rather than just measurement (Wilson, 2020).

Despite their importance, Indigenous thresholds often face political resistance and institutional barriers. For example, provincial authorities did not entirely accept the Metlakatla First Nation’s thresholds, reflecting tensions between Indigenous governance and dominant development agendas (Joseph et al., 2017). In Sweden, Sami demands for ‘toleransnivå’ (development limits) have similarly been ignored despite legal protections for reindeer herding (Larsen et al., 2017). Thresholds must be legally recognised and regionally coordinated to be effective. For instance, the absence of enforceable thresholds in British Columbia’s CEA framework has led to inconsistent, discretionary decisions that fail to protect Indigenous rights and lands (Muir, 2022).

The literature collectively underscores the necessity of incorporating Indigenous-defined indicators, triggers and thresholds as the foundation for meaningful I-RCEAM. These thresholds must be culturally grounded, collaboratively determined, and legally supported to ensure that RCEAM does not perpetuate harm through fragmented, quantitative, or solely ecological lenses. Setting such thresholds offers a pathway towards more equitable, precautionary, and place-based decision-making frameworks that respect Indigenous rights, knowledge, and stewardship practices.

4.2.4 Spatial and temporal boundaries

A sustainable CEAM increasingly recognises that spatial and temporal scales align with ecological and social realities, as well as with Indigenous governance, knowledge, and cultural values. The area of interest depends on the development's scope or planning region and must reflect the ecological and management scales of the VCs involved. Assessments may extend beyond a project's immediate footprint because VCs may span multiple spatial scales (e.g., community or species range) (Wilson, 2020). The chosen scale for the region (Indigenous country(ies)) can significantly influence the effectiveness of the I-RCEAM. Larger regions may dilute visible impacts, whilst smaller ones may exaggerate them. Therefore, careful justification of area selection is crucial for a meaningful analysis (Wilson, 2020).

In this regard, Awâsis (2020) argues for integrating Anishinaabe people's values (Canada) spatial-temporalities into CEA, emphasising that setting spatial and temporal boundaries must be grounded in Indigenous values. This approach challenges the commonly used linear and institutional temporal frameworks. Anishinaabe temporalities reflect a decentralised, land-based system of governance and understanding, marked by the interconnectedness of humans, non-humans, and the land. These timeframes are shaped by ceremonies, seasons, and seven-generation thinking, in contrast to timelines tied to election cycles, fiscal years, or court processes (Awâsis, 2020). Spatial boundaries, similarly, are not limited to human-centred or project-specific zones. Instead, they encompass kinship-based territorial relations (e.g., clan governance) and include nonhuman temporalities essential to life cycles and ecological stewardship (Awâsis, 2020). The clan-based relationships connect people to specific habitats, informing impact assessments deeply rooted in lifelong and ancestral experiences with the land and its beings (Awâsis, 2020).

Diggon et al. (2022) underscore that spatial and temporal boundaries must be grounded in Indigenous jurisdiction and priorities. The regional boundary of the Marine Plan Partnership for the North Pacific Coast – MaPP was defined to align with bioregional and oceanographic characteristics. Still, the sub-regional planning boundaries were set based on Indigenous territories, ecological considerations, and shared planning priorities. This intentional inclusion of Indigenous-defined spatial units created overlapping sub-regions where boundaries could not be demarcated, showcasing flexibility and collaboration across spatial zones (Diggon et al., 2022). Indigenous, provincial, and federal governments and marine stakeholders jointly endorsed the Ecosystem-based Management (EBM) framework developed through MaPP. It aimed to support ecosystem integrity and human wellbeing, whilst being adaptive to socio-ecological dynamics. Importantly, it maintained spatial and temporal ecosystem characteristics necessary to sustain Indigenous lifestyles (Diggon et al., 2022).

Likewise, Blom (2023) underscores that spatial and temporal boundaries should not be arbitrarily defined or based solely on biophysical or administrative convenience. Instead, they should reflect the cultural and ecological realities of Indigenous peoples.

The IPCIA framework, grounded in Sámi reindeer husbandry knowledge, proposes three spatial levels:

- Local (direct project area)
- Intermediate (adjacent land)
- Regional (entire Indigenous cultural landscape or land rights area).

Temporal analysis must also include past, present, and future disturbances, emphasising the ongoing cumulative impact of multiple projects, not just new developments. Crucially, cumulative impacts must be interpreted through IK systems that integrate landscape, traditional livelihoods (e.g., reindeer husbandry), and human wellbeing (Blom, 2023).

Godwin (2016) questions the direct applicability of CIA to Cultural Heritage Management (CHM) but notes the core issue of boundary-setting. The author critiques the difficulty in defining an appropriate 'catchment' or assessment area for impacts on Indigenous cultural heritage, questioning whether it should be based on

biogeography, river systems, cultural areas, or Native Title boundaries. Each option presents challenges and may reflect arbitrary or externally imposed constructs. This reinforces the argument that Indigenous perspectives must guide boundary-setting to ensure culturally meaningful assessments.

Muir (2022) presents evidence that Indigenous VCs require different spatial and temporal boundaries than those commonly applied in Western scientific frameworks. For instance, the cultural value of hunting species cannot be understood solely at the site of direct impact, as cultural effects often manifest later and in distant places (e.g., in education and health practices within communities). The author emphasises that pre-IA studies, led or supported by Indigenous communities, are crucial to ensure that spatial boundaries accurately reflect Indigenous geographies and that their effects are culturally appropriate. Considering Indigenous values means that CEAM must use multiple overlapping spatial and temporal boundaries for each VC (Muir, 2022). For example, species considered healthy on a national scale may be endangered in Indigenous territories due to local conditions, making locally defined Indigenous boundaries critical for assessing cultural significance (Muir, 2022).

In the study by Barber and Jackson (2011), the authors provide detailed insights into spatial and temporal boundaries from an Indigenous perspective from the Pilbara (WA, Australia). Aboriginal custodians stress the interconnectedness of upstream and downstream responsibilities, advocating for spatial boundaries that reflect hydrological and cultural connectivity. This view includes obligations to future generations, highlighting the temporal dimension of Indigenous stewardship. Participants expressed concern over the lack of cumulative assessment frameworks that account for impacts beyond lease boundaries or long-term timelines, particularly regarding water diversion, quality degradation, and ecosystem disruption from mining activities.

Ho-Tassone et al. (2023) note that whilst cumulative effects depend on spatial and temporal interactions (e.g., in watersheds), Western governance lacks the processes to integrate this understanding across sustainability pillars fully. They advocate for strategic governance revisions that accommodate systems thinking and Indigenous temporal and spatial knowledge. Joseph et al. (2017) and Kidd et al. (2024) similarly argue that regional CEAM processes capable of spanning large spatial and long-term temporal scales are essential. However, such processes are rare in Western Canada, and project-level assessments often fail to consider broader cumulative effects unless regional baselines are included (Joseph et al., 2017).

Across all studies, a consistent theme is that implementing I-RCEAM effectively requires spatial and temporal boundaries that are defined by and respect IK systems, governance, and cultural values. This approach ensures that assessments are ecologically meaningful and culturally relevant, supporting sustainability for future generations in line with Indigenous worldviews. Without this foundation, RCEAM risks becoming a technocratic tool that fails to prevent the erosion of Indigenous rights, cultures, and lands, whilst compromising the landscape's sustainability.

4.2.5 Stressors and direct/indirect effects

In mining contexts, cumulative impacts include both source impacts (local changes to natural, social, human, or economic capital) and sink impacts (broader regional impacts such as additions such as dust or greenhouse gases and water resources), with source impacts often being more complex to understand due to ill-defined spatial extents and longer-term effects (Franks et al, 2009). Indigenous wellbeing is affected not only by physical changes but also by socio-cultural disruptions such as loss of access to water sites, spiritual linkages, and cultural practices essential to their daily lives (Barber and Jackson, 2011; Sangha et al., 2015; Boldy et al., 2023).

The management of cumulative impacts requires an understanding of the types and characteristics of these impacts, including their interactions and relationships. Franks et al. (2009) highlight that managing 'sink' impacts (localised effects) often involves technical controls or emission standards, whilst managing 'source'

impacts (broader regional effects) typically requires thresholds, limits, and allocation methods. Market-based instruments like trading schemes and offsets are increasingly used to manage these impacts efficiently. However, whilst sink impacts are more straightforward to measure and mitigate locally, source impacts—such as increased demand on regional health services from multiple mines—are harder to isolate and manage (Franks et al., 2009).

Mining and other industrial activities affect Indigenous wellbeing beyond immediate economic benefits, often disrupting spiritual, artistic, ritual, and social practices tied to land and water (Leyton-Flor and Sangha, 2024; Sangha et al., 2015). This disruption fractures the interconnected physical, human, and sacred worlds fundamental to Indigenous identities and livelihoods (Barber and Jackson, 2011). Holcombe (2022) emphasises that for Indigenous Australian peoples, cumulative impacts encompass not only mainstream environmental stressors but also uniquely cultural, spiritual, and social dimensions tied to Country. These impacts include loss of access to sacred and cultural sites, destruction of customary harvest areas, and the compounding of historical disempowerment related to control over land and development decisions. Holcombe (2022) stresses that CIA must account for the intersection and compound nature of these impacts, as they are transformative rather than additive. For example, restrictions on accessing Country disrupt cultural practices and intergenerational knowledge transfer, leading to a broader loss of cultural integrity and wellbeing.

Leyton-Flor and Sangha (2024) emphasise that Indigenous wellbeing extends beyond conventional health and economic metrics, encompassing physical, mental, emotional, and spiritual dimensions that are deeply connected to land and culture. Mining impacts can have long-lasting effects on wellbeing, especially through contamination (e.g., lead, radiation) and damage to sacred sites integral to Indigenous identity. This underscores the importance of assessing not only immediate but also long-term cumulative impacts on Indigenous communities (Leyton-Flor and Sangha, 2024).

CEA critically depends on understanding direct and indirect effects on VCs, especially when assessing impacts on Indigenous peoples. CEAs must integrate both direct and indirect effects to effectively address impacts on Indigenous communities, whose cultural and social systems are deeply interconnected with their environment (Muir, 2022). Indirect effects are particularly critical for Indigenous peoples due to the interdependencies inherent in their ways of life, which amplify their vulnerability to secondary and tertiary disturbances across multiple geographies and over time (Muir, 2022).

Frameworks like the IPCIA (Blom, 2023) utilise Risk and Vulnerability (RAV) analysis to explicitly incorporate both direct and indirect effects on Indigenous cultural landscapes, traditional ecosystem services, and human wellbeing. Blom (2023) recognises that indirect impacts are often visible at intermediate or regional scales rather than just locally. This approach underscores the importance of multi-scale, culturally grounded cumulative analysis, addressing the shortcomings of conventional impact assessments that often ignore indirect effects beyond the immediate project footprint.

The literature highlights that direct and indirect effects on Indigenous communities form the essential basis for meaningful I-RCEAM, and that failing to consider indirect, temporally and spatially displaced effects fundamentally undermines both scientific credibility and Indigenous wellbeing.

4.2.6 Significance

Understanding and incorporating Indigenous significance is fundamental to effective I-RCEAM. Joseph et al. (2017) emphasise that significance is fundamentally about acceptability from the perspective of those affected, which means that Indigenous definitions of significance must guide assessments. Their work illustrates how the cumulative effects significance thresholds should be assessed in relation to baseline conditions that are often already degraded, reinforcing the need for Indigenous-led determination of significance. Nakamura (2008) critiques conventional EIA for failing to meaningfully integrate Indigenous

cultural and moral values, sacred landscapes, and cultural resources. Indigenous voices are often marginalised, and 'non-scientific' IK is excluded from final decisions, undermining the recognition of Indigenous significance in assessment processes.

Jolly and Thompson-Fawcett (2023) present Indigenous experiences with cultural impact assessments (CIAs), illustrating that these assessments often fail to consider the significance of Indigenous communities because significance is primarily judged through Western scientific measures, thereby discounting Indigenous perspectives. This leads to disillusionment, as Indigenous-identified significant cultural impacts are minimised, resulting in regulatory approvals that ignore Indigenous values and recommendations.

In the study by Sutton et al. (2013) the authors critically examine the assessment of cultural heritage significance within the EIA process in the Hunter Valley (NSW, Australia), focusing on the tensions between Indigenous perspectives and archaeological/scientific approaches to significance. The author highlights confusion and ambiguity in key heritage terms, such as 'values' and 'significance', within NSW legislation and practice, noting how heritage practitioners have misappropriated these terms to justify reductionist and positivist assessments. Such assessments often treat significance as an objective, embedded property of places, quantifiable through scientific criteria and 'scorecard' systems. This process marginalises intangible Indigenous values and diminishes Indigenous voices, reinforcing power imbalances with archaeologists positioned as 'scientific experts' (Sutton et al., 2013). Aboriginal cultural heritage significance, therefore, must be understood as the subjective, shifting values of Aboriginal people, arising from complex relationships with place, history, and culture.

That requires qualitative and anthropological methodologies in Aboriginal Cultural Heritage Assessments (ACHAs) that incorporate intangible heritage and the lived experiences of Indigenous communities, moving beyond rigid scientific quantification (Sutton et al., 2013). The authors also address the selective heritage preservation privileging sites deemed 'scientifically significant' whilst overlooking or destroying Indigenous heritage lacking physical evidence or stereotypically 'traditional' features. Notably, the authors argue that the cumulative impacts of multiple mining developments are rarely addressed adequately in ACHAs or heritage legislation. Cumulative impacts can increase site rarity and distress over time, yet the current heritage system lacks mechanisms to reassess significance dynamically or to incorporate accumulated social and psychological effects (Sutton et al., 2013).

Leyton-Flor and Sangha (2024) further illustrate Indigenous concerns regarding the impacts of mining. Traditional Custodians see threats not only to physical landscapes but also to the cultural and spiritual significance embedded in their country. The inability to protect these values leads to frustration and disempowerment, as exemplified by the Mirarr people's experience with uranium mining in Kakadu National Park (Northern Territory, Australia), where access to spiritual sites is restricted (Leyton-Flor and Sangha, 2024).

Similarly, Jackson et al. (2014) argue that Indigenous environmental assessments must appreciate the socio-economic and cultural importance of natural resources, which are often undervalued or overlooked in dominant economic frameworks that rely on market-based valuation. In the Australian context, Boldy et al. (2023) examine the crucial link between biodiversity and ecosystem services valued by Indigenous peoples in Western Cape York. Mining buffer zones designed to protect biodiversity, such as riparian areas, often fail to safeguard many plant species important for Indigenous food, medicine, and cultural materials. This gap indicates the need for CEA to prioritise Indigenous significance over generic biodiversity indicators, whilst also complying with existing regulations.

Goolmeier et al. (2024) provide an example of an Indigenous-led evaluation of Culturally Significant Species (CSEs) on Bundjalung Country (NSW, Australia), in which expert Knowledge Holders affirmed the alignment of priority species management with Indigenous objectives. However, they note that evaluations at smaller, clan-based scales might yield different results, underscoring the importance of Indigenous governance in setting assessment criteria.

Concerning water values, Jackson (2005) discusses the challenges of incorporating Indigenous cultural values into Western resource management frameworks, particularly intangible and dynamic values such as those associated with water. Indigenous ecological knowledge is crucial to defining environmental water requirements, yet it is often excluded from formal studies. The author stresses that the separation of 'cultural flows' from environmental flows risks marginalising Indigenous values, and it advocates for assessments that fully integrate Indigenous socio-ecological relationships rather than treating cultural values as separate or secondary. Yet in the Australian context, Larson et al. (2019) emphasise that Indigenous Land and Sea Management Programs (ILSMPs) provide wellbeing benefits closely tied to Indigenous people's relationships with their environment.

These concepts differ fundamentally from Western notions of wellbeing, which focus on financial or external metrics. They argue that cumulative effects assessments must incorporate the significance of Indigenous-defined wellbeing and value systems, which are inherently linked to the health of natural resources and the continuation of cultural traditions and communal identity.

4.2.7 Baselines

A fundamental step in CEA involves establishing VCs' baselines or current status, which includes key Indigenous values to understand their conditions before evaluating project-specific and cumulative impacts (Joseph et al., 2017). This baseline characterisation uses quantitative and qualitative information, considers key drivers and other stressors affecting VCs, and projects trends relative to ecological or social thresholds (Joseph et al., 2017). This iterative process is essential for identifying effects that require further detailed study to set baselines aligned with desired outcomes that support adaptive management, particularly in degraded landscapes, where current conditions are far behind the desired ones.

Considering Indigenous perspectives and knowledge in establishing these baselines is increasingly recognised. Indigenous peoples have long maintained healthy ecosystems and managed resources sustainably (Ho-Tassone et al., 2023). Acknowledging these perspectives and values is crucial for effective intercultural collaborations to mitigate cumulative effects, especially amid modern pressures such as population growth and intensified socio-economic activities (Ho-Tassone et al., 2023).

Understanding the ecological, cultural, and socio-economic roles of Indigenous values within broader systems is also key (Ehrlich, 2022). Assessments should not only collect baseline data on the VCs themselves but also their relationships and interconnections within larger environmental and social systems. This systems thinking approach helps visualise the function and importance of Indigenous values as integral parts of the ecosystem and community wellbeing, thus informing more holistic CEA (Ehrlich, 2022).

A major challenge lies in the limited integration of social impact assessments, especially those focused on Indigenous peoples, into broader environmental management and mine closure plans. For example, in the case of the Ranger Mine (Northern Territory, Australia), the social baseline data and impacts on Indigenous people are poorly incorporated into closure planning, hindering the understanding of cumulative social effects and appropriate management (Lawrence and O'Faircheallaigh, 2022). This outcome highlights the risk of neglecting Indigenous social and cultural baselines, which are essential for comprehensively assessing cumulative effects and managing impacts throughout project lifecycles.

Tulloch et al. (2024) provide an example of baseline assessment in the context of ecosystem health and species persistence in Indigenous-governed coastal regions. They quantify current conditions, showing variable persistence probabilities for key species and linking these to pressures from resource extraction and human activities. Such quantitative baselines are essential for evaluating the cumulative effects on ecosystem components that hold cultural and subsistence value for Indigenous communities. In this regard, Boldy et al. (2023) demonstrate the critical need to map the distributions of culturally significant species as part of baseline condition assessments in mining-affected Indigenous landscapes. Their work reveals that

current biodiversity protections (e.g., buffer zones) often fail to safeguard species that provide indigenous peoples with vital ecosystem services and cultural benefits. They argue that understanding the baseline status of such values is necessary to mitigate and manage cumulative impacts effectively throughout the mining lifecycle.

Peletz et al. (2020) highlight the challenge of defining environmental baselines in Indigenous IA, particularly in regions experiencing rapid environmental and climate change. Traditional baseline data quickly become outdated, and Elders report that historic knowledge no longer applies. Inuit Qaujimaningit (IQ), for example, is presented not as static or historic knowledge but as a living, adaptive way of understanding the environment, which is crucial for setting baselines under uncertainty. Furthermore, IQ informs not just baseline conditions but also guides the IA process, bridging the gap between Indigenous perspectives and formal assessment systems.

The lack of data can also be a challenge. In many regions, including Australian tropical river systems, a significant knowledge gap exists concerning ecosystem processes and Indigenous use patterns, which limits effective baseline characterisation and IA (Jackson et al., 2014). Indigenous subsistence and customary uses are often undervalued or 'hidden' within economic valuation frameworks that prioritise market-based measures, which poses challenges for adequately capturing their importance in CEAs (Jackson et al., 2014). In this regard, CBM offers the potential to improve biophysical baseline studies by involving Indigenous communities and collecting data that meets Western scientific standards. However, IK itself is often not systematically incorporated into scoring or evaluation rubrics by non-Indigenous scientists (Kidd et al., 2024). Therefore, integrating IK alongside Western science remains crucial to fully capturing the baseline conditions of Indigenous values.

The foundational role of Indigenous baselines (social, cultural, economic, and ecological) in understanding and managing cumulative effects is a recurring theme across the literature. Without long-term, scale-appropriate, and culturally inclusive baseline data, RCEAM risks marginalising Indigenous perspectives and failing to capture the full spectrum of environmental, social and cultural change.

4.3 Retrospective assessment

Gunn and Noble (2012) stress that developing a baseline for CEA requires more than simply describing current conditions. Instead, it requires a retrospective analysis of how VCs have changed over time and whether these changes are significant for sustainability. This approach avoids accepting past environmental degradation as the 'new normal' and enables a better understanding of cumulative impacts by examining historical trends. The authors describe efforts to identify relationships between indicators of VC change and various human or natural disturbances. These disturbances include landscape features such as the density of linear developments (e.g., roads, trails), the percentage of cleared land, edge density, rates of land conversion, river crossing densities, impervious surfaces, and natural processes such as flood or fire frequency.

The goal is to characterise how these drivers of change affect VCs over space and time, enabling the prediction of future conditions under cumulative change. Importantly, Gunn and Noble (2012) emphasise that thresholds are critical for assessing the accumulated state of the environment (the baseline) to understand the significance of past cumulative effects and potential future stressors. They note that many cause-and-effect relationships between disturbances and VC responses may be unknown. However, qualitative associations or correlations can still inform retrospective assessments. Moreover, suppose cumulative past impacts have already degraded a VC. In that case, any further decline is considered significant, underscoring the importance of understanding historical conditions to inform management. The

retrospective phase of I-RCEAM involves recognising past pressures and the consequent landscape changes they have driven.

4.3.1 Past pressures

Arnold et al. (2024) emphasise that understanding current social and environmental conditions requires a thorough understanding of historical pressures. The T̓silhqot'in Indigenous Assessment process in Canada integrates knowledge of the Nation's history, including the effects of government policies, colonisation, past developments, environmental changes, and socioeconomic stressors, which shape present-day social conditions. Although project-level IA cannot fully address the broad scope of these historic factors, assessments must not ignore legacy impacts and the broader social, political, and environmental context surrounding projects. This approach also incorporated location-based criteria for assessing requirements, highlighting the importance of 'place' in cumulative effects considerations (Arnold et al., 2023).

Similarly, Adams et al. (2023) foreground the importance of historical pressures by engaging Knowledge Holders to document the history and extent of cumulative pressures on lands and waters since colonisation by identifying both widespread pressures (such as climate change impacts on phenology and water temperature) and localised pressures, including recreational boating and contamination. These inputs formed the basis for conceptual models linking pressures, habitat, prey, and focal species distributions. Adams et al. (2023) stress the sensitive nature of discussing post-colonial cumulative effects, acknowledging the emotional impact on Indigenous participants and emphasising the need for culturally respectful and open-ended dialogue throughout this knowledge-gathering phase.

Gratani et al. (2016) note that past pressures, particularly demographic changes and land development, threaten Indigenous identity and connection to Country in the Australian context. Participants in her study voiced concerns about population growth, housing development, and land subdivision, which risk eroding cultural ties and Indigenous presence on traditional lands. Frequent and ongoing engagement with Country, through both use and non-use activities, is vital for reaffirming Indigenous identity and continuity in the face of these pressures.

The literature highlights that addressing past pressures on Indigenous key values and the consequent landscape changes through historical context, IK, and the acknowledgment of legacy impacts is foundational for meaningful RCEAM. Consequently, that is true for I-RCEAM.

4.4 Prospective assessment

Gunn and Noble (2012) describe the prospective phase of CEA, in which models—spatial, linear, quantitative, or qualitative—are developed from retrospective baseline data and new information to predict how VCs respond to future stressors across multiple projects and regional actions. This includes 'summing up' individual effects to assess aggregate impacts on VC condition and trend analysis to evaluate whether regional environmental issues will worsen or improve. Scenario analysis is recommended to manage uncertainty and explore a range of possible future VC conditions under different development regimes. Furthermore, Gunn and Noble (2012) emphasise the need to identify appropriate mitigation measures for VCs experiencing negative incremental effects from projects. This process requires evaluating the total cumulative effects on VCs, not merely the relative magnitude of one project's impact, and assessing how much additional change is tolerable based on thresholds or management targets established in baseline assessments. If VCs are already degraded, management must prioritise restoration or rectification, considering the range of future outcomes predicted through prospective assessment. The prospective phase

of I-RCEAM encompasses predicting future effects, mitigation and improvement strategies, and scenario analysis (Table 7).

Table 7 – I-RCEAM Prospective Assessment phase criteria and parameters.

Prospective Assessment Phase		
Components	Criteria	Parameters
Prediction of Future Effects	System Functioning	Impact on VC resilience, collective impact magnitude, societal value interpretation, and impact acceptability.
	Predicted Impacts	Magnitude of change, collective impact, effects on system resilience, long-term environmental and socio-cultural changes.
	IK Integration	Integration of IK, community input on TEK and lived experience.
Mitigation and Improvement Strategies	Thresholds for Impact	Maximum tolerable changes, system-level impacts, VC health degradation, and impact on community health.
	Mitigation Strategies	Restoration, avoidance, minimisation, and offset strategies.
	Proactive vs. Reactive Mitigation	Proactive (spatial integration, cumulative impact anticipation) vs. reactive (response to identified impacts).
	IK Integration	Inclusion of traditional management practices (e.g., cultural burning, water flow restoration), and proactive planning.
	Governance Roles	Clarity of responsibility amongst agencies, Indigenous communities' roles, and institutional capacity for effective mitigation.
	Cultural and Biodiversity Values	Integration of biodiversity and cultural values in mitigation strategies, Indigenous-led decisions on land use.
Scenario Analysis	Predictive Frameworks	Development of plausible development scenarios.
	Spatial and Temporal Projections	Spatial visualisation of impact scenarios, long-term forecasting, and quantification of ecosystem health.
	Community Validation	Indigenous input on local/regional impact understanding, and validation of scenario outputs by local communities.
	Governance Integration	Incorporation of Indigenous governance in decision-making processes, and alternative development trajectories.
	Ecological and Societal Trade-offs	Forecasting species health, ecosystem sustainability, and socio-economic impacts under various development scenarios.

4.4.1 Prediction of future effects

Ehrlich (2022) highlights the critical step in CEA of assessing predicted changes in system functioning by understanding the role and context of VCs within the system. This involves evaluating individual predicted impacts on each VC and their combined, collective effects. The key questions include whether these predicted impacts reduce system resilience and whether the magnitude of collective impact warrants significance designation. Such determinations rely on societal values and guide decisions about the acceptability of impacts and the need for additional mitigation measures to reduce or avoid cumulative harm.

Peletz et al. (2020) illustrate challenges and lessons from the Kiggavik Uranium Mine Project in Nunavut (Canada) regarding predictions in IA. The dust dispersion model was questioned by local community members based on their lived experience with harsh winter conditions and regional wind patterns, revealing a disconnect between model predictions and local knowledge. This case highlights the crucial role of Inuit Qaujimaningit (IQ) in providing vital context to enhance the accuracy and relevance of project impact predictions. The Nunavut Impact Review Board (NIRB) emphasised the importance of incorporating IQ, particularly regarding impacts on culturally valued marine wildlife species, and suggested that insufficient baseline data and inadequate incorporation of IK contributed to the project's recommendation not to proceed.

Further, Peletz et al. (2020) describe how Inuit knowledge and Western science were viewed as complementary and mutually reinforcing in IA processes. This shows the importance of combining diverse knowledge to achieve accurate effects prediction.

4.4.2 Mitigation and improvement strategies

Gunn and Noble (2012) focus on cumulative effects in a practical assessment context, emphasising that mitigation strategies must consider the total effects on VCs from the project, combined with other sources. They argue that understanding thresholds or maximum tolerable changes in VC conditions is essential to setting effective mitigation targets. When VCs are already degraded, mitigation must include restoration or rectification efforts. This framework sets a clear foundation for impact mitigation strategies that are integral to CEA and subsequent management.

Effective RCEAM emphasises establishing robust impact mitigation strategies from the outset, as explored across various contexts and studies. Ehrlich (2022) emphasises that effective mitigation of collective impacts requires a systemic, collective approach that addresses cumulative effects at a higher system level, particularly in relation to community health, well-being, and cultural values. This systemic mitigation acknowledges that project proponents alone cannot fully address cumulative impacts, especially when these add to pre-existing effects. The author further recommends a two-tiered mitigation focus for cumulative effects: first, mitigate impacts on individual VCs or their interactions to reduce cumulative harm; second, if system-level impacts remain significant, apply additional system-level mitigations or offsets that foster system resilience, possibly through other agencies or policy instruments. If unacceptable collective impacts persist, project modifications or rejection should follow.

Gondor (2016) adds that mitigation strategies often reflect community concerns, integrating IK mainly reactively in project design and mitigation, rather than proactively embedding Indigenous values and practices throughout project planning. Mitigation measures ranged from environmental controls (e.g., dust suppression, wildlife movement) to social conditions (e.g., camp bans on drugs and alcohol), reflecting a patchwork rather than systemic integration of IK into CEM.

Heiner et al. (2019) explore proactive mitigation and advocate advancing proactive mitigation planning by spatially integrating biodiversity and Indigenous social/cultural values to inform CEM. Their framework enables Indigenous communities to proactively assess development proposals and negotiate mitigations, applying the mitigation hierarchy (avoid, minimise, offset) informed by spatial data highlighting vulnerable areas and values. This approach aims to enhance the effectiveness of managing cumulative impacts at regional scales, facilitating FPIC, and achieving better conservation outcomes by jointly addressing biodiversity and cultural values. The authors note that whilst biodiversity mitigation frameworks, which often prioritise based on rarity and vulnerability, are well developed, similar social and cultural value criteria are less established but crucial. Integrating these values into CEA and mitigation planning supports more informed negotiations and long-term sustainable management, reducing conflicts and costs associated with reactive responses (Heiner et al., 2019).

The avoidance principle is also emphasised. Godwin (2016) highlights the avoidance principle embedded in Queensland legislation (Australia) and in best practices such as the Burra Charter, which mandate that management parties first seek to avoid harm to Aboriginal cultural heritage and, where avoidance is impossible, to minimise harm. This principle shapes impact mitigation strategies by requiring iterative examination of project redesign and mitigation programs to minimise impacts on cultural sites. However, Godwin (2016) notes a critical challenge: the actual effectiveness of these mitigation measures often remains unknown until late in project design, typically post Environmental Impact Statement (EIS). This uncertainty complicates the modelling of Aboriginal Cultural Impacts (ACI) and cumulative impacts across multiple simultaneous projects, particularly when subsurface or unidentified sites are involved, making it

difficult to conduct meaningful cumulative assessments until actual impacts are fully documented. Likewise, Walker et al. (2021) reinforce the primacy of avoidance in impact mitigation within cumulative effects frameworks, particularly for biodiversity protection. They outline a rigorous, criteria-based approach to identify effects that must be avoided or remediated, prioritising irreversible biodiversity losses or those unlikely to be replaced within 25 years. Their approach views avoidance of adverse impacts as foundational, with remediation and mitigation as secondary, recognising that restoration rarely fully compensates for habitat loss and is often poorly enforced. They argue that impact mitigation strategies should explicitly incorporate ecosystem status (including highly modified and regenerating ecosystems) into management to maintain biodiversity and ecosystem services over time. This establishes a clear procedural basis for CEM by defining impact thresholds and prioritising mitigation early in project planning (Walker et al., 2021).

Boldy et al. (2023) extend this theme into mining contexts in Western Cape York, focusing on including ecosystem services in impact mitigation strategies to address cumulative effects on culturally diverse Indigenous landscapes. They argue that mining operations frequently destroy vegetation and ecosystem services without adequately compensating Indigenous peoples for lost benefits. Mitigation strategies must incorporate IK and priorities by enabling pre-mining harvest and use of forest products, supporting Indigenous livelihoods, and ensuring ongoing access to ecosystem services throughout mining and post-mining phases (Boldy et al., 2023). The Nunavut Impact Review Board (NIRB) offers a model of effective impact mitigation within CEM by integrating monitoring as an active, ongoing responsibility throughout the project lifecycle rather than treating it as a post-approval formality, thereby improving the implementation of mitigation strategies (Peletz et al., 2020).

Goolmeer et al. (2024) also reinforce the importance of Indigenous-led mitigation in ecosystem management, demonstrating how Bundjalung participants advocate for integrating traditional management practices, such as cultural burning, restoration of water flows, and active management of cultural pathways, into broader ecosystem management strategies. However, challenges in defining responsibility for mitigating and monitoring impacts may cause uncertainties. Social impacts, such as in Kakadu National Park, reveal institutional gaps that undermine effective impact management and CEA (Lawrence and O’Faircheallaigh, 2022). The lack of clarity over agency roles has led to mistrust between Indigenous Traditional Custodians and managing bodies, emphasising the need for clearly assigned responsibilities in mitigation frameworks.

Setting mitigation strategies grounded in systemic, collective, and adaptive frameworks is vital for I-RCEAM. These strategies must transcend individual project VCs to address interconnected social, cultural, and environmental systems, involve multiple governance actors (including Indigenous governments), and adopt proactive, spatially informed planning that integrates IK and biodiversity values. This holistic approach improves the ability to mitigate cumulative effects effectively and sustainably.

4.4.3 Scenario analysis

Scenario analysis is increasingly recognised as a vital foundation for proactive I-RCEAM, particularly in the context of Indigenous community values and biodiversity conservation. Spatial visualisation and community validation of scenario outputs enable a nuanced understanding of impacts at local and regional scales, supporting adaptive management decisions.

Governance and decision-making processes benefit from incorporating scenario analysis alongside community preferences. Adams et al. (2023) emphasise the fundamental role of developing alternative plausible development scenarios as a critical step in CEA. Engaging Indigenous Knowledge Holders and regional stakeholders, their approach focuses on a 25-year timeframe relevant to local planning and stewardship. The scenarios target industries under Indigenous influence (such as forestry, energy, mining, tourism, and aquaculture) with assumptions about constant background pressures to manage elicitation workload. Elicited expert predictions on species health under these scenarios are aggregated regardless of

knowledge system and incorporated into a Bayesian Network model, enabling probabilistic forecasting of species and ecosystem health across landscapes.

This approach provides spatially explicit, quantitative predictions to inform Indigenous-led governance and value trade-offs. The approach contrasts with many past CEAs, which have been ineffective at integrating IK and sovereignty. Prioritising Indigenous collaboration, the scenario-based method provides a future-focused, knowledge-driven basis for assessing cumulative effects and supporting decision-making that considers long-term community and ecological values (Adams et al., 2023).

Frameworks such as the Framework for the Assessment and Management of Cumulative Effects on the North Pacific Coast (Wilson, 2020) reinforce the role of future scenario forecasting in CEAs. They highlight that assessing the cumulative effects of projects or regional development strategies requires estimating changes in indicators and management concerns over time, using scenarios to inform decision-making, and designing management responses to mitigate cumulative effects (Wilson, 2020).

In essence, scenario analysis provides a spatially explicit method for I-RCEAM. It enables stakeholders and rightsholders to evaluate alternative futures and design development trajectories that conserve biodiversity and Indigenous values over the long term.

4.5 Decision-making and implementation

Structured decision-making frameworks form the foundation of effective I-RCEAM, particularly when guided by Indigenous values and governance, which explicitly consider temporal framing and procedural approaches. According to the reviewed literature, current frameworks often favour short-term, project-specific timelines and rapid economic development priorities, thereby limiting meaningful consideration of environmental and cultural impacts. Effective CEA requires centring Indigenous governance as a key decision-making pillar (Adams et al., 2023) (Table 8).

Table 8 – I-RCEAM Decision-making and Implementation main aspects.

Decision-making and Implementation	
Components	Main aspects
Indigenous Governance and Decision-Making Strategies	• Indigenous-led decision authority. • Inclusion of Indigenous temporalities, protocols, and knowledge systems. • Cultural alignment and confidentiality.
Potential for Collaborative Governance	• Multi-scalar Indigenous participation. • Self-determination. • Creation of a ‘shared space’ for dialogue and negotiation. • Autonomous Indigenous decision-making bodies.
Management	• Co-production of knowledge. • Place-based and value-informed decision-making. • Transparent, adaptive management with Indigenous leadership. • Tiered triggers and social choice framing. • Culturally aligned management and shared governance.

4.5.1 Indigenous governance and decision-making strategies

Indigenous governance may involve different aspects, such as project design and decision-making strategies for implementation. Concerning the CEA process, Goolmeer et al. (2024) present an Indigenous-led decision-

making model for the designation and management of culturally significant species, emphasising that decision-making authority within Indigenous governance ensures that management reflects traditional ecosystem-wide approaches. This model integrates biocultural objectives and structured decision-making to achieve desired outcomes. The authors emphasise that Indigenous leadership in decision-making enhances cultural relevance and ownership.

Indigenous temporalities and cultural protocols, which are crucial when shaping decision-making strategies, determine that failing to integrate them tends to marginalise knowledge systems, undermining the quality and legitimacy of CEAs, particularly where procedures emphasise transparency through public accessibility, which conflicts with confidentiality needs around IK (Darling et al., 2022). This tension impacts documentation and the willingness of Indigenous communities to share sensitive knowledge, thereby weakening decision-making bases for CEM.

In the context of CIAs in Aotearoa New Zealand, a broad spectrum of outcomes highlights the variable effectiveness of decision-making and implementation strategies (Jolly and Thompson-Fawcett, 2023). Whilst some CIAs have positively influenced decisions, leading to design changes and consent refusals that align with Indigenous perspectives, many outcomes remain superficial or symbolic ('tick box' exercises) with limited substantive influence on project design or approval processes. Whilst some CIAs result in consent conditions for cultural monitoring or minor design adjustments, spiritual values and longer-term cultural governance objectives remain poorly integrated into formal decisions (Jolly and Thompson-Fawcett, 2023).

Land use and consultation policies (such as the Tsleil-Waututh Nation's Stewardship Policy) (Canada) provide clear, transparent, and consistent decision-making frameworks before assessments. These policies ground decision-making criteria in Indigenous legal principles and stewardship obligations, shifting focus from conventional environmental-economic trade-offs to strategic, integrated cultural, social, environmental, and economic objectives (Nishima-Miller et al., 2024; Atlin and Gibson, 2017; Arnold et al., 2023). This strategic foundation enhances ILIA by establishing preconditions for project approval aligned with Indigenous governance.

The central role of IK in decision-making is highlighted by cases such as the Doris North project (a gold mine located in Nunavut, Canada), where community values regarding environmental and cultural integrity directly shaped conditions like pipeline removal during decommissioning, overriding proponents' impact assessments (Peletz et al., 2020).

The MaPP framework (Wilson, 2020) explicitly connects CEA to decision-making by underscoring that assessments inform statutory decisions within legal and policy boundaries. The quality and completeness of value-based information directly influence decision outcomes and the mitigation of cumulative impacts. For assessment results to effectively guide decisions and management, clear agreements on process and governance are required to embed assessment findings within implementation strategies.

This synthesis underscores that I-RCEAM is most effective when decision-making authority is clearly structured, legally and procedurally sound, inclusive of Indigenous governance and knowledge systems, and integrated within a transparent, tiered governance framework that links assessments to actionable management strategies.

4.5.2 Potential for collaborative governance

The reviewed literature supports the establishment of collaborative governance as fundamental for effective I-RCEAM. In this process, collaborative, multi-scalar governance remains essential. Gustafsson and Schilling-Vacaflor (2022) examine how Indigenous participation is influenced across governance scales, demonstrating that exclusion at one level can limit participation at others. Conversely, Indigenous-led initiatives can

influence governance frameworks at all levels, underscoring the importance of co-created, cross-scalar approaches to CEAM.

In this regard, it is crucial to address structural inequities in governance. Larsen et al. (2017) reveal how CEAM failures in Sweden stem from state withdrawal and the delegation of governance to uneven negotiations between developers and Sami communities. These structural issues reflect political choices that sideline Indigenous rights. The authors advocate collaboration and the creation of shared spaces for dialogue, facilitated by independent researchers, to build capacity and promote more balanced governance outcomes. Workshops involving civil servants and Sami participants (Larsen et al., 2017) facilitated reflection and joint problem-solving, revealing that constructive CEAM governance depends on long-term engagement, resistance movements, and coalition building. Such participatory processes empower both Indigenous communities and government actors to envision and support governance reforms.

Halseth et al. (2016) highlighted precedents for integrative governance processes in managing cumulative effects, drawing on Canadian examples such as the Cumulative Environmental Management Association (CEMA) in northern Alberta. The CEMA includes over 50 members and is organised into four caucuses: Aboriginal, Government, Non-government Organisations, and Industry, with governance by four directors from each group. Whilst CEMA develops management frameworks and best practices and facilitates dialogue to reduce cumulative impacts (particularly from oil sands development), it holds no formal decision-making power and functions instead in an advisory capacity. The authors argue that effective regional governance to address cumulative impacts will require establishing autonomous decision-making authorities, thereby distinguishing future frameworks from current advisory-only models. This is important because most existing regional frameworks in Canada lack both alignment (e.g., with natural boundaries like watersheds) and decision-making authority. Without such power, these frameworks are often subordinate to broader provincial or federal political priorities, and as a result, they risk ignoring their own recommendations.

The literature indicates a growing consensus that Indigenous governance, grounded in self-determination and integrated with collaborative, multi-scalar structures, is crucial for effective I-RCEAM. Only through Indigenous authorities and fostering transparent and inclusive governance processes can I-RCEAM address current shortcomings and support sustainable outcomes in RCEAM.

4.5.3 Management

Effective management of regional cumulative effects requires genuine collaboration, particularly with Indigenous communities. Kown et al. (2024) explain how tiered management triggers were established within the Metlakatla Indigenous-led CEAM system. Management decisions were context-specific, recognising community capacity and external regulatory constraints. The Community-based Cumulative Effects Management Working Group (CEMWG) was factored into the feasibility of implementation and prioritised community-defined values. The group emphasised transparent processes, rationale documentation, and consensus-building. Notably, they proposed restorative and proactive management triggers, allowing for action whether a VC was declining or already in a critical condition. This helps avoid shifting baselines by ensuring management sets clear boundaries for acceptable change.

In Gondor (2016), IK was leveraged for project-specific management recommendations in Inuit communities. Community workshops facilitated the inclusion of IK in developing operational changes, particularly in areas related to mine operations and safety, resulting in new local economic opportunities.

Goolmeier et al. (2024) also discuss Indigenous-led management strategies concerning the Australian context. According to the authors, management frameworks should support transparent, place-based decision-making, protect ICIP, and address barriers such as a lack of decision-making power and limited on-Country presence. Key management actions and challenges include:

- cultural burns and fire regime restoration
- infrastructure and invasive species management
- cultural pathways, songlines, and water flows maintenance
- prioritisation through consequence tables where all actions met biocultural conservation objectives
- challenges in integrating traditional practices into national conservation strategies in Australia.

In Australia, the Indigenous Land Management (ILM) approach, also known as ‘caring for country’, is an example of management practices rooted in millennia-old relationships between Indigenous peoples and their traditional territories (Hill et al., 2013). ILM operates at a cross-cultural interface, requiring collaboration with governments, conservationists, stakeholders, and rightsholders. ILM encompasses a broad suite of management activities:

- customary and cultural practices (e.g., burning, ceremonies, knowledge transfer)
- environmental and natural resource management (e.g., weed and feral animal control, fire and water management)
- commercial activities (e.g., bush food harvest, cultural tourism, land restoration)
- community wellbeing efforts (e.g., dust mitigation, firewood collection, waste management).

Ho-Tassone et al. (2023) discuss the integration of Indigenous governance and knowledge into management systems. The authors argue that recognising Indigenous peoples as end users ensures they co-determine monitoring questions and values, thereby directly informing management priorities. In this direction, Jolly and Thompson-Fawcett (2023) illustrate how cultural indicators can inform management by evaluating the effectiveness of CIAs, thereby contributing indirectly to the adaptive management of cumulative effects.

Mackay et al. (2024) present a management model that integrates environmental, social, cultural, and economic factors through causal chains, scenario analysis, and collaborative planning. The Integrated Assessment Framework embeds co-production of knowledge and emphasises adaptive environmental management, with a focus on sustainability and human welfare outcomes. This model emphasises that management is not a top-down process, but rather one where stakeholders and rightsholders are involved, from case study selection to impact analysis, thereby building capacity for shared decision-making.

In the study by Beausoleil et al. (2022), the authors examine Indigenous Community-based Monitoring (ICBM) in the Canadian Oil Sands region (OSR), focusing on the integration of IK and Western science in environmental monitoring. Central to this integration are the distinct but interrelated topics of management, monitoring, and evaluation, which form a foundation for effective CEAM.

Another example is the Metlakatla CEM Program (Metlakatla First Nation, 2019), which establishes a structured, tiered framework for setting management triggers and actions as the foundation for CEAM. Each priority value has a broad desired goal, tiered management zones (standard, cautionary, critical), and corresponding management actions (standard, enhanced, stringent), forming a clear regime for when and how to act. These triggers are informed by community values, traditional knowledge, scientific data, and scenario planning, ensuring culturally and ecologically appropriate decision-making. Setting management triggers is recognised as a social choice process, not just a technical assessment, requiring dialogue about trade-offs, acceptable risk, and implementation capacity. Regular monitoring and review are built into the framework to ensure flexibility and responsiveness. The management strategy is rooted in Metlakatla’s long-term vision, aligning actions with community priorities whilst accounting for external governance challenges and implementation constraints (Metlakatla First Nation, 2019).

The literature shows that recognising Indigenous peoples as co-producers of knowledge ensures that cumulative effects are managed in ways that align with community values, contributing to more sustainable realities over time.

5 Most significant barriers and opportunities for an I-RCEAM in Australia

This section presents the results of yarns developed in collaboration with one Aboriginal Corporation (PKKP), as well as fourteen interviews conducted with individuals involved in the industry, government, and non-governmental organisations, including research agencies. The objective of the yarns and interviews was to explore the barriers and opportunities to incorporate IK into RCEAM in the Australian context, from Indigenous and non-Indigenous perspectives.

The results indicate that the negative effects of mining outweigh its positive effects. Amongst these engaged, there is unanimous support for Indigenous co-leadership in assessing and managing cumulative effects. However, significant barriers, such as inadequate legislation, impede progress. Simultaneously, opportunities such as co-management agreements highlight viable pathways for developing and implementing I-RCEAM.

Despite efforts to engage multiple Indigenous communities in mining regions across various States by sharing the research proposal and exploring potential collaborations, only one community (PKKP) was able to participate in the study timeline. Whilst broader community participation was sought, PKKP Traditional Owners (TOs) provided a valuable and comprehensive perspective on barriers and opportunities to incorporate IK into RCEAM in Australia. However, accurately identifying shared and distinct perspectives amongst Indigenous communities in Australia will require input from additional groups going forward.

5.1 Indigenous perspectives

The PKKP Aboriginal Corporation (PKKPAC) represents the Puutu Kunti Kurrama and Pinikura peoples, the native title holders for approximately 10,888 square kilometres in the Pilbara region of Western Australia. The PKKP community is culturally strong and deeply connected to their Country, with many members residing in towns such as Tom Price, Paraburdoo, Karratha, Carnarvon, and Perth. Like many remote Aboriginal communities, the PKKP demographic profile skews towards younger age groups, with a high proportion of children and young adults. As the cultural and governance body for Traditional Owners, the Corporation is responsive to these younger demographics whilst planning for long-term sustainability and community wellbeing.

The Puutu Kunti Kurrama people and the Pinikura people are two separate but related language groups speaking for their own Country as well as a shared area. Whilst these two groups are distinct and unique, they also observe common Lore and customs that facilitate the protection and sharing of resources. Despite representing the perspective of only two Indigenous groups, PKKP is considered an emblematic group, working for the protection of the environment and cultural values especially after the Juukan Gorge incident in 2020, in which mining operations of Rio Tinto destroyed two ancient Aboriginal rockshelters on Country with evidence of continuous human occupation for over 46,000 years. PKKP people have hosted mining operations in their Country since the early 2000s, experiencing the cumulative effects of these activities. These effects have repercussions on the relationships between the community and mining companies, encompassing both past and present practices, including positive and negative aspects related to mining operations and mine closure. A summary of the barriers and opportunities identified by PKKP for incorporating IK into RCEAM in the Australian context is presented in Table 9.

Table 9 – Indigenous Perspectives – PKKP peoples’ views on barriers and opportunities for incorporating IK into RCEAM in the Australian context.

Indigenous Perspectives – PKKP peoples	
Barriers and Opportunities for incorporating IK into RCEAM in the Australian context	
Barriers	
Mine closure planning and management issues	Lack of meaningful engagement; closure plans developed without detailed information; impact assessments done without PKKP participation; limited capacity to review technical documents; broken commitments (such as regarding water flows and cultural sites); distrust; uncertainty about mining town futures; desire to repurpose infrastructure for community benefit.
Poor engagement	Engagement occurs late (often near closure); meetings are hard to arrange; the industry is unwilling to cover costs for site surveys; consultation feels pressured and superficial; there is a lack of cultural awareness; PKKP seeks early, respectful, sustained dialogue.
Western scientific dominance in significance assessments	Cultural significance assessed through Western science instead of IK; Aboriginal Cultural Heritage Committee (ACHC) assessments may use assessors unfamiliar with PKKP Country; risk of inappropriate decisions; need for plain-language reports and storytelling; lack of reporting standards; insufficient monitoring leading to heritage damage.
No data sharing	Industry withholds environmental, water, disturbance, and monitoring data; communities cannot assess cumulative impacts; water data is particularly crucial; lack of transparency undermines accountability and cultural water management; collaboration becomes imbalanced.
Inadequate legislation and a lack of government capacity	Heritage and environmental laws fail to protect cultural landscapes; Native Title boundaries impose artificial lines; agencies are under-resourced; regulators shift responsibility to Prescribed Body Corporations (PBCs); pastoral and mining leases dominate decision-making with limited Indigenous input.
Non-inclusive decision-making processes	Section 18 permits the destruction of significant sites (e.g., Juukan Gorge); communities are pressured into agreements; and there is a lack of a genuine Indigenous voice in approvals.
Opportunities	
Early engagement and partnerships	FPIC requires early, culturally appropriate engagement; long-term relationships; clear cultural governance and accountability; and respect for Indigenous timelines and authority.
Co-leadership in mine closure planning	Desire for an active role in baseline studies, closure planning, environmental management, especially water; recognition of ranger expertise; need for PKKP-led environmental strategy, land use plans, and statements of cultural values.
Co-leadership in mining development management	Legally binding co-management protocols; PKKP has the final say through the Land Committee; model for reconciliation after the Juukan Gorge tragedy; challenges remain when government agencies bypass protections; need to include essential service agencies and pastoralists in the rules.
Regional agreements with other Indigenous groups	Seek unified regional voice on shared issues (such as water, fire, flora/fauna, and land use); Yule River Bush Meeting and Martuwarra initiative seen as best practice; cooperation strengthens cultural continuity and influence.
Capacity building	Stronger Prescribed Body Corporate (PBC) needed to lead, not just respond; requires long-term funding and skilled staff; proponents should fund capacity building; investment in emerging leaders, governance training, and succession planning; increases negotiating power and self-determination.

5.1.1 Overview

Participants from PKKP (three from Puutu Kunti Kurrama people, three from Pinikura people, and 1 PKKPAC staff) shared direct experiences with the cumulative effects of mining activities on their Country. These lived experiences were critical in shaping their perceptions and in identifying the barriers, opportunities, and

aspirations associated with developing an I-RCEAM and its potential implementation. Grounding the process in community experience was seen as essential for guiding future actions that are meaningful and aligned with local perspectives.

“Each activity [such as mining operations and pastoral stations] affects Country. Whatever they do on Country, they must manage the impacts of it, and also the perception of the impacts by people who live it first-hand.”

“We are collective people. One action affects all.”

The value of Country was a central theme throughout the yarns. The connections that Country holds were described as vital to maintaining the link between landscape, culture, and community, and to ensuring environmental, cultural, economic and social health and cohesion.

“Country is knowledge, geographical locations. You tie yourself to it. You are historically attached to Country, language, food [...].”

An Indigenous perspective that approaches Country, culture, and community as an integrated whole, at the landscape/regional scale, was considered crucial. Incorporating IK into RCEAM was viewed by participants as essential to ensuring that the views and aspirations of the PKKP peoples are meaningfully reflected in future mining operations. This perspective is particularly important in the context of mine closure, where sustaining social cohesion, protecting environmental and cultural values, and supporting long-term economic sustainability are key priorities.

“The incorporation of Indigenous Knowledge is very welcome. If Indigenous Knowledge is not incorporated, there is no cohesion, communication, and respect.”

5.1.2 Negative cumulative effects

There is a significant legacy of cumulative effects from mining activities, primarily negative, linked to landscape alterations that impact the social and cultural wellbeing and continuity of the community, as well as its surrounding environment. Small-scale mining was generally perceived as having a lower impact than large-scale operations, which involve more sophisticated equipment and extensive infrastructure. Notably, these mining activities often occur alongside land uses on pastoral leases, such as livestock grazing and vegetation clearing, further pressuring the landscape.

Climate change was also identified as a contributing factor that compounds the environmental impacts caused by mining and pastoral activities. Paradoxically, the energy transition, widely seen as essential to address climate change, was cited as a driver that could intensify these impacts due to its increasing demand for mineral extraction.

“Our old people relied on the seasons and climate to be able to deliver native fruits. Trees, kangaroos, emus, and turkeys were there. They knew how to sustain and manage Country. Now we have many seasons, and the climate has changed.”

The environment, holistically understood, is of critical importance to PKKP and is deeply connected to the people’s social, cultural, and spiritual wellbeing. This connection is grounded in kinship bonds and the profound relationship between people and the land. Participants identified several primary effects of mining activities that have significant impacts and, when accumulated over time, produce systemic disturbances. These include:

1. **Destruction of culturally significant sites**, which profoundly disrupts the community’s connection to Country. This loss negatively impacts cultural practices, belief systems, spiritual bonds, and the community’s sense of identity, belonging, and cohesion.

“Mother, grandmother, sister’s Country does not exist anymore. “Country is left upside-down. It is not recognisable. It is destroyed.”

2. **Landform alterations**, including tailings hills, watercourse diversion, lowered water tables, tailings dams, and open pits. Water diversion, specifically, was mentioned as a major cause of significant landscape transformations, drying out some areas, affecting native flora and fauna, whilst redirecting water flow to other places, often resulting in the creation of ecosystems that would not naturally exist there. These changes disrupt the local biodiversity and ecological balance. Similar impacts occur when areas are flooded or when underground water conditions are altered, leading to the degradation or replacement of existing ecosystems. These changes significantly impact Country, culture, and community by altering the physical landscape and its systems, in turn, disrupting connections to Country, the practice of cultural traditions, and the transfer of intergenerational knowledge. In addition, modifications to water also affect downstream “neighbours”, causing a domino effect.

“Geographical points for camping and hunting have changed significantly with mining activities, such as dust hill, for instance.”

“Those ‘fake’ ecosystems must be kept forever, according to our responsibilities of caring for Country. We want our place back to its original state.”

“The spiritual connection is gone. We cannot recreate the creek and the landform.”

“What will I show to my children, my grandchildren? It’s our responsibility to teach. We need to pass on our knowledge. With mining, it’s getting harder. It will be a second-hand story if we can’t live it anymore.”

3. **Removal of trees and other vegetation, and the death of animals**, which elicit strong emotional responses such as anger, distress, and sadness. These experiences, besides causing environmental disturbances, contribute to psychological stress and mental health challenges, further compounding the impacts on cultural connection, wellbeing, and the ability to engage in traditional practices.

“Our bush tucker has been destroyed. I cannot see the animals on Country anymore.”

“No consideration is given to how animals and plants will be affected. It makes Country ugly.”

“There is no green there anymore. I feel angry. This breaks our hearts. It is a nightmare. People get depressed.”

“We feel responsible, too. Should I allow it? And there is little we can do.”

4. **Noise disturbances and dust production**, affecting fauna, flora and people.

“The gold goes overseas. We got waste.”

5. **Pollution of air, soil, and surface water and groundwater**, which compromises water quality and its cultural, spiritual, and social values for the community. Water is seen as vital to all life and plays a central role in sustaining Country, culture, and community, whether physically, socially, culturally, or spiritually.

“Water is critical. Medallion’s gap mining is a source of history. The Snake sits there. Dreaming stories. Dreamtime stories are central to our existence, and they are related to the water.”

“Duck Creek is impacted, also the aquifer underneath. The creeks are becoming dried up. Springs are dying. Trees are dying.”

“What is gonna happen to the water after the mine is closed? Without water, we cannot keep our connection to Country. Water is always the case, the conversation.”

6. **Lack of access to Country**, which restricts traditional practices such as ceremonies, rituals, hunting, fishing, gathering, and camping. This limitation disrupts cultural responsibilities and connections to Country. Restricted access, particularly due to mining operations and the strict protocols they impose, was seen as contradictory, given the community's cultural heritage rights and environmental obligations under the Native Title Act 1993. Similar access issues were also noted on pastoral leases.

"We want to walk freely during mining and post mining. Mining sites are difficult to access."

"Isolation from Country. It is the emotional and historic isolation that worries me."

"Access to Country is crucial to restore it and heal people and Country."

7. **Royalty issues**, which were associated with a range of negative cumulative impacts, particularly affecting the destruction of Country and the future of younger generations. The reliance on royalty payments has been perceived as discouraging workforce participation and contributing to substance abuse. These issues emerge within a broader context of dispossession and disconnection from Country, culture, and community, conditions that many view as perpetuating cycles of poverty.

"There is no incentive for the young people to work."

"The Elders group has great concern, because people are more dependent on royalties.

Perhaps, it is worse than being dependent on welfare [Centrelink]."

Tensions within and between families regarding the distribution of royalties were also highlighted. Such disagreements often stem from negotiations over mining agreements, which can exploit the community's internal disputes and reflect differing values and perspectives on how mining activities should be managed and the benefits they should share.

"We get more royalties. But they are nothing compared to what they are taking away from us. It causes discussions. It causes families to argue, to fight. There is no harmony among family groups no more."

"Mining companies are very offensive towards TOs. They play financial games at the cost of traditional bonds to Country."

Discussions on rehabilitation and restoration, and how to address issues caused by royalty distribution, raised essential questions about their validity and the extent to which these processes can deliver meaningful outcomes aligned with the community's visions and aspirations. These aspirations include addressing both past and present impacts, and supporting the re-composition of Country, culture, and community. In this context, the active participation of community members in rehabilitation and restoration efforts is seen as essential, not only for restoring Country, but also for healing people and strengthening their connections to Country. In addition, having a unified system grounded in common ground and shared values for conducting royalty negotiations was seen as a possible way forward.

5.1.3 Positive cumulative effects

Despite the negative effect above, revenues from mining activities were recognised as bringing economic benefits, including job creation and business opportunities (such as those managed by PKKP Enterprises). The existing Trusts managed by the Prescribed Body Corporation (PBC), which are also supported by mining royalties, provide funding for housing, education, and medical care for members, with increased homeownership. There is a target to be reached in the future for future generations to access the Trusts. Additionally, royalties are utilised to support the PBC's programs, including the Language Program, the On Country Program, and the Rangers Program.

There is a recognised need to diversify the PBC's business activities to ensure long-term viability beyond the life of mining operations. Interest was also expressed in exploring opportunities within the mine

rehabilitation sector. Opportunities could include expanding existing enterprises and establishing new ones to provide services related to mine closure planning and post-mining land use strategies.

“Gold mines are opening and closing. There are no continuing employment and royalties that support the corporation and its people.”

These initiatives contribute to both individual and collective wellbeing, supporting cultural continuity and environmental stewardship. Whilst tensions and structural challenges persist, especially regarding royalties and social cohesion, there is a growing awareness of the importance of strategic governance, intergenerational planning, and economic diversification in transforming short-term financial gains into lasting community benefits.

5.1.4 Barriers to incorporate Indigenous Knowledge in RCEAM

Mine closure plans and management issues

Current practices around mine closure planning and management were identified as significant barriers to the incorporation of IK within the RCEAM framework. A key concern reported by PKKP participants was the lack of meaningful community engagement in the development of mine closure plans. In many cases, the industry seeks consent to close a mine without providing detailed information or engaging in genuine dialogue with PKKP members. Impact assessments are often conducted without community participation, leaving communities with limited time and capacity to review complex technical documents. These gaps limit PKKP’s ability to make informed contributions and undermine trust in the process.

Another significant barrier identified by PKKP participants was the lack of accountability in upholding social licence to operate agreements and other management commitments, for example, promises to maintain water flow or protect culturally significant waterholes. These failures reflect broader issues of industry non-compliance with previously agreed arrangements, which in turn erode the foundation for implementing meaningful Indigenous involvement in RCEAM.

“They [industry] do their own impact assessment, and we need to accept it. This is the way it is managed.”

“They do not know what they wanna do. We are barely informed about what they do. They walk away and leave the destruction behind.”

“They need to have a plan from the onset.”

Another issue raised concerns about the future of mining towns such as Karratha, Port Hedland, and Newman once mining activities end. There is uncertainty around what plans, if any, are in place to manage the infrastructure that will be left behind in those towns, as well as on Country. Questions remain about how these assets will be repurposed or maintained, and whether there is a coordinated strategy to support the long-term sustainability of these communities post-mining. The idea of repurposing mining assets for community use was raised.

“We expect mining companies to remove machinery and buildings. Clean up Country and leave the infrastructure that will benefit the community, for instance, a village that can accommodate people when mining is gone.”

Poor engagement

PKKP participants reported poor engagement practices. Very often, the industry engages only a few years before closure, leaving no option to participate appropriately in the development of mine closure plans and

management. As a result, solutions are forced on PKKP without considering the community's views, aspirations, and priorities.

"We want to be part of the mine plan and design. They need to work 20 years in advance."

"They do not wait until mining is finished to start the closure. It must start earlier and with proper engagement."

Concerns were raised about the difficulty of organising meetings with mining companies when it is in the interest of the PKKP community. Additionally, companies often lack the willingness to cover the costs for PKKP members to participate in site surveys. This overlooks the fact that such surveys are a service provided to help companies meet their regulatory obligations. According to participants, the obligations arising from mining operations have created stress and impacts on the community, implying that the industry must be accountable. Another point mentioned is that the industry often lacks cultural awareness and tends to treat all communities the same, demonstrating a lack of understanding of IK and culture.

"I would like to go to Country and sit down with the mining people and talk. They think that all the groups are the same."

In response to these issues, the PKKP members involved in the yarns recommend early and proactive engagement, greater collaboration, and meaningful dialogue and negotiation. This approach recognises that mining activities represent a significant and complex cultural shift for the community, requiring respectful and sustained relationship-building from the outset.

Western scientific dominance in significance assessments

PKKP participants emphasised that significance assessments are primarily based on Western scientific criteria, typically led by archaeologists and anthropologists, rather than being grounded in IK systems, which generates distortions that lead to non-culturally based evidence and ineffective assessment of cultural effects and values. On the other hand, the participants highlighted that in Western Australia, the Aboriginal Cultural Heritage Committee (ACHC), whose members (mostly Aboriginal people) are appointed by the Minister for Aboriginal Affairs, is responsible for overseeing cultural heritage matters at the State level, with a particular focus on determining the significance of heritage sites. However, the system allows assessments to be conducted by Aboriginal people from outside the affected Country. This approach, intended to anticipate future impacts, may increase the likelihood of inappropriate decisions and further harm on Country. It risks overlooking locally specific cultural knowledge and undermines the authority of PKKP members on their own land.

"We must give value and significance to a place."

"I want to see Country protected, and less mining. Or mining agreed to keep the significance of Country. Younger people must understand the significance of Country for our community, my grandfather, my father, my mother [...]."

Effectively communicating the significance of cultural heritage sites attributed by the PKKP community was mentioned as being critical. This includes not only producing detailed technical reports but also providing plain-language versions that incorporate interpretation, storytelling, and context. Such approaches are essential for ensuring that IK is appropriately recorded, understood, and integrated into cultural heritage studies. To support this effort, a clear reporting standard is needed, including a consistent template, a defined scope of work, and expectations around the type and depth of information provided. This level of specificity will help to ensure that reports contain meaningful, culturally relevant content that supports informed decision-making. Equally important is the need for ongoing monitoring after a professional completes a report. In some cases, communities have returned to heritage sites years later only to find they

have been damaged or destroyed. Without monitoring and accountability mechanisms, reporting alone is insufficient to protect cultural heritage in the long term.

No data sharing

A key barrier to effective I-RCEAM is the mining industry's lack of transparency and data sharing. Critical information, including site disturbance records, environmental monitoring results, and impact assessments, is often withheld or not made readily accessible. This lack of access makes it extremely difficult to assess, track, or manage cumulative impacts across landscapes and over time in a desirable way. Without consistent and shared data, communities are left without the tools to understand the full extent of change on Country. Specifically, access to water data was identified as essential, particularly the data industry provides to regulators, for developing meaningful and effective water management plans. Without access to this information, PKKP members and the PBC are operating in the dark, unable to fully assess the impacts of water extraction, discharge, or diversion on Country, mainly on cultural sites and ecological systems. Water is not just a resource, it is a living cultural entity and central to the health of people, land, and lore. This transparency would ensure accountability, support evidence-based decision-making, and trust building. Without it, understanding and managing water resource risks are incomplete, one-sided, and ultimately harmful to Country.

Improved data-sharing protocols and transparency were considered essential for informed decision-making, long-term planning, and the meaningful incorporation of IK into RCEAM. Without access to this information, any process claiming to be collaborative or inclusive remains fundamentally imbalanced.

Inadequate legislation and a lack of government capacity

Legislation was also reported as a barrier to I-RCEAM, mainly the limitations concerning the Western Australian Aboriginal Heritage Act 1972, the Western Australian Environmental Protection Act 1986, and the Native Title Act 1993.

According to the community, the Western Australian Aboriginal Heritage Act 1972 does not provide adequate guidance or authority to address the community's needs in determining which sites should be protected and why they hold significance. It is not designed to protect or manage Aboriginal heritage proactively. Instead, its focus is limited to assessing the potential impact on specific sites, often neglecting the broader cultural and spiritual significance of places as interconnected landscapes. As a result, many important areas are excluded from consideration altogether. Participants underscore that, for example, the Western Australian Environmental Protection Act 1986 protects threatened species but does not address culturally significant species, thereby compromising the future of ecosystems and culture.

Participants raised that, under the current Native Title system, territorial boundaries are represented as straight lines on a map, which they consider an imposed construct rooted in Western legal and administrative traditions. These 'white society lines', as referred to in the yarns, dictate where one claim ends and another begins, drawing artificial separations across Country. As highlighted by PKKP participants, Indigenous Country boundaries are not defined by lines, but by natural landmarks, such as rivers, hills, and waterholes. These features carry cultural meaning, lore, and stories that connect people to place. The idea of stopping at an invisible line contradicts the interconnected nature of Country and kinship, thereby affecting and limiting the responsibilities and capabilities of CEAM.

"The Ashburton River on our Country is the bloodline place for our family and another language group. The Northern side is my mother's Country, and the Southern side is my grandfather's Country."

This artificial system not only divides communities but also grants pastoralists and mining companies extensive control over tenement or lease areas. Within those lease boundaries, they often hold the legal authority to make decisions, alter landscapes, and conduct activities with minimal input or accountability to Traditional Owners. This imbalance of power further marginalises Indigenous voices and undermines cultural obligations to care for Country holistically and continuously.

“Before mining, we knew the language groups. There was no segregation. The Elders ruled. Now, that Kinship is just a word. There is no cohesion and connection anymore.”

“Native Title and mining interactions must focus on the protection of the present landscape according to the Elders' advice to reflect who we are and enable future generations to keep culture and Country.”

Agencies from the Western Australia Government, such as the Environmental Protection Authority (EPA), the Department of Planning, Lands and Heritage (DPLH), and the Department of Biodiversity, Conservation and Attractions (DBCA), were mentioned as, in many cases, supportive of Indigenous groups' requests relating to heritage protection and environmental stewardship. However, their ability to respond meaningfully is often constrained by systemic issues.

“We wish the agencies and departments could participate more in the mining process to protect heritage and the environment.”

According to participants, these agencies are typically understaffed and under-resourced, and lack the institutional support needed to implement or advocate for substantial change. Even well-intentioned regulatory personnel face significant limitations. Without adequate political backing, legislative clarity, or operational capacity, their efforts to uphold Indigenous rights and protect Country are frequently compromised. As a result, meaningful reforms are delayed or diluted, and the gap between policy rhetoric and practical outcomes continues to widen.

These agencies and the WA Government more broadly were reported to be not fully regulating mining activities, allowing PBCs and mining proponents to engage directly without meaningful oversight or involvement. The main issue is determining who should regulate such activities. Instead, those agencies permit negotiations between PKKP and mining companies to proceed independently, with the outcomes of these negotiations —typically in the form of a management plan—serving as the basis for approval conditions. In doing so, the regulatory bodies fail to fulfil their regulatory responsibilities, effectively hiding behind the PBCs rather than actively upholding their role.

Non-inclusive decision-making process

The decision-making process itself was identified as a barrier to the protection of Aboriginal heritage. In particular, the use of Section 18 of the Western Australian Aboriginal Heritage Act 1972, which enables the destruction of culturally significant sites with ministerial approval, was raised as a serious concern. The destruction of Juukan Gorge was cited as a prominent example. Although Rio Tinto had obtained legal approval under heritage laws, the incident highlighted significant flaws in those laws. It raised critical issues about corporate accountability, Indigenous rights, and the need for stronger cultural heritage safeguards.

“There is a significant place here, we say. They go to Section 18. Why do surveys?”

“The Minister can veto any decision. We must make sure that the Juukan Gorge issue never happens again.”

The community participants expressed a strong desire to have a genuine voice in these processes. They emphasised that they should not be pressured into agreements that do not reflect their values or priorities.

“They [mining companies] give you everything you know, until you say no. Then, everything stops. We sit at the table. Discuss. They tell us one thing and then do another. It’s the same discussion over and over again.”

“Native Title does not allow one to say NO to mining activities.”

5.1.5 Opportunities to incorporate Indigenous Knowledge in RCEAM

Early engagement and partnerships

PKKP participants emphasised the critical importance of engaging with the right people from the very beginning, including both professionals and community members with cultural authority. As one participant noted:

“They need to engage as early as possible with the right people on board, professionals and members. We want to make positive change, driven by Elders like myself.”

“We must get a voice to ensure that operations can incorporate traditional practices.”

An early engagement framework should be established well in advance of any exploration activity. This is essential to achieving FPIC and to avoid pressure-driven consultations. The process must allow sufficient time for communities to ask questions, be heard, and participate in the gathering, assessment, and management of data that affects their Country, community, culture, and future. Ongoing consultation must continue throughout the life cycle of a mine. Genuine dialogue, transparency, and long-term relationship-building are key to ensuring that mine closure planning remains responsive to community values, expectations, and rights.

“Relationships must be ongoing. A true, genuine partnership. We want to be more proactive than reactive.”

“We are not anti-mining, but we do not want people running over us. We want real, true negotiations.”

“Decades ago, there was no consultation. With Native Title, they have to consult.”

Concerns were also raised about the quality and integrity of consultation processes. Participants warned that some mining companies may employ manipulative tactics or engage in rigid, one-sided negotiations that fail to reflect a genuine partnership or consent.

“We need to be careful, because mining companies can manipulate people. Negotiations can be dogmatic.”

This highlights the need for clear protocols, cultural governance structures, and accountability mechanisms to ensure consultation is meaningful rather than merely procedural. Participants emphasised that respect for Indigenous lore, leadership, and timelines is essential to building trust and avoiding extractive or coercive engagement practices.

Co-leadership in mine closure planning

PKKP participants expressed a clear and consistent desire to move beyond consultation and into genuine co-leadership in the planning, design, and management of mining projects across their Country.

“We want to be able to inform the design of mining plans.”

For the participants, co-leadership means having an active role in shaping decisions from the earliest stages, including baseline assessments, impact studies, and operational and closure planning. This is not only a

matter of rights and responsibilities, but also about achieving better outcomes for Country, culture, and future generations. A key area of concern is water management, particularly regarding permits, reinjection practices, and long-term aquifer recovery.

“PKKP wants to guide, support, and inform best practices for water management.”

“Water reinjection is a good practice, but we need water management plans in place.”

PKKP participants are calling for robust, co-developed water management plans, along with ongoing monitoring and evaluation of industry compliance with environmental conditions. The participants highlight that water cannot be managed in isolation. It must be understood in the context of animals, plants, and spiritual relationships with the land.

“We must manage the vegetation and the animals together with the water.”

The community is also actively managing Country through rangers and heritage protection work and seeks stronger recognition and integration of that expertise into mine life-cycle planning.

“We have been actively managing cultural heritage sites.”

“We want to minimise or avoid adverse impacts on natural resources and cultural sites, and help proponents to protect those sites, getting better outcomes.”

This effort includes support for revegetation and ecological restoration wherever possible, and a demand for more strategic, long-term environmental planning by proponents that incorporates IK.

“We want revegetation and as much restoration as possible.”

“Western practices will heavily impact future generations. We had to adapt to those practices to survive. Embed them in the traditional practices.”

To ensure their values are respected and incorporated meaningfully, the participants expressed the need to develop their own environmental strategy plan, land use and management plan, and a statement of values and concerns to inform baseline data collection and IA studies.

“State what matters for PKKP from an environmental and heritage perspective, for example, as a baseline for Impact Assessment studies. This is what we have to do.”

These tools would form the foundation of Indigenous-led planning and provide a clear framework for evaluating mining proposals at every stage of the project life cycle. Co-leading mine closure strategies will ensure they align with cultural obligations, environmental needs, and community aspirations for Country’s future.

“Industry must have a robust mine closure plan. PKKP must be involved in it. Currently, we do not have any involvement at all. It is our Country.”

“We must be there to approve the plans [such as mine closure and water management], to ensure the water flows. We must find a solution together.”

Co-leadership in mining development management

An agreement is now in place with Rio Tinto that recognises and protects cultural heritage rights. This co-management framework is built on the principle of co-leadership, in which both parties have meaningful roles in decision-making. The goal is a win-win situation, respecting and safeguarding PKKP rights whilst allowing agreed development that does not compromise fundamental cultural values. Whilst it may not be possible to protect every cultural site, this agreement ensures that the most culturally and spiritually significant sites are protected. Importantly, PKKP now has a voice, a say in where mining or other development can and cannot occur on their Country.

The co-management agreement includes Heritage Management Protocols that go beyond the legislative minimums. These protocols are legally binding and set clear expectations for all parties. Following the Juukan Gorge tragedy, which had a profound and traumatic impact on both PKKP and mining companies, the agreement with Rio Tinto has become a model of reconciliation and co-leadership. It recognises the need to not just comply with the law but to build trust, respect, and accountability into everyday decision-making.

The agreement ensures that if Rio Tinto fails to meet its obligations, PKKP can pursue legal action. According to the participants, this arrangement was hard-won and reflects a shift in how business is done post-Juukan Gorge incident, not just from a legal standpoint, but from a value-based one.

“When mining companies go into an agreement, they cannot walk away anymore and leave a mess.”

A key part of this co-leadership model is the Co-Management Committee. This committee plays a central role in reviewing all company proposals that impact Country and heritage, preparing recommendations and advice for the Land Committee, and identifying conditions for supporting or rejecting proposals.

The Land Committee, comprising representatives of PKKP peoples, has the final say on development proposals. This requirement ensures that mining companies cannot force decisions on Country and that community control is maintained. Significantly, this committee operates both within and beyond the legal framework, often without government support. For example, Section 18 of the Western Australian Aboriginal Heritage Act 1972 can only be applied if PKKP supports it, effectively giving PKKP a veto power. In this context, the co-management agreement with Rio Tinto is seen by participants as best practice. Despite being a one-off arrangement focused solely on heritage issues, it sets a new standard for other Indigenous communities to follow. It may be extended to different topics, such as environmental ones. However, the co-management agreement with Rio Tinto demonstrates that win-win outcomes are possible when PKKP members are respected as equal partners. By embedding co-leadership, legal safeguards, inclusive governance, and cultural respect into these agreements, PKKP is not just protecting Country, but leading a new way forward for how land, culture, and development can coexist.

“The Rio Tinto Agreement was the first one, and with PKKP. They should continue the dialogue with other TOs.”

“We would like to generate other groups’ interest in participating in co-management agreements with industry, as we have, to secure future generations’ rights together.”

In addition, decision-making in PKKPAC is family-centred, with family representatives sitting on the PBC, and additional input gathered through:

- community forums, such as the Annual General Meeting
- direct engagement with members on key issues
- consultations with Traditional Owner (TO) groups to ensure culturally safe decisions.

This layered approach ensures that decisions reflect the collective community will, not just boardroom discussions. It honours the principles of self-determination and cultural governance. Whilst co-leadership agreements and heritage protocols have strengthened the role of PKKP in protecting Country, participants reported that challenges remain, particularly with government agencies like Main Roads, Synergy, and Water Corporation. These entities can bypass key heritage protections, including Section 18, by claiming exemptions related to essential services, public safety, or strategic infrastructure. According to the participants, these terms are often vaguely defined and loosely applied, allowing projects to proceed with minimal or no consultation. Language such as ‘urgent’, ‘critical’, or ‘state-significant’ is frequently used to justify rushed decisions, effectively undermining the spirit of co-leadership and increasing cumulative effects. This ability to circumvent regulation highlights the ongoing need for stronger accountability mechanisms and for co-management agreements to explicitly include these agencies in consultation protocols, ensuring Indigenous communities are not sidelined, even in cases involving so-called essential services.

Another critical source of cumulative effects, which adds to the impacts of mining operations, is pastoral activities. Whilst there is often a need to maintain good relationships with pastoral leaseholders, especially where land access overlaps, there remains a significant legislative gap regarding their obligations for cultural heritage protection. Unlike mining or infrastructure projects, pastoral activities are often excluded from formal consultation processes, despite their potential to impact heritage sites over time. This legal gap places the burden on PKKP members to manage these relationships informally, without the backing of regulation or a binding co-management framework. To ensure consistency and respect across all land uses, participants suggest strengthening this area of the law to require pastoral operations to engage in meaningful consultation and to protect cultural sites.

Regional agreements with other Indigenous groups

Whilst each Indigenous group can only speak for their own Country, and each language group and Nation has its own Lore, stories, and responsibilities, PKKP participants recognise that many of the challenges they face are shared across the region. Issues like water, flora, fauna, fire management, and land use do not stop at boundary lines. The importance of building regional agreements with other Indigenous groups was also raised. Agreements based on mutual respect, common sense, and shared ground. According to the participants, the old divisions of ‘my Country’ and ‘your Country’ must make way for a unified voice. The participants acknowledge that it’s not about giving up identity or authority, but rather about strengthening the collective cultural continuity, ensuring that cultures stay strong and their voices are heard together on issues that affect all. Regional cooperation is not just strategic, it is necessary and timely.

“We are all part of the same environment and must work together to protect it.”

“Do it jointly with other language groups, who are Native Title holders, and also with government and non-government sectors. Onslow, Roebourne, Marble Bar, and Port Hedland have a shared vision.”

The participants cited two regional initiatives considered good practices with the potential to be amplified: the Yule River Bush Meeting, which brings together people from WA Mid-West and the Pilbara, and the Martuwarra (Fitzroy River) Indigenous initiative in the Kimberley.

The Yule River Bush Meeting is an example of regional collaboration and Indigenous-led governance. It is an annual gathering organised by Yamatji Marlpa Aboriginal Corporation (YMAC). The Yule River meeting provides a culturally grounded, community-driven forum where PKKP and other communities come together to discuss issues of common concern, most notably, education, training, health, and broader policy matters affecting Country and culture. Critically, there is a standing request for Ministers and government representatives to attend (not to lead), but to listen and engage with the groups. The Yule River Bush Meeting embodies the potential to leverage co-leadership and unity at a regional level, demonstrating how grassroots voices can drive top-level policy conversations when given the space and respect to do so.

The Martuwarra (Fitzroy River) Indigenous initiative in the Kimberley is another example of regional Indigenous leadership that was mentioned. This initiative represents a proactive and united approach by Indigenous groups along the Fitzroy River who are working together to protect one of Australia’s last free-flowing river systems. Martuwarra Council brings together six Indigenous groups with a shared responsibility for the river, working to safeguard the river from harmful development. The Martuwarra River Keepers program supports Traditional Custodians in using IK to restore Country, build sustainable cultural economies, and champion the river’s right to flow. This initiative strengthens efforts to protect the river from major threats such as fracking and climate change.

Capacity building

Capacity building within the PBC was considered critical to ensuring that PKKP members are not just consulted but actively lead the decision-making processes that affect their Country. With a more capable PBC, we can transition from passive participants to proactive leaders in negotiations and planning. This includes having in-house expertise to engage with mining companies throughout the entire life cycle of a project, from early approvals to closure and rehabilitation.

“The PBC is our backbone. Our staff helps us. They fight first for us. They stand in front of us. Mining companies need to come and talk to us.”

In recent years, relationships with mining companies have improved significantly due to the presence of new staff, including individuals who previously worked in the industry and are fluent in the language. However, the lack of funding to retain experienced professionals remains a barrier. This gap highlights the need for long-term investment in PBC capacity. According to the participants, the government should require all proponents to fund capacity-building measures as a standard condition of engagement, ensuring that PBCs have the right people, with the proper knowledge, at the table. It is also vital for PKKP participants that PKKP invest in emerging leaders and staff training so they understand mining processes, corporate governance, and the terms of relevant agreements. Succession planning is also key to maintaining strong, consistent relationships with proponents over time. Capacity building is a strategic, long-term commitment to Indigenous self-determination and effective co-leadership.

In conclusion, the PKKP participants’ perspective reveals that the legacy and ongoing impacts of mining extend far beyond environmental degradation, encompassing deep cultural, emotional, and intergenerational harm. The exclusion of IK from regulatory frameworks and mine closure planning reflects broader systemic inequities that continue to marginalise Indigenous voices and disrupt relationships to Country. However, the insights shared by PKKP participants also point to a path forward, one rooted in respect, reciprocity, and shared authority. By embedding IK through early engagement, co-leadership, culturally appropriated RCEAM framework, and culturally grounded governance, mine closure planning can evolve into a process that not only mitigates harm but also actively supports cultural continuity and community resilience. Achieving this requires structural reform, genuine power-sharing, and a sustained commitment to Indigenous-led futures. Only then can development be reconciled with the enduring rights, responsibilities, and sovereignty of Indigenous peoples.

5.2 Non-Indigenous perspectives

In this section, we present the results of 14 interviews conducted with individuals from the industry, government, non-governmental organisations, and research agencies. In addition to the yarns developed with PKKP, the interviews aimed to explore barriers and opportunities to incorporate IK into RCEAM in the Australian context. The results indicate an evident willingness to develop and implement an I-RCEAM framework, including exploring co-leadership opportunities as a viable pathway. However, key barriers are embedded within the broader context of business operations, including existing regulations and practices that require critical review and revision. Note that the term Traditional Owner(s) was used in this section to refer to Indigenous individuals or groups, reflecting the terminology applied by interviewees. The non-Indigenous perspective barriers and opportunities identified by interviewees for incorporating IK into RCEAM in the Australian context are summarised in Table 10.

Table 10 – Non-Indigenous perspectives on barriers and opportunities for incorporating IK into RCEAM in the Australian context.

Non-Indigenous Perspectives	
Barriers and Opportunities for incorporating IK into RCEAM in the Australian context	
Barriers	
No data sharing	Data is withheld due to commercial sensitivity and competitive pressures; no regulatory mandate to share; EPA cannot compel sharing, creating fragmented assessments; misalignment with Indigenous data sovereignty expectations; and a lack of consistent rules discourages transparency and regional baselines.
Non-inclusive decision-making	Decisions ultimately rest with the government or proponents, with Indigenous views treated as consultative rather than influential; IK is often undervalued in formal processes; early governance structures lock in exclusion; cultural concerns, especially around water, are rarely embedded.
Lack of government capacity	Agencies lack the staff, funding, and technical expertise needed for cumulative assessments; heritage and IK functions are under-resourced; Indigenous participation is undercompensated and inconsistently supported; skills shortages hinder holistic, systems-level evaluation.
Outdated legislation and institutional silos	Century-old laws and a lack of IK mandates limit Indigenous inclusion; departmental silos prevent coordinated, cumulative assessments; cultural values are considered only when tied to biophysical effects; legislative gaps make IK integration voluntary and inconsistent.
Poor engagement	Traditional Owners face limited capacity and overwhelming demand for input; engagement remains transactional and extractive; bureaucratic hurdles and fragmented processes prevent meaningful dialogue; lack of long-term relationships undermines trust.
Post-mine closure challenges	Unclear governance and land responsibility after closure restrict Indigenous involvement; a lack of long-term funding and institutional support limits the scope of ranger or stewardship roles; closure impacts Indigenous communities disproportionately; potential exists but needs early investment.
Time and budget constraints	Short project timelines undermine trust-building and IK integration; budget pressures reduce co-designed research and Indigenous engagement; IK becomes a discretionary cost; mismatched temporal expectations lead to unmet commitments.
Opportunities	
Capacity building	Long-term investment in Indigenous governance and leadership is essential; capacity building must also occur within government/regulators via on-Country learning; recognition of IK as legitimate expertise requires procedural reform; co-leadership becomes possible with sustained support.
Early engagement and relationship-building	Engagement must begin early, be relational, and be embedded in organisational systems; trust is central and easily eroded; on-ground presence and respect for cultural protocols are essential; aligning timeframes supports meaningful participation.
IK incorporation and Indigenous co-leadership	IK is often marginalised by scientific dominance but can reshape assessment foundations if included early; Indigenous priorities differ from Western metrics and require structural inclusion; co-leadership models show promise but need investment in governance capacity.
Mandatory regulation and guidance for I-RCEAM	Lack of explicit IK requirements limits consistency and longevity; mandatory frameworks (such as in Canada) could institutionalise IK alongside science; structural reform is slow but necessary; interim procedural solutions could embed Indigenous authority sooner.
Regional collaboration and strategy	Current practice is fragmented; regional coordination can address cumulative effects; collaborative initiatives (e.g., the Pilbara Cultural Land Management Project (PCLMP)) show how shared platforms and ranger programs support IK integration; strategic oversight strengthens trust and landscape-scale management.

Barriers and Opportunities for incorporating IK into RCEAM in the Australian context

Risk management	Cumulative risks are poorly recognised without IK; early involvement reduces long-term financial, environmental, and cultural risks; mandated CEAM encourages collaboration; Indigenous worldviews expand the definition of risk and support better long-term planning.
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5.2.1 Barriers to incorporate Indigenous Knowledge in RCEAM

No data sharing

A significant barrier to the effective and meaningful involvement of Indigenous peoples in RCEAM, as reported by interviewees, is the lack of robust, transparent, and equitable data-sharing mechanisms. Interview participants repeatedly highlighted that current data practices not only limit technical integration across assessments but also undermine trust, cultural respect, and recognition of Indigenous rights and governance.

Several participants noted that whilst the requirement for CEA is becoming more embedded in environmental legislation, data ownership and sharing continue to be governed primarily by proprietary concerns rather than collective or public benefit. One industry participant noted that despite investing millions in data collection, proponents are often reluctant to share data due to competitive pressures and concerns that disclosure might hinder their ability to secure approvals.

“You might spend \$10 million doing all of your survey work just to give it to someone else for free.”

This fear is compounded by legal sensitivities surrounding land development and cumulative thresholds, where “whoever develops first is probably gonna be the only one that gets an environmental approval.”

This protective stance is not limited to inter-organisational relationships. Even within entities, such as joint ventures involving Indigenous partners, data sharing may be restricted. The implications of such constraints are considerable, particularly when Indigenous groups are required to participate in cumulative assessments without access to data relevant to their lands, values, and communities.

An interviewee from the WA environmental policy and legislation space further highlighted the institutional limitations around data sharing. The EPA, for example, lacks the legislative authority to compel proponents to share data, even when cumulative effects outside the immediate project envelope are clearly at stake.

“The proponents can’t be compelled [...] the EPA does not have the power to compel them to share those data either.”

This lack of sharing creates a fragmented approach to assessment, where each proponent focuses narrowly on their operations, despite the broader catchment-scale impacts. Beyond technical and legal constraints, deeper methodological and ethical concerns were raised. Indigenous conceptualisations of data and knowledge differ significantly from Western scientific paradigms, and this misalignment must be addressed to ensure respectful integration. As one researcher reflected:

“Their understanding of data is a very different one from our understanding of data [...]. We also [must] listen to their way of thinking and then try to combine these two worlds.”

Data sharing initiatives that do not take Indigenous data sovereignty, consent, and stewardship seriously risk being perceived as exploitative. This concern was clearly articulated by another researcher, who argued that knowledge is treated as a resource rather than a responsibility.

“The risks are inappropriate management of knowledge or using that inner exploitative way, using it as a resource as opposed to not taking ownership over it, but you having that information to inform decision-making.”

The problem is further exacerbated by the lack of consistent regulatory frameworks that require data sharing amongst all relevant actors. One interviewee, who worked in the WA regulatory space, noted that whilst some companies may be willing to share data, they hesitate to do so unless it is a universal requirement.

“They only want to do it if everyone’s required to do it [...] Otherwise, everyone will go back down to the lowest common denominator.”

This absence of a level playing field disincentivises voluntary leadership and hinders the creation of shared regional baselines. However, as a participant highlighted, some examples and precedents could inform reform. For instance, WA’s Privacy and Responsible Information Sharing Act 2024 (PRIS Act) mandates the disclosure of public data after a limited period of commercial confidentiality, subject to specific established rules that strike a balance between protecting private investment and promoting public interest. A similar policy model, adapted for cumulative environmental data, could support a more transparent and inclusive RCEAM process.

Ultimately, overcoming data sharing barriers is not solely a technical or administrative task. It is a matter of justice, trust, and respect. Without substantial changes in how data is governed and shared, efforts to embed Indigenous perspectives and knowledge in RCEAM will remain fragmented and insufficient.

Non-inclusive decision-making processes

A recurring theme throughout the interviews is that decision-making structures within CEAM often exclude or marginalise Indigenous voices, thereby undermining efforts to achieve meaningful Indigenous involvement. Whilst consultation and community engagement may occur in some contexts, the absence of real decision-making power and structural inclusion limits their effectiveness and perpetuates unequal governance systems.

Several interviewees noted that ultimate decisions on land use, project closure, and rehabilitation are often determined by government priorities or corporate finance rather than through co-led processes with Indigenous groups. In the case of a post-mining land use project, one industry participant acknowledged that whilst Indigenous and local community views are essential, they hold little sway in actual decision-making.

“Whether it’s community members in Collie, Indigenous members that live in Collie or elsewhere [...] I think their opinions are important, but I’m not necessarily sure of how much say they get to make in the decision-making process.”

“Although community reference group meetings are held, the process stops short of integrating Indigenous voices due to the lack of established communication mechanisms and structural barriers to inclusion.”

These statements reflect a broader issue: when power remains centralised in government or proponent hands, Indigenous involvement becomes consultative at best, not co-decisional. Moreover, the governance structures established early in project approval processes often determine the extent to which Indigenous involvement is possible downstream. One interviewee from the WA regulatory space noted that decisions made at the project’s outset can significantly influence the entire governance framework, either facilitating or hindering Indigenous inclusion over time. The participant described negotiations for a processing plant, during which a benefits agreement was struck for broader Aboriginal communities. At the same time, the specific group whose Country would be directly impacted struggled to ensure their environmental concerns

were formally addressed. Despite a visible EIA process being run by the EPA, IK and cultural concerns, especially around water, were not embedded structurally.

Similarly, IK is often not recognised as legitimate or influential in shaping outcomes. The same participant reflected critically on how IK is not valued, noting that whilst engagement with Indigenous people might occur:

“Indigenous Knowledge [is] not really being understood, valued, [or] changing anything [...] not valued basically in the decision-making process.”

This observation underscores a fundamental flaw in current governance systems: the persistence of technocratic or colonial models that treat IK as supplemental rather than central to environmental decision-making, in contrast to the Canadian and Norwegian examples discussed in section 2.3.

Lack of government capacity

According to the interviewees, the effective and meaningful Indigenous involvement in RCEAM is significantly constrained by limited government capacity, both in terms of resources and institutional capabilities. Interviews across the industry and public sector consistently highlighted a shortage of skilled personnel, fragmented responsibilities across agencies, and underinvestment in the scientific and Indigenous involvement functions necessary to support cumulative, landscape-scale assessments.

Government agencies responsible for managing environmental assessments often lack the human and financial resources to undertake broader responsibilities, such as managing protected areas or participating consistently in Indigenous involvement processes. As one participant with experience in the WA regulatory space explained, even when areas of high conservation value are identified, the government does not have the capacity to protect or manage them:

“It’s not like the regulator or government has the capacity to make it a National Park [...] because they don’t have the resources or the money to manage it.”

This lack of capacity has direct consequences, for example, for the recognition and preservation of culturally significant sites. Current tenure systems often force development even in areas identified as sensitive or valuable, because the legal and economic frameworks incentivise land disturbance over conservation.

The disparity in involvement between different departments was also raised. Whilst agencies such as the Department of Water and Environmental Regulation (DWER) routinely participate in environmental impact assessments (EIAs), others, most notably the Department of Planning, Lands and Heritage (DPLH), often lack the staffing or mandate to engage in heritage survey processes. One industry participant explained that:

“They don’t send a person out. They’re not involved in your heritage survey in any way [...] If the government and that department had Indigenous people that were working for them [...] reviewing the reports [...] asking questions and holding us accountable, that would be a really good process.”

This absence creates an imbalance, where Indigenous participation in heritage surveys is often assumed to be ad hoc, underpaid, and not fully integrated into the broader decision-making process. Indigenous individuals are typically paid only for the days spent in the field. At the same time, follow-up, reporting, and participation in impact mitigation are left unpaid, effectively demanding volunteer labour to ensure their own cultural values are protected. This not only limits ongoing involvement but shifts the burden onto individuals who often lack the institutional support that agency staff enjoy.

A further dimension of the capacity issue lies in the erosion of scientific and technical expertise within regulatory bodies. Several interviewees highlighted how regulators now struggle to attract and retain skilled personnel, especially in competition with the resource sector. Specifically, the interviewee with a regulatory background says that:

“There’s been decreasing investments in the science capability within regulator organisations [...] [and] an under-appreciation of the significance of the science that underpins their work.”

Specialised skills such as hydrological modelling and systems-level cumulative impact modelling are in short supply, limiting the government's ability to assess broader environmental changes and to incorporate Indigenous landscape-level understandings. Even when such expertise exists within private companies, it is typically deployed at the project level, rather than aligned with the whole-of-system thinking necessary for CEAM. This misalignment hampers the creation of regional environmental baselines and shared frameworks that could accommodate both Western science and IK systems.

Outdated legislation and institutional silos

Enhancing Indigenous involvement in RCEAM faces two critical and interrelated barriers in the current WA context: outdated legislative frameworks and institutional silos. These systemic barriers significantly limit not only the inclusion of Indigenous values in decision-making but also constrain meaningful participation and shared governance.

A common theme across all interviews was the inadequacy of current legislative frameworks to incorporate IK and values into CEAM. One participant highlighted that WA’s water legislation, dating back to 1914, remains in effect, characterising it as part of an outdated policy infrastructure that "shaped those views" of ownership and management in ways that are incompatible with contemporary understandings of Indigenous rights.

A participant from the WA environmental policy and legislation space echoed this concern, noting that there is no legislative requirement for Indigenous involvement or for incorporating IK. This legal omission significantly weakens any systemic obligation for the EPA or project proponents to involve Traditional Owners in decision-making processes in a meaningful way. The interviewee stated that:

“You're right from a legislative point of view, there is no requirement, [and] the use of Indigenous Knowledge and Indigenous Environmental Knowledge and values are not explicitly called out in the legislation.”

Although some protections for Indigenous heritage were previously assumed under the Aboriginal Heritage Act 1972, the Juukan Gorge incident in 2020 exposed its severe limitations, demonstrating a lack of appropriate legislative infrastructure dedicated to safeguarding Indigenous values beyond some heritage sites.

One interviewee from the regulatory space added that “the rights of Indigenous people in our regulatory setting are not contemporary,” which in turn undermines the “responsibilities of the government” and creates barriers for even well-intentioned actors within agencies to act meaningfully. This disconnect reveals that outdated laws not only fail to facilitate Indigenous involvement in RCEAM but also actively disempower good practice by failing to support it through clear mandates.

Another systemic issue repeatedly mentioned was the persistence of departmental silos, which hinders integrated, cross-agency collaboration essential for RCEAM and meaningful Indigenous involvement. A participant from the WA environmental policy and legislation space similarly observed the impact of bureaucratic fragmentation. Whilst the participant acknowledged that “behind the scenes [...] there’s a lot of communication [...] across agencies,” he also admitted that from the outside, these efforts “probably appear [...] more siloed”. The participant added that “even within companies, they will be broken into their particular areas of focus,” which mirrors the siloed structure of government and industry and further complicates coordinated action across sectors, stakeholders, and rightsholders.

This participant also explained that economic and social dimensions of cumulative effects are essentially “outside the scope of the environmental regulator’s remit” and are instead considered separately. This

reflects the narrow remit of environmental assessments, which, despite not including Indigenous ecological knowledge, compartmentalises decision-making and inhibits holistic approaches that could incorporate Indigenous socio-cultural, spiritual, and economic values. The combined impact of outdated legislation and institutional silos severely limits the capacity for IK to be recognised, let alone embedded, in RCEAM processes. The participant stated that:

“A lot of the discussions that I was having with mining companies were about them having to improve their relationship with Traditional Owners [...] to include them in the assessment process.”

However, without a legislative mandate, such efforts often rely on voluntary action and goodwill, or on ‘sticks’ like the appeals process to encourage better behaviour. Even where Indigenous values are recognised, they are often subordinated within narrow legislative interpretations. For example, one interviewee described how cultural values concerning environmental issues are only considered when tied to biophysical changes, such as a drying waterhole affecting a sacred site. This biophysical filter limits the scope of Indigenous worldviews, which are relational, place-based, and difficult to compartmentalise. An interviewee also noted that non-listed species or values identified by Traditional Owners are not necessarily considered within the current legislative framework, unless they are deemed likely to become significant in the future. This underlines the reactive rather than proactive nature of existing assessment regimes.

Poor engagement

Poor engagement with Indigenous communities is a systemic and persistent barrier to implementing IK and participation in RCEAM. The interviews suggested that capacity constraints, bureaucratic hurdles, fragmented engagement structures, and a legacy of extractive practices all contribute to ineffective and often tokenistic consultation. Only by addressing these issues directly can RCEAM processes begin to embody Indigenous involvement.

A dominant theme emerging from interviews is the severe constraint on TO groups’ ability to participate in engagement processes due to limited internal capacity. This limitation affects not only their availability to engage but also the quality and continuity of such engagement. Participants highlighted that TO representatives are often stretched thin across multiple sectors, projects, and obligations. Engagement schedules are typically set years in advance, yet their success remains contingent. This issue is compounded by the fact that the same few individuals with cultural authority are repeatedly approached. The result is an over-reliance on a small number of people with the cultural authority to speak on behalf of the community, creating a systemic imbalance between the high volume of external demands and the limited supply of Indigenous voices authorised to respond. One interviewee from industry explained that:

“Our ability to engage with Traditional Owners is extremely limited by their capacity [...]. We’re not the only proponent [...] engagement is not the Traditional Owners’ only job.”

“If you’re a corporation and you have an Indigenous engagement division [...] they’re all talking to the same people [...]. It’s a lot of pressure on individual points in the community.”

In many cases, existing engagement mechanisms are either underdeveloped or overly transactional, limiting their effectiveness. For example, some regions lack any formal process for engagement on closure or cumulative effects. The same participant explained that:

“We don’t have any kind of formal engagement process in place with Indigenous people [...]. Traditional Owners have been invited to [the community reference group] for a number of years and have never been able to attend.”

Even when engagement occurs, it often reflects extractive tendencies, with Indigenous individuals and groups viewed as sources of information rather than collaborators. This reflects broader critiques of

engagement processes that treat IK as a data point rather than a foundation for co-management. This is clear in the statement of an industry interviewee:

“We often go into stakeholder engagement because we need to extract from you what your values are [...]. It's about taking from you something to allow us to make a decision.”

In some cases, the process is further obstructed by logistical and bureaucratic hurdles. For instance, one participant described the difficulty of compensating Traditional Owners for their time. Without formal mechanisms to fund Indigenous participation in planning or closure, participation becomes voluntary, unrecognised, and unsustainable. This participant explained that:

“One of them has his own ABN [...] but other Traditional Owners don't, so you're sort of asking them to sacrifice their personal time [...].”

Interviewees from industry also acknowledged that many current challenges in engagement stem from historical neglect.

“We didn't involve Indigenous people when we started ripping holes into the continent. So, now there's a big mess, and we're asking for their help [...]. They're gonna ask: Why now are you getting me involved? Why should I care now?”

The failure to build long-term, trust-based relationships continues to impede collaboration. In one example, a participant from the regulatory space lamented that in the 1990s, at a flagship environmental research institute, there was “zero engagement with Indigenous people and zero recognition and value of Indigenous Knowledge.” Despite efforts at co-management in park operations, for instance, Indigenous voices were excluded from the scientific domain. These patterns persist today, with an industry interviewee noting that without open and regular communication, it is “really challenging to take their considerations into our future plans if we don't actually know what they are.”

The regulatory environment also contributes to poor engagement. National and state-level consultation prescriptions are often overly standardised and poorly adapted to local contexts. This leads to Aboriginal organisations being “swamped” with engagement requests they neither want nor can process. A participant from the regulatory space said that:

“They're done at such a generic level [...]. They just have no capacity to be properly varied at a local and regional level.”

Furthermore, the project-by-project nature of current engagement frameworks leads to fragmentation. As one industry interviewee noted:

“If we're going individual project by individual project [...] you're starting at zero each time [...]. If we start looking at a landscape scale through cumulative effects assessment or a Country scale through traditional lands, this could create more meaningful, sustained engagement that respects Indigenous perspectives at the appropriate cultural and ecological scales.”

Intra-community dynamics and governance challenges further complicate engagement. For example, some TO groups require engagement with multiple family groups rather than a single representative entity. These dynamics require sensitive and sustained relationship management, which many proponents are unprepared for. As one industry interviewee explained:

“There might be three or four families that you have to engage with [...] and for whatever reason, they're not willing to engage as a whole.”

Another industry participant expressed frustration at the challenges of establishing contact or initiating discussions with Aboriginal corporations.

“I've written several times, but I've never had a response [...] because we're not going through an environmental impact assessment, there's no legal requirement.”

This illustrates how regulatory triggers often determine whether engagement occurs at all, reinforcing a reactive rather than proactive model of consultation.

Despite these systemic barriers, interviewees offered suggestions for improving Indigenous engagement in RCEAM. Several noted the need for properly funded, long-term engagement structures, such as paying Aboriginal corporations to appoint dedicated staff to attend meetings. According to an industry participant, this model would alleviate the burden on individual Traditional Owners and enable regular communication.

"We would happily pay Traditional Owners to come to our meeting [...]. We just need to set it up formally with the Aboriginal Corporation."

Another promising approach is the use of facilitated regional councils, where all relevant stakeholders and rightsholders can meet collectively rather than in fragmented one-on-one engagements. Crucially, effective engagement must go beyond procedural compliance to address relational and ethical dimensions. This includes building trust, acknowledging historical harms, and creating space for IK systems to shape decisions rather than just supplement them.

Post-mine closure challenges

A central barrier identified by an industry participant is the lack of clarity regarding post-mining land use governance and the long-term responsibilities associated with infrastructure and site management.

"It creates challenges because often there's [...] financial [issues]. If you want to leave infrastructure behind, someone has to be accountable for maintaining it going."

The uncertainty surrounding who will inherit responsibility, whether it be government, community organisations, or private entities, presents a serious obstacle to planning and the inclusion of Indigenous groups in closure strategies. Crucially, the question of "who is actually set up to look after it" becomes pivotal. In cases where Indigenous land stewardship aligns with closure objectives, the lack of a clear institutional framework or dedicated support for Indigenous governance effectively excludes their participation. Moreover, without secure long-term funding mechanisms, Indigenous organisations may be unable or unwilling to accept post-closure responsibilities, even when alignment with cultural values and land care traditions is strong. In some contexts, especially where state governments drive closure due to ownership links with regional industries, centralised control can further marginalise local and Indigenous input. Such top-down planning, whilst perhaps efficient from a policy standpoint, may bypass community-led visioning processes, including those that could centre Indigenous values and knowledge systems. When closure transitions are dictated externally, the opportunity for Indigenous communities to shape land use outcomes consistent with their cultural priorities is severely constrained. One industry interviewee noted that:

"Because it's being initiated by the WA Government [...]. They're also heavily involved in a way that they wouldn't be if we were a gold mining company [...]. They're trying to recruit new industry [...] and they'll be heavily involved in determining what the post-mining land use is as well."

The social dimension of mine closure also presents barriers to Indigenous involvement in post-closure environmental management. Although Indigenous workers represent a small proportion of the mining workforce in some regions, closure disproportionately impacts them and their families, particularly in regional towns with high Indigenous unemployment. Whilst some workers may relocate for similar employment elsewhere, others, especially those with strong cultural and familial ties to the region, are likely to remain. An industry participant said that:

"We really only have a small percentage of Indigenous workers, but it obviously impacts those workers when the mine closes and their families."

This context of economic marginalisation further limits Indigenous participation in post-closure planning, as communities may lack the resources and organisational infrastructure to engage meaningfully. Without dedicated transitional programs or employment pathways tied to rehabilitation or land management, closure may deepen existing inequities. Despite these challenges, interviewees also identified critical potential pathways for Indigenous involvement in post-closure rehabilitation and monitoring. Rehabilitation work often offers better conditions than mine operations, as it does not require night shifts and aligns with Indigenous land stewardship values. The same industry participant stated that:

"There's definitely going to be ongoing rehabilitation activities and work [...]. Potentially, it does open options for people that don't currently work for us to get involved."

However, realising these opportunities depends heavily on the capacity of Indigenous organisations to mobilise and sustain involvement. One participant from industry mentioned a local Aboriginal organisation that is setting up a ranger program with the potential for long-term participation in rehabilitation. This sort of initiative underscores the need for deliberate, early investment in Indigenous organisational capacity, long before closure commences, as well as sustained funding post-closure to ensure continuity of employment, cultural authority, and knowledge transmission.

Time and budget constraints

Time and budget constraints are amongst the most significant structural barriers to the integration of IK. These constraints manifest not only in the early design phases but also in how projects evolve, especially as they approach closure. Incorporating IK systems in RCEAM requires deep, trust-based relationships. Establishing relationships within compressed project timelines is challenging. This reality clashes with the project-driven logic of most environmental assessments, which are typically constrained to two- to three-year cycles. These timeframes make it exceptionally difficult to engage Traditional Owners meaningfully, particularly in the early planning phases, when their knowledge could fundamentally shape assessment frameworks and outcomes. As a researcher highlighted:

"The social conflicts that are apparent within these groups [...] pose massive risks for any project where you're involved in Indigenous groups, especially in the long term [...]. It's normally the face of a lot of trust building before you even get started, connect with their Elders, visit in their Country, visit them there."

Another key theme is the misalignment between Western project timelines and Indigenous cultural timeframes. One participant from industry pointedly observed:

"Western society likes to bite things to keep moving on some sort of trajectory on our timelines, but often that doesn't necessarily align with Aboriginal people's timelines [...]. Access to people is becoming quite difficult unless you already have relationships formed historically."

The pressure to 'move quickly' often leads to shallow consultation and undermines long-term partnerships. This dynamic reinforces short-termism in environmental governance and deprioritises the integration of Indigenous worldviews that operate on different temporal logics. A participant from industry noted that:

"You're often responding really quickly to pressures from industry, from government [...]. You don't often get the thinking space you need to be able to deal with some of these things."

Budget limitations exacerbate the challenge of integrating IK. As companies and governments operate within constrained budgets, the incorporation of IK is often limited to existing datasets, rather than co-designed data collection or lived cultural narratives. These shortcuts, although not necessarily ill-intentioned, restrict Indigenous agency and overlook the contextual, place-based knowledge that could enrich assessments. An interviewee from industry noted that:

"We do not have enough time to collect additional on-ground data in terms of TO engagement and opportunities [...]. Instead, we are working with existing heritage teams to see how their data can be utilised."

Even when companies signal commitment to Indigenous involvement, such programs are highly vulnerable to cost-cutting as projects near closure, as an industry interviewee said:

"As they're getting close to closure [...], they're doing deep dive reviews looking for cost-type things. And there's enormous risk to programs that have been signaled, well-intentioned [...], unless they're overtly planned for and mandated, they're very vulnerable at that moment."

This recurring pattern reflects a risk-averse approach to long-term involvement. From the industry's perspective, participants say, Indigenous involvement, if not embedded in regulatory frameworks or incentivised through long-term governance models, is seen as a discretionary cost rather than a core responsibility. This quote from an industry interviewee illustrates this fact:

"Companies are going to make decisions around responsibilities to shareholders [...]. If it's not part of the broader framework, all the good intentions evaporate."

Time and budget constraints not only limit Indigenous involvement but can also lead to damaging outcomes when expectations are raised and then not met. In one example given by a researcher, Traditional Owners were asked what landform they wanted after closure and requested a return to the river's natural course.

"The landform didn't allow for that [...]. You're letting people express a desire that there was never any ability [to realise]. Does that then create an expectation that is damaging?"

These cases highlight a moral hazard: inviting Indigenous input into decisions when the time and resources to act on that input do not exist. The same interviewee stated that:

"We can do it, but it's going to be an exorbitant amount of time and resources [...]. Then, it evolves into a conversation around whether that investment is the best use of those additional resources [facing the existing issues in an Indigenous community]."

In many jurisdictions, structural resistance to change also prevents long-term investments in Indigenous involvement. Even where the need for regional frameworks and Indigenous inclusion is acknowledged, the political and economic environment discourages reforms perceived as costly or time intensive. Without a shift in the regulatory and authorising environment, the space for IK remains discretionary and fragile. As one participant from the mining rehabilitation and licence space noted:

"You'll have an uproar [...]. Because if there's anything considered more regulation, more requirement on industry, that will put industry off [...]. It'll just end up being a big lobby group against it."

5.2.2 Opportunities to incorporate Indigenous Knowledge in RCEAM

Capacity building

The successful integration of Indigenous involvement in RCEAM depends not only on institutional willingness and regulatory frameworks, but also critically on capacity building within Indigenous communities and across government and industry. A clear illustration of capacity building success can be seen in the health sector during the COVID-19 pandemic. As a participant from the regulatory space stated:

"Some of the best performing organisations through COVID were the medical Aboriginal organisations. There'd been many decades of investment from the Commonwealth in Aboriginal medical organisations, particularly in regional and remote areas, to build up leadership, to build up governance, to ensure that there's a long-term view."

This case underscores that genuine Indigenous capacity results from long-term, consistent investment in both institutional infrastructure and individual leadership development. Applying the same principle to RCEAM would mean supporting Indigenous governance bodies to actively shape regional environmental planning, not as stakeholders, but as co-leaders.

Capacity building must also extend to non-Indigenous institutions. A critical shift can occur when government officials and regulators engage with existing IK systems on Country. One powerful example came from an interview describing a two-day visit led by a traditional lawman who guided senior regulatory officials through culturally significant landscapes. The same participant above noted that:

"He was singing to Country. He was taking us around to culturally important sites."

The interviewee continued saying that a colleague, who leads a compliance auditing team, had never been out on Country before. The experience radically shifted her perspective.

"She hardly slept all night because she was realising her day-to-day procedures [...] did not value their [Indigenous] expertise. They were not treated as experts at all."

"[If this insight had been shared in a boardroom or office setting], she would have nodded [...] but I cannot overstate the importance of people getting out on Country [...] and seeing their responsibilities through a completely different lens."

This highlights that capacity building is not a one-way process. It also involves decolonising the mindset and practices of decision-makers, enabling them to understand Indigenous perspectives not as peripheral but as central to assessing and managing cumulative effects.

The same example also reveals a deeper structural problem that capacity building could help overcome: the failure of regulatory systems to recognise IK as a legitimate form of expertise. This administrative equality, whilst seemingly neutral, in fact erases cultural authority and historical relationships with place. Effective capacity building, therefore, involves reengineering institutional policies and procedures to recognise, prioritise, and resource Indigenous expertise in assessments. This is not about creating parallel systems but about embedding cultural knowledge into core regulatory operations, particularly in contexts where cumulative effects are most profound and long-term.

Early engagement and relationship-building

Across the interviews, a recurring theme emerges: early, sustained, and respectful engagement is not only an ethical imperative but a practical necessity for meaningful Indigenous involvement in RCEAM.

Early engagement is crucial for incorporating Indigenous voices into the planning and decision-making process at its formative stages. As one participant explained, building effective partnerships means starting not with top-down objectives, but with listening. A participant from the regulatory space explained that:

"We're building a partnership [...] and we're going to talk our way through all the risks and opportunities [...] but primarily listen to [the Traditional Owners], what their priorities are."

This shift from consultation to partnership highlights a more relational and less transactional approach. However, for such engagement to be sustained and effective, it must also be formalised in organisational systems. The same interviewee noted that engagement becomes meaningful only when embedded in institutional structures and responsibilities.

"You are embedding them [engagement obligations] in the performance agreement of the CEO, who then embeds it in the performance agreements of individual decision-makers [...]. They become part of your normal governance arrangements."

This suggests that early engagement cannot rely solely on goodwill. It must be operationalised through accountability mechanisms that ensure long-term commitment. In this process, trust was repeatedly identified as both the cornerstone and the consequence of meaningful engagement, as an industry interviewee highlighted:

"100% right, it comes down to trust again and relationships [...]. If you can't have people working [in a] trust relationship, then generally you're probably not going to get the outcome you're hoping for."

This is echoed in reflections about intra-community dynamics. Trust is not only needed between government or industry and Indigenous peoples, but also within and across diverse Indigenous groups themselves. An industry participant said that:

"The complexities of some of the communities and differences within those communities are really difficult to unravel [...]."

Rather than seeing this only as a barrier, such complexity was reported as reinforcing the need for early and patient relationship-building that recognises community-specific governance, diversity of views, and the legitimacy of multiple knowledge systems. One significant insight raised was the ineffectiveness of centralised, top-down approaches to building meaningful relationships. A researcher highlighted that:

"One of the challenges is when we try to drive those relationship-dependent things from a central point [...]. That's not actually that helpful compared to actual on-the-ground relationship building."

This aligns with critiques of 'checkbox' engagement, where formal obligations are met procedurally without building mutual understanding or respect, as noted by an industry interviewee:

"At the moment, the way we engage them conventionally is we just go through the boxes and tick the boxes. Every community's different."

Instead of superficial consultation, relationship-building in RCEAM requires an on-the-ground presence, ongoing dialogue, and respect for cultural protocols, including awareness of significant seasonal periods, such as law time. An interviewee from a non-governmental organisation explained that:

"You need to understand that guys up in the Kimberley and Pilbara [...] come anywhere from November to January is their law time. So, you're not going to have them there for that time because they can't do law."

Moreover, engagement strategies must recognise the asymmetry of timeframes between Indigenous communities and project proponents. This mismatch can compromise outcomes unless engagement is early enough to accommodate Indigenous planning cycles and long-term thinking, rather than being confined by industry-driven project timelines. As a researcher noted:

"The timeframes are [...] disparate, like the goals of each person in the relationships are different [...]. That's a big challenge."

Crucially, participants warned that trust, once broken, is complicated to repair. This is especially critical in RCEAM, where decisions can have lasting impacts on Country, culture, and community wellbeing. Mistakes in early engagement are difficult to correct and may delegitimise the entire process. As one participant from the mining rehabilitation and licence space highlighted:

"Many of the issues arise because maybe work hasn't been done in a manner that builds that trust, that long-term relationship [...]. If you make a mistake and you ruin that trust, you're done. There's no coming back from that."

Indigenous Knowledge incorporation and Indigenous co-leadership

Participants acknowledged that IK is often marginalised in current CEAM approaches, where Western scientific frameworks continue to dominate. This methodological gap results in CEAM that lacks cultural and ecological nuance, failing to reflect Indigenous worldviews that understand landscapes as interrelated systems of environmental, social, and spiritual value. An industry interviewee noted that:

“Western science versus traditional knowledge [...] does present challenges where they don't necessarily align and how that is managed or how you reflect those differences in designs or mitigation measures.”

In many cases, Traditional Owners are still only partially involved in the effects assessment process. Typically, after key decisions have already been made. This highlights how late-stage engagement often overlooks the opportunity to shape foundational understanding. This reflects a broader issue: the exclusion of IK from the design stage, where it could have the most influence.

Moreover, several participants emphasised the difference in priorities between Indigenous communities and Western regulators. Whilst environmental assessments may focus on threatened species from a scientific perspective, Traditional Owners “might see kangaroos and very common species as really important because of their cultural values.” This misalignment underscores the importance of incorporating Indigenous values from the outset, ensuring that scientific perspectives do not overshadow local priorities.

Another prominent theme is the lack of co-leadership by Indigenous organisations in cumulative effects governance. Interviews showed that the future of CEAM lies in Indigenous-led, co-governed approaches that are locally grounded and holistically informed. As one participant from the mining rehabilitation and licence space noted:

“Traditional Owners’ values and aspirations need to be considered [...] including their own aspirations to create jobs and be involved in the process.”

Yet, the capacity for Indigenous leadership in environmental governance is constrained by historical and structural barriers. Participants consistently advocated for shared governance models that reflect Indigenous priorities and leadership. An industry interviewee said that:

“You need key stakeholders around the table and talking [...] when you get people to talk on a similar level, then you do achieve outcomes.”

Others pointed out the value of forums like yarning circles to foster dialogue grounded in equality and cultural safety, stressing that ‘creating a norm’ through repeated, inclusive engagements could lead to systemic change. However, building towards co-leadership is not without challenges. There are capacity gaps within some Indigenous communities. Gaps are not due to a lack of knowledge but instead to the absence of long-term investment in governance structures. Despite these gaps, there is widespread recognition that Indigenous co-leadership and knowledge integration are essential for the long-term success and legitimacy of I-RCEAM. A desire for more collaborative models increasingly accompanies this recognition, as noted by an industry participant:

“We're past that point. Without Traditional Owners’ engagement and support, [mining] is not going to happen. It's not socially acceptable, and it's not something that's been proposed anymore.”

Whilst current legal and political constraints may limit full decision-making power, participants reported that these partnerships are a vital first step towards Indigenous regulatory authority. From a procedural standpoint, embedding IK requires frameworks that recognise its holistic, place-based, and evolving nature.

Mandatory regulation and guidance for I-RCEAM

The evolving policy landscape for CEAM in Australia reflects both a significant regulatory gap and an opportunity to reform governance by including IK systems. Despite amendments to the Environmental Protection Act 1986, in 2020, that require the EPA to consider cumulative impacts, this requirement remains loosely operationalised. This absence of structured, enforceable regulation is particularly problematic in areas with dense and long-standing resource development, where Traditional Owners have repeatedly raised concerns about the cumulative impacts of multiple overlapping developments on their Country. Concerns that remain insufficiently addressed in current environmental assessment processes. An industry participant said:

“[TOs] are being engaged with individually for developments, lacking the resources or the ability to understand what such proposals mean cumulatively for their lands and cultural values.”

Despite engagement with Traditional Owners during project-level approvals, a growing consensus suggests that these efforts are not leading to holistic, systems-level recognition of Indigenous rights or knowledge. A central reason for this is the lack of a ‘mandated requirement’ for IK to be incorporated into CEAM. As one interviewee observed from a long regulatory career, if IK or science is not framed as a ‘mandated responsibility’, but merely a corporate social responsibility, it becomes vulnerable to resource withdrawal and lacks longevity in organisational commitment. This parallels the trajectory of workplace safety and environmental protection, both of which became institutionalised only after becoming legally mandated.

Indeed, as a participant from the regulatory space stated, the current regulatory structure lacks a “very explicit authorising environment” that can enshrine IK and ensure its parity with Western science in long-term strategic planning. Without such mandates, there is a risk that well-meaning initiatives will collapse under shifting institutional priorities. Conversely, the present moment offers a strategic opening: with increasing recognition of the role of Traditional Owners as rightsholders rather than stakeholders, a reframing of regulatory roles and expectations could be transformative. The same participant noted that:

“Within the current regulatory frameworks, acknowledging that we’ve just discussed that they’re not exactly aligned. I think there’s got to be like an opportunity for Indigenous Australians or the Traditional Owners of the land to have direct input into government, whether that be through established positions, advisory groups or particular roles to be able to put in there additional steps to make sure that cultural impacts are being considered and incorporated into these kinds of assessments. I think that a mechanism is currently lacking, and because it’s not there, it’s easy not to include.”

The international context, especially Canada, was cited as an example that offers instructive comparisons. In Canada, decades of legal reform and policy experimentation have led to mechanisms that recognise IK on par with Western science, albeit through a ‘clunky’ and at times contested process in its early phases. Australia, by contrast, is “a step before that beginning point”, where there is still no consistent mechanism to integrate the knowledge, rights, or priorities of Indigenous peoples into high-level decision-making.

The implications for this are significant, according to the interviewees. Indigenous communities often provide critical insights into land use planning and ecosystem change, informed by millennia of lived experience. Yet the mechanisms in place in Australia fail to confer “appropriate authority to the next landholders that are going to look after that piece of land” post-mining, with the government continuing to centralise these decisions. Interviewees repeatedly highlighted the lack of procedural structures to embed these perspectives into CEAM. Some called for direct input mechanisms, including advisory roles or statutory positions for Indigenous representatives, to ensure that cultural impacts and Indigenous land use priorities are incorporated into formal assessment and management procedures.

Yet the road to reform is not without institutional inertia. Interviewees highlighted the slow and complex process of regulatory change, with one note saying that it could take “10 years” to amend Acts, develop new

regulations, and issue relevant guidance documents. Such systemic sluggishness underlines the need for interim procedural solutions whilst long-term legislative reforms are developed. Fundamentally, the question is not merely one of incorporating IK into existing frameworks, but instead redefining those frameworks in a way that genuinely reflects Indigenous rights, responsibilities, and worldviews. This includes acknowledging that IK, like Western science, must be contextualised, interpreted, and applied by those who hold it.

In summary, the lack of mandatory regulation and guidance for an I-RCEAM in Australia is both a structural gap and a transformative opportunity. Moving forward, this moment could be seized to create a new paradigm of shared stewardship, one in which IK is not an afterthought but a foundational element of an I-RCEAM.

Regional collaboration and strategy

Despite growing attention to RCEAM, current practice in Australia remains fragmented, inconsistent, and primarily driven by developers. A recurring theme in the interviews is the absence of meaningful coordination amongst proponents, regulators, and Traditional Owners at a regional level. As an industry interviewee said:

“Ideally, it would be all the proponents coming together to discuss with the Traditional Owners about all the proposed developments on their country at once as a group [...]. But I haven’t been a part of that process.”

This lack of collaboration leads to duplication, inconsistency, and, ultimately, an inability to understand or manage cumulative effects effectively. The same interviewee noted that:

“If it’s not done collaboratively [...]. People will be presenting different results [...]. It’s not a consistent approach. It makes it hard for the regulator, Traditional Owners and the public to understand what the actual impact is.”

Interviewees consistently expressed concern that, without strategic oversight, values that are important to Indigenous groups could be undermined by uncoordinated development. For instance, traditional water sources may be simultaneously impacted by multiple users who lack an understanding of their significance or of the cumulative pressure on these resources. On this topic, the above interviewee commented:

“Rather than both people taking water from the same spot, [we should be] working together to take it at different times or from different areas to preserve that value, rather than working independently.”

Some promising practices were identified, particularly those grounded in landscape-scale values and long-term planning. Interviewees working in the Pilbara described the Pilbara Cultural Land Management Project's strategic proposal as a promising initiative. The Pilbara Cultural Land Management Project (PCLMP) is a collaborative initiative involving 12 Pilbara TO groups, with support from the Pilbara Development Commission, Rio Tinto, and the State Government. The project aims to empower Traditional Owners to lead environmental and cultural land management efforts. Key objectives include building technical capacity, developing shared digital platforms for data exchange, supporting the establishment of ranger programs, and fostering a knowledge-sharing network to safeguard Country and culture for future generations. This process begins by placing values on a broad scale before drilling down into project-level assessments, enabling values to be considered cumulatively across space and time. An industry interviewee said:

“It allows you to cover or to address the landscape scale values and not start at zero each time like you would for individual developments.”

This approach aligns with what Traditional Owners have long requested: a regional understanding of effects, rather than disjointed project-specific consultations. The benefit of strategic RCEAM is not only ecological or

procedural, but also relational, as it helps rebuild trust through transparent, early, and long-term involvement. The same interviewee highlighted that:

“Traditional Owner groups want this landscape-scale understanding [...]. If they keep asking for that and it’s continually not undertaken, then you are going to damage relationships.”

Several participants identified a critical shift in practice: from ‘engagement’ to actual involvement, as exemplified by co-leadership/leadership models. Whilst rare, some examples demonstrate how Indigenous organisations can lead or co-lead monitoring and decision-making processes. One such instance was described in relation to Murujuga, where Indigenous organisations oversee governance of rock art monitoring. An interviewee from the regulatory space explained that:

“That is a genuine partnership between government, industry and the Aboriginal organisations [...] with the objective of handing over the science over time [...]. This is moving power, decision-making, and rights over to an Aboriginal organisation.”

However, this remains the exception rather than the norm. Interviewees pointed to the lack of conditioning on approvals as a missed opportunity to formalise such partnerships. For instance, recent Commonwealth approvals could have been utilised to establish long-term, shared science programs. Nevertheless, this was not the case. The same interviewee above noted that:

“There’s a window of opportunity when a company is getting a huge approval [...]. If only they’d been conditioned to invest in long-term shared partnership science [...] that’s a missed opportunity.”

The results from interviews indicate that the time for coordinated I-RCEAM is now, not as a reactive measure, but as a proactive reimagining of how land, culture, and development are planned and sustained.

Risk management

Interviewees repeatedly emphasised that existing project-level assessments often fail to identify and effectively manage cumulative risks across landscapes and timelines. In this context, risks are not only biophysical but deeply cultural and relational. The risk lies in the continued lack of awareness and knowledge about existing values, their long-term impacts, and whether these impacts are approaching critical thresholds. An interviewee from industry highlighted that:

“You might not like what this impact assessment shows. But no one’s ever quantified this. There may be values that are already beyond or close to the tipping point [...]. That might be the first time [Traditional Owners have] ever seen that [...]. It’s actually been quantified. So, there is a massive risk.”

For proponents, risk is often viewed in terms of potential development constraints. Yet, several interviewees argued that early identification of risks can avoid greater costs, whether financial, environmental, cultural, or social, later on, showing that developing I-RCEAM might be seen as a long-term investment. The same interviewee continued:

“It may show that they cannot develop areas they thought they were going to be able to develop. But, [...] it’s better to know those issues now than in 20 or 30 years time [...] to plan for them and try and mitigate [...] or change designs [...] or work with other proponents.”

This argument reframes risk not as a barrier but as a strategic insight. I-RCEAM provides the opportunity to understand the cumulative trajectory of development impacts before irreversible damage occurs, thereby allowing companies to make adjustments. This approach aligns with long-term business sustainability and enhances social licence, especially as community and regulatory expectations evolve. A participant from industry stated that:

“If the risk wasn’t identified until a later date, then it might be too late [...]. We might not be able to get environmental approval at that point. There are changes in social licence to operate, societal expectations, Traditional Owners’ expectations [...].”

Crucially, Indigenous perspectives can reshape how risks are defined, perceived, and managed. What may not be considered a risk from a Western regulatory standpoint, such as disruption to spiritual relationships with land, may be of utmost importance to Indigenous communities. Including IK early and systematically in RCEAM offers a pathway to more comprehensive, culturally grounded risk assessments. However, this approach requires more than ‘engagement’. It necessitates structural involvement and power-sharing. As one interviewee pointed out, private companies are driven by risk minimisation related to timelines, approvals, and costs. Therefore, demonstrating how Indigenous involvement reduces long-term risks can be a lever for reform. Another industry participant highlighted that:

“It really is a case of just flipping things and saying, well, how does a regional assessment offer the ability to reduce the risk around the things that drive individual organisations?”

I-RCEAM provides a unique platform for cross-team and cross-proponent collaboration, which is essential for understanding and mitigating regional-scale risks. These collaborative processes are currently rare. In the past, teams operated independently with little cumulative insight. However, by building cumulative effects assessments into large-scale approvals, proponents are now incentivised to ‘buy in’ to more integrated risk management. The same participant above continued:

“Because we are looking at a larger area and a longer-term project, it provides a lot more opportunity for us to work together to better understand those impacts and collaboratively [...] manage or mitigate them.”

“Now [...] it’s actually providing the opportunity for teams to do it, whereas before [...] they may have wanted to do it, but there was not the opportunity.”

Regulatory practice is beginning to acknowledge this shift. In WA, for instance, environmental scoping documents increasingly mandate CEAM, as do those in New South Wales, Queensland, and Victoria. This regulatory pressure presents both a challenge and an opportunity: developers must manage risk more systematically, with Indigenous involvement as a key enabler. Whilst industry is being pushed to confront cumulative risk, the government also has a role to play in accepting uncertainty and enabling innovation. Another industry interviewee said that:

“You’d hope that government would be prepared to take a risk [...]. For this stuff to happen, it’s the 80/20 rule. You’re 80% sure it’s going to be OK, but it’s something new [...] you’re going to be prepared to have that failure now and again.”

This attitude is crucial if IK systems are to be integrated meaningfully. Risk-averse governance may default to the familiar, whilst transformative risk management demands embracing new approaches. In its current form, CEAM remains underutilised as a risk management tool. Fragmented, project-by-project approaches obscure the broader trajectory of cumulative effects and often bypass Indigenous worldviews entirely. Yet as these interviews make clear, this is not just a failure of governance, it is also a missed opportunity.

In sum, the incorporation of IK and leadership into RCEAM, according to the interviews taken, demands more than goodwill or short-term initiatives. It requires profound, structural transformation. Systemic barriers, including poor data sharing, outdated legislation, and fragmented governance, must be dismantled to allow Indigenous authority to be embedded meaningfully and permanently in RCEAM. This involves not only legislative reform and institutional accountability, but also long-term investment in Indigenous governance and data sovereignty. When Indigenous leadership is formally recognised through co-decision-making, RCEAM can evolve into a truly holistic and culturally grounded framework, one capable of supporting both environmental and cultural integrity and the self-determination of Indigenous communities.

5.3 Synthesis

There is an emerging, though uneven, consensus amongst both Indigenous peoples and their non-Indigenous counterparts, including government and industry, about the need to reform CEAM practices. This includes integrating IK and co-leadership into RCEAM. Both groups acknowledge the systemic barriers that marginalise Indigenous participation, such as poor engagement, data withholding, outdated legislation, and institutional silos. There is agreement on the importance of co-led governance models that prioritise early engagement, transparency, and long-term partnerships with indigenous groups on Country, which are essential for achieving credible environmental, cultural, social, and economic outcomes. A key point of convergence is the recognition that Indigenous-led strategies grounded in Indigenous values and legal authority can yield more sustainable, culturally appropriate outcomes.

A Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis (Table 11) on perspectives highlights both shared opportunities and divergent challenges between Indigenous and non-Indigenous perspectives on incorporating IK into RCEAM. Indigenous strengths include strong cultural authority, on-Country knowledge, and successful models of co-leadership and regional collaboration, like the Yule River and Martuwarra initiatives. In contrast, non-Indigenous strengths stem from an increasing institutional recognition of IK's value and growing support for co-leadership and early engagement. Both perspectives agree that relationship-based engagement and the integration of IK are vital opportunities for reshaping planning and assessment processes. However, the analysis also reveals significant differences in the challenges each group faces. Indigenous communities focus on burdens such as late engagement, limited resources, and power imbalances. While non-Indigenous institutions point to internal issues, such as a lack of structural mandates to integrate IK. Both perspectives raise concerns about inadequate legislation, insufficient government capacity, and the dominance of Western scientific frameworks, underscoring the need for systemic reform and long-term investment to support a more inclusive, culturally informed approach to I-RCEAM.

However, whilst alignment is evident in high-level principles, differences remain in how thoroughly these commitments are enacted in practice. Indigenous participants consistently emphasise the emotional, spiritual, and intergenerational impacts of mining, as well as the urgent need for power-sharing and cultural authority in decision-making. In contrast, non-Indigenous institutions often acknowledge these needs in theory but fall short in practice, with engagement, for instance, frequently remaining symbolic or reactive. This highlights “whilst the rhetoric of reform is gaining traction, there is a critical gap between intention and action”. According to the interviewees, not all stakeholders have embraced the deeper systemic and regulatory changes required to embed Indigenous co-leadership structurally rather than situationally in CEAM. Bridging this gap will require enforceable legal reforms, resource redistribution, and genuine institutional commitment to review current governance systems. These are the next steps that both sides increasingly agree must be taken. However, the urgency and depth of transformation demanded by Indigenous communities are not yet universally shared.

The findings from the literature review, yarns and interviews are congruent and aligned. The yarns with PKKP members and interviews align with the principles reported in the literature review conducted, mainly the importance of co-led RCEAM processes, focusing on Indigenous people's rights, relationships, processes, and outcomes; the development of value-driven and place-based assessments; the implementation of systemic and holistic assessments; the importance of integrating IK and Western science knowledge; and the practice of adaptive management. Additionally, the implementation of an I-RCEAM through a value-system framework, guided by the principles outlined above and grounded in Indigenous values, was consistently endorsed as a promising pathway for enhancing Indigenous involvement in RCEAM.

Table 11 – SWOT analysis based on Indigenous and non-Indigenous perspectives on incorporating IK into RCEAM.

SWOT Analysis		
SWOT Category	Indigenous Perspectives – PKKP peoples	Non-Indigenous Perspectives
Strengths (enablers)	• Strong cultural authority, IK systems, and Country-based knowledge. • Ranger programs and cultural governance already operating. • Community-driven co-leadership models (e.g., co-management agreement with Rio Tinto). • Regional collaboration traditions such as Yule River and Martuwarra initiatives.	• Recognition of IK as a valuable expertise in improving CEAM. • Increasing willingness to consider co-leadership models. • Understanding that relational, early engagement improves outcomes. • Existing regional platforms for collaboration (e.g., PCLMP).
Weaknesses (constraints)	• Limited PKKP resources and staffing for reviewing complex documents. • Insufficient capacity to participate due to time, cost, and workload pressures. • Constraints due to imposed legal boundaries (such as Native Title lines). • Engagement often occurs too late to influence outcomes.	• Government/regulators have limited staff, funding, and technical capacity for IK integration. • Weak institutional processes for culturally appropriate engagement. • Fragmented departmental silos. • IK often deprioritised when timelines or budgets are tight.
Opportunities (positive possibilities)	• Early engagement based on FPIC and respect for cultural authority. • Co-leadership in water management, closure planning, and ecological restoration. • Regional alliances to strengthen unified Indigenous influence. • Long-term capacity-building and succession planning to strengthen PKKP leadership. • Embedding cultural authority through binding protocols and agreements.	• Structural reforms mandating IK and improving regulatory guidance. • Regional coordination to reduce fragmentation in assessments. • Long-term investment in both Indigenous and regulator capacity. • Integrating IK into risk management improves project certainty. • Early, relational engagement avoids conflict and builds trust.
Threats (barriers/risks)	• Data withholding prevents cultural water management and cumulative impact assessment. • Decisions are often made without Indigenous authority, resulting in cultural loss. • Weak legislation fails to protect cultural landscapes. • Under-resourced regulators push responsibility onto PBCs. • Western scientific dominance leads to misinterpretation of cultural significance. • Poor engagement and rushed timelines undermine IK integration.	• Data-sharing not mandated by law; commercial sensitivities restrict access. • Governance structures structurally exclude Indigenous authority. • Outdated legislation limits IK integration and cross-departmental cooperation. • Fragmented processes, tight budgets, and short timelines undermine engagement. • Lack of clarity in post-mine closure responsibilities increases risk and costs.

6 Conclusion

This study makes a significant contribution to the existing body of knowledge by addressing a critical gap in research and practice concerning Indigenous Involvement in RCEAM and systematically and comprehensively incorporating IK, particularly in the context of mine closure in Australia. Through an extensive review of international best practices and literature, as well as yarns and interviews, it lays the conceptual foundation for an I-RCEAM framework grounded in Indigenous values and principles. The study also identifies the most

significant barriers and opportunities to implement it in Australia. Unlike existing approaches that limit Indigenous involvement to consultation at a local scale, this study advocates for Indigenous leadership at a regional scale, aligned with holistic and systemic assessments, going beyond environmental and heritage regulations, supported by collaborative governance and the creation of a 'shared space' where Indigenous and non-Indigenous interact on equal terms. The findings provide a roadmap for integrating Indigenous authority into RCEAM, promoting more inclusive and culturally responsive outcomes in Australia's transition away from mining.

This study underscores that Indigenous leadership in RCEAM requires the active involvement of Indigenous communities from the earliest stages of planning through to implementation and long-term monitoring. Drawing on successful international models, particularly from Canada, it highlights that Indigenous leadership is most effective when supported by co-leadership arrangements, legislation, adequate funding, internal governance capacity, and trust-based partnerships. The study highlights that voluntary corporate efforts are insufficient on their own and must be reinforced by legal mandates. It also emphasises the foundational role of Indigenous rights, relationships, processes, and outcomes, as articulated in guiding frameworks such as the Aashukan Declaration (2017). Central to effective Indigenous involvement is the recognition of data sovereignty, FPIC, and community-defined wellbeing. The study advocates the integration of IK through approaches such as 'Two-Eyed Seeing', which respects cultural indicators and relational worldviews without assimilating them into Western scientific paradigms. By promoting an adaptive, values-driven I-RCEAM framework, the study offers a pathway toward a culturally grounded RCEAM process.

The proposed I-RCEAM framework offers a transformative model for regional planning and mine closure in Australia. Building on the four established phases of cumulative effects assessment, with the addition of an Initiation Phase, the framework is designed as a dynamic, non-linear, and circular model grounded in Indigenous perspectives. It prioritises the conservation of socio-cultural-ecological systems, landscape-scale thinking, knowledge integration, and contributions to sustainability. Unlike conventional approaches that centre on technical or regulatory definitions, I-RCEAM defines VCs through Indigenous social, cultural, ecological, and economic lenses. It enables proactive governance, recognises historical impacts, supports participatory scenario planning, and promotes shared decision-making. Critically, the framework shifts involvement from tokenistic consultation to co-leadership and methodological equity, offering a clear pathway toward place-based, sustainable regional futures. Through long-term, values-driven planning and collaborative governance, I-RCEAM has the potential to serve as a powerful vehicle for cultural continuity, community self-determination, and environmental integrity.

The insights gathered from the literature review align closely with the yarns conducted with representatives of PKKP peoples and with interviews with individuals from industry, governmental, and non-governmental agencies. Across all sources, there was consistent support for implementing an I-RCEAM framework rooted in Indigenous values and guided by the outlined principles, highlighting its potential to enhance Indigenous co-leadership in RCEAM.

The PKKP participants' perception of mining reflects a deep awareness of the cumulative and predominantly negative impacts that have unfolded over time. These effects are seen not in isolation but as layered disturbances that compound across generations, disrupting landscapes, ecosystems, cultural practices, and spiritual connections to Country. Whilst small-scale mining was viewed as less harmful, large-scale operations and their associated infrastructure were identified as key drivers of lasting change, especially when combined with pastoral land uses and the growing pressures of climate change. Critically, the paradox of the energy transition, intended to mitigate climate impacts, was highlighted as a future threat to Country. Participants conveyed a strong sense of loss: of sacred sites, biodiversity, clean water, traditional food sources, and access to Country. This loss translates not only into environmental damage, but into profound emotional, psychological, and cultural harm. The legacy of mining is experienced as an accumulated burden, interrupting intergenerational knowledge transfer and weakening the cultural fabric that binds people to

their land. These insights underscore an urgent need to reframe approaches to CEAM, centering on regional, community-led initiatives and decision-making to address past harms and support cultural continuity.

According to the perspective of PKKP participants, the incorporation of IK into RCEAM for mine closure planning remains significantly hindered by systemic, legislative, and procedural barriers. Current industry practices reflect a pattern of poor engagement, lack of transparency, and minimal accountability, resulting in the exclusion of PKKP members from meaningful participation in decisions that affect their Country. Inadequate data sharing, failure to honour social licence to operate commitments, and a reliance on Western legal and scientific frameworks continue to marginalise Indigenous voices and disconnect communities from their cultural responsibilities. Legislative frameworks, such as the Aboriginal Heritage Act 1972 and the Native Title Act 1993, often reinforce colonial boundaries and overlook the holistic, relational nature of IK, undermining its role in environmental stewardship and post-mining planning. Until these structural issues are addressed, through early and sustained engagement, culturally responsive legislation, transparent information sharing, and genuine power-sharing in decision-making, the integration of IK in RCEAM will likely remain superficial, placing Country, culture, and community at continued risk.

PKKP participants emphasised that embedding Indigenous voices from the outset in effects assessments enables culturally-informed, long-term planning that aligns with community values and responsibilities to Country. Co-leadership frameworks, such as the agreement with Rio Tinto, illustrate what is possible when Indigenous governance, legal safeguards, and cultural authority are recognised and respected. These models, though currently rare in Australia, demonstrate how mine closure can transition from a compliance-based process to one grounded in a commitment to cultural continuity, thereby limiting the level of inevitable destruction when possible. Regional cooperation, capacity building, and community-led strategies (such as the regional Yule River Bush Meeting in the Pilbara) further enhance the potential for scalable, Indigenous-led governance. Whilst structural challenges persist, particularly in terms of legislative limitations and agency accountability, the pathway forward is clear: the meaningful incorporation of IK requires a shift in power, resources, and respect. With sustained investment and commitment, co-led mine closure planning can become a model for how development and Indigenous self-determination can coexist to protect both Country and culture for generations to come.

The challenges raised in the yarns and interviews are not isolated, but interlinked, creating a system where Indigenous involvement remains reactive and tokenistic in the eyes of both the PKKP participants and as perceived by non-Indigenous people. The withholding of critical environmental data, for example, not only limits technical accuracy but also undermines trust and Traditional Custodians' ability to protect Country effectively. Legal and bureaucratic structures further entrench exclusion by keeping Indigenous perspectives outside the scope of land use planning, particularly when cumulative effects are not holistically addressed. Despite these entrenched issues, interviewees are increasingly aware that meaningful change is both necessary and possible. Interviews highlight a shared recognition that RCEAM must evolve beyond minimal compliance toward a collaborative, co-led governance model. This evolution would include enabling Indigenous data sovereignty, funding long-term engagement and capacity building, and reforming legislative frameworks to embed aspects of Indigenous leadership. The shift from isolated, project-level approvals to regional, place-based assessments offers a timely opportunity to reimagine governance, where Indigenous communities are not just consultees, but rightsholders and co-decision-makers with authority over the futures of their lands.

Initiating this shift requires enhancing Indigenous involvement in a structural, not situational, manner. I-RCEAM represents a move beyond fragmented, short-term engagement, assessment, and management models tied to project timelines, and instead becomes a long-term, Indigenous value-based framework integrated into project governance. This change can require institutional accountability and procedural commitments that centre Indigenous voices and values on relevant issues from the outset. Such structural shifts can be seen as vital not only for achieving credible environmental outcomes valued by both Indigenous and non-Indigenous communities but also for fostering reconciliation and land stewardship. Only with

consistent and formalised Indigenous leadership in RCEAM, can I-RCEAM evolve into a truly regional and holistic framework with an institutionalised space for dialogue and negotiation, enabling all parties to deliberate on decisions. Fundamentally, the integration of IK and leadership into RCEAM depends on both capacity building in Indigenous communities as well as in industry and government, and systemic change. Long-term investment in Indigenous governance, cross-cultural competency, and institutional reform are critical. Non-Indigenous institutions must also commit to what academics would refer to as decolonising their practices, recognising IK as equally valid and central to RCEAM. When paired with regionally coordinated strategies, I-RCEAM has the potential to become a powerful tool for transitioning away from mining to achieve more sustainable and resilient futures for all.

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Appendix A – Literature review methods

Review scope

This qualitative literature review examined Indigenous involvement in RCEAM, focusing on how to systematically incorporate IK in Regional Cumulative Assessment and Management (RCEAM), particularly in the context of mine closure in Australia, setting the basis for an Indigenous RCEAM (I-RCEAM) framework to guide mine closure planning and inform decision-making for mining transitions. The review focused on studies that addressed Indigenous perspectives on impact assessment, cumulative effects assessment and management, land management, and governance. Complementary studies related to the theory and concepts of assessing and managing cumulative effects, Indigenous values and knowledge, the impacts of mining on Indigenous lands, and the regulation of cumulative effects assessment and management in Australia were also included to provide context. Studies that did not mention Indigenous perspectives, those that mentioned them but were not focused on, and those that were not relevant to this study according to its objectives were excluded.

The thematic analysis was conducted to explore major themes related to the study's objectives. The publications were categorised into five overlapping thematic groups: case studies, principles, criteria and parameters, Indigenous involvement approaches to effects assessment and management, and Australian regulations. One article could fall into more than one group. This review was not registered in a public database.

Data sources and search strategy

An extensive literature search was conducted to identify relevant publications. Full-text reviews ensured that key insights were not missed. References from selected publications and other documents were also reviewed to identify additional studies relevant to the initial search that were not captured. Based on this approach, the final set of documents represents a comprehensive sample of pertinent literature.

The Web of Science (WoS), the globally most trusted and robust database, was searched, covering the period from January 1, 2000, to December 20, 2024. This timeframe was adopted to encompass the literature from the adoption of the EPBC Act (1999) to the present day. Searches were conducted across titles, abstracts, and keywords. The search strings combined terms such as (Indigenous OR "First Nations" OR FN OR Aboriginal OR "Traditional Custod*" OR "Traditional Own*" OR "Indigenous Communit*" OR "Aboriginal Communit*" OR "Traditional Communit*" OR "First Nations Communit*" OR "Indigenous-led") AND ("cumulative effects assessment" OR "cumulative impact assessment" OR "impact assessment" OR "cumulative effects assessment and management" OR "regional cumulative effects assessment and management"). Proximity search operators were deliberately excluded to avoid filtering out potentially relevant studies. Disciplinary filters were not applied, recognising that multiple disciplinary fields can address the main topic of this study. Documents regarding articles, reviews, conference papers, and book chapters were considered. Only English-language documents were included. The WoS search involved nested Boolean combinations across multiple thematic terms, filtered for English language. Google searches for grey literature were developed using the terms above, along with references that emerged from the reviewed documents.

Final search string for WoS was: Indigenous OR "First Nations" OR FN OR Aboriginal OR "Traditional Custod*" OR "Traditional Own*" OR "Indigenous Communit*" OR "Aboriginal Communit*" OR "Traditional Communit*" OR "First Nations Communit*" OR "Indigenous-led" (Topic) and "cumulative effects assessment" OR "cumulative impact assessment" OR "impact assessment" OR "cumulative effects assessment and management" OR "regional cumulative effects assessment and management" (Topic) and English (Languages).

Screening process

The initial search yielded 359 records from WoS. Titles and abstracts were screened for relevance, resulting in the exclusion of 313 documents. Full texts were retrieved for the remaining 46 documents; one was discarded due to lack of access, leaving 45 for in-depth review, all of which were peer-reviewed papers. Through reference mining, an additional 31 relevant peer-reviewed papers were identified and deemed suitable for inclusion in this study. A total of 76 peer-reviewed papers were included in the review. From Google searches, the following studies were selected: four Indigenous-led CEAM frameworks due to their comprehensiveness; six relevant book chapters; and 17 reports, totalling 103 documents included in the final synthesis. Prior literature reviews were retained, as they contributed original insights helpful in mapping the evolving body of knowledge on this topic.

Data extraction and analysis

NVivo 2020 (v20) was used for thematic coding. The publications were assessed against the study objectives using a consistent framework that did not privilege any individual study over others. In NVivo, initial codes were applied based on recurring concepts in the literature, such as: leadership, Indigenous rights, place-based, Indigenous values, knowledge integration, and adaptive management; and RCEAM-related themes such as: valued components, indicators, triggers, thresholds, stressors, significance, baselines, mitigation, scenario analysis, Indigenous governance, decision-making, and management. As the analysis progressed, codes were added inductively to capture new themes. Simultaneously, papers were cross-referenced manually to ensure comprehensive data capture. Results were tabulated to identify convergence and divergence across findings and to explore limitations and under-addressed issues in the literature. All studies touching on Indigenous involvement in RCEAM were included in the synthesis.

Research limitations

Given the emerging nature of Indigenous involvement in RCEAM, the literature specifically addressing this topic is limited, underscoring the relevance of the current study. Future reviews may expand the scope to include a more in-depth analysis of operational approaches for the practical application of an I-RCEAM.

Appendix B – Yarns and interview methods

Yarn method

Two yarn circles (Bessarab, D., and B. Ng'andu. 2020) were held at the PKKP Aboriginal Corporation (PKKPAC) in Karratha. PKKPAC is the Prescribed Body Corporate (PBC) representing the Puutu Kunti Kurrama and Pinikura peoples (PKKP). One yarn was held on August 18th, with three Puutu Kunti Kurrama participants and one PKKPAC staff member. Another was held on August 22nd with two Pinikura participants and the same previous PKKPAC staff member. An additional yarn was developed through a phone call with one member of the Pinikura people. Associate Professor Raquel Tardin-Coelho, from Curtin University, facilitated the yarns.

The yarns, developed in August 2025, focused on exploring PKKP's perceptions of the cumulative effects (both negative and positive), as well as the barriers and opportunities related to incorporate IK into RCEAM in the Australian context. The main topics were grouped into four blocks: Block 1 – Cultural practices and principles for Caring for Country, Culture and Community that must be at the basis of any activity on Country; Block 2 – Community's visions, aspirations, and perceptions of the cumulative effects of mine closure on their Country; Block 3 – Barriers and opportunities to incorporate Indigenous knowledge in RCEAM; and Block 4 – Mitigating negative effects and realising positive effects of mine closure in the future through Indigenous involvement in RCEAM.

During the yarning, participants were free to move between topics, introduce new ones, share personal stories, and express their views and experiences in any way they choose, including how to develop the yarns. The listed topics served more as a starting point to facilitate the conversation rather than a fixed sequence to follow.

The research protocol included:

1. Co-developed the yarning protocol collaboratively with PKKP participants, with their informed consent.
2. Conducted two yarning sessions at the PKKPAC office and one over the phone. One session was audio-recorded, whilst the other two were documented through notetaking. All recordings and note-taking were done with participant consent.
3. Transcribed the audio-recorded yarn anonymously and compiled typed notes from the other sessions. All transcription and documentation processes were carried out by Curtin University staff with participant consent.
4. Verified the accuracy and completeness of the transcriptions and notes with participants after the yarning sessions.
5. Conducted qualitative thematic analysis of the verified transcripts and notes, including coding using NVivo qualitative analysis software.
6. Returned the findings from the thematic analysis to PKKP in a format of their choosing.
7. Sought and incorporated feedback on the findings from PKKPAC staff into the final report.
8. Provided a final briefing to PKKPAC staff on the project findings and outcomes.

Curtin University Human Research Ethics Committee (HREC) has approved this study (HRE2024-0701), which Murdoch University reciprocated.

Interview method

Fourteen semi-structured interviews were conducted between July and September 2025 by Dr Monica Maharjan and Associate Professor Raquel Tardin-Coelho with purposively selected individuals from industry, government, and non-governmental organisations, including research agencies, to ensure representation across key stakeholder groups. Each interview, conducted either in person or online, lasted approximately 90 minutes and was divided into two sessions: one dedicated to methodological aspects of RCEAM and the other to Indigenous involvement in RCEAM (I-RCEAM). All interviews were developed with consent. Regarding I-RCEAM, the interviews aimed to explore barriers and opportunities to incorporate IK into RCEAM in the Australian context.

The interviews followed the same topics as the four blocks used in the yarns, allowing for gathering related information amongst the two groups. All interviews were audio-recorded and then transcribed using the Teams automatic transcription tool. Transcripts were anonymised by removing identifying information and replacing it with a code during analysis to protect participant confidentiality. Codes (such as GR, IR, RR, and CR) were assigned to representatives from government, industry, research, and the community, respectively. Each transcription file was then edited in Microsoft Word and checked against the audio recording. 'Track changes' was used to document changes made to the automated transcriptions.

A thematic analysis was conducted using coding techniques in NVivo 2020 (version 20). All interview transcripts were reviewed in NVivo, and relevant data were coded based on the study's objectives. Initially, codes were identified and organised according to the themes explored in the interviews. As the analysis progressed, additional codes were developed inductively, expanding upon the initial set. Subsequently, these codes were grouped according to their thematic similarity.

Curtin University Human Research Ethics Committee (HREC) has approved this study (HRE2024-0723), which Murdoch University reciprocated.

Research limitations

Despite efforts to engage multiple Indigenous communities across several States, most were unable to participate due to existing commitments, leaving the Puutu Kunti Kurrama and Pinikura (PKKP) peoples as the only group able to be involved. Whilst broader participation was sought, PKKP Traditional Owners provided valuable insights into the barriers and opportunities for incorporating Indigenous Knowledge into RCEAM. However, gaining a fuller understanding of shared and distinct Indigenous perspectives in Australia will require the involvement of additional communities in future work.



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