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Kakadu Sea Country Strategy 2025–2035

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Acknowledgement of Country

The Marine and Coastal Hub acknowledges Aboriginal and Torres Strait Islander peoples as the first peoples and Traditional Owners and custodians of the land and waterways on which we live and work. We honour and pay our respects to Elders past, present and emerging.

Aboriginal and Torres Strait Islander peoples represent the world's oldest living culture. We celebrate and respect this continuing culture and strive to empower Aboriginal and Torres Strait Islander peoples.

Executive summary

Kakadu National Park's marine and coastal ecosystems are globally significant and culturally and ecologically rich, yet they are still underrepresented in management, research, and protection efforts. With a rapidly changing climate, increasing development pressures, and the spread of invasive species, these environments face escalating threats that demand an ambitious and strategic response.

This Sea Country Strategy for Kakadu National Park builds on the foundations of previous management and aligns with the Kakadu Research Strategy 2025–2035. It sets out a coordinated, culturally responsive and scientifically rigorous research agenda to protect and enhance Kakadu's marine and coastal values.

The Strategy emphasises Indigenous leadership and 'two-way science', recognising Bininj/Mungguy Traditional Owners' cultural authority, deep connection to Sea Country and their role in decision-making, research, and management. Based on a consultative process with Bininj/Mungguy Traditional Owners, key themes for research priorities were identified, including:

- **Sea Country management and protection**, protecting culturally significant marine species and habitats, including mapping and assessing biodiversity and cultural values across seagrass meadows, mangroves, mudflats, wetlands and estuaries.
- **Culturally important species**, including turtle, dugong, barramundi, golden snapper, shellfish.
- **Important places**, evaluating human activities, including tourism, recreational fishing, and adjacent development.
- **Feral animal and weed management**, pigs and buffalo programs paired with data-driven removal strategies and assessing the extent and impact of weed invasion across coastal floodplains.
- **Climate change**, monitoring and adapting to impacts such as saltwater intrusion and sea-level rise.

This Strategy provides a pathway for prioritising marine science and management within Kakadu, guiding investment and collaboration with Traditional Owners, government and research institutions. By supporting ethical, place-based, and co-designed research, this Strategy ensures that management decisions are grounded in cultural knowledge and scientific evidence to safeguard Kakadu's Sea Country for generations to come.

1 Background

Kakadu National Park is Australia's largest terrestrial national park and one of only a few places globally recognised for its outstanding cultural and natural World Heritage values. While the Park spans vast floodplains, savanna, and stone country, its marine and coastal environments – adjacent to the Van Diemen Gulf – remain comparatively understudied, underrepresented in management plans, and vulnerable to escalating threats.

The coastal interface of Kakadu is home to complex estuarine ecosystems, biodiverse mangrove forests, saltmarshes, mudflats, and intertidal zones that support species of global conservation concern, including sea turtles, dugongs, shorebirds, and critically endangered river sharks. These ecosystems are deeply connected to Bininj/Mungguy culture and identity, providing food, stories, sacred sites, and livelihoods.

Despite this significance, the northern boundary of Kakadu ends at the mean low water mark. This limits the coordinated management of marine environments beyond the intertidal zone. Consequently, there are considerable research gaps in understanding the distribution of species, the functioning of ecosystems, and the cumulative impacts of climate change, invasive species, and human activity in the coastal region.

Traditional Owners have long observed and documented changes in Sea Country – including mangrove dieback, Melaleuca Forest decline, and the arrival of saltwater species upstream. These observations resonate with scientific projections of major ecological shifts driven by sea-level rise, increasing temperatures, and more frequent extreme weather events. Yet, much of Kakadu's current research and monitoring has focused on terrestrial and freshwater ecosystems.

This Strategy responds to the growing call from Bininj/Mungguy, scientists, and managers for a coordinated marine science and management effort that:

- Addresses immediate threats,
- Integrates Traditional Owner knowledge with scientific inquiry,
- Fosters culturally grounded methodologies, and
- Supports development of community-led adaptation and conservation solutions.

It aligns with broader national and international commitments, including Australia's obligations under the EPBC Act, the Ramsar Convention, and the Convention on Biological Diversity. It contributes to the goals outlined in the Kakadu Research Strategy (2025–2035).

By investing in Sea Country now, Kakadu can lead the way in co-managed, climate-responsive conservation of Australia's most iconic Sea Country landscapes.

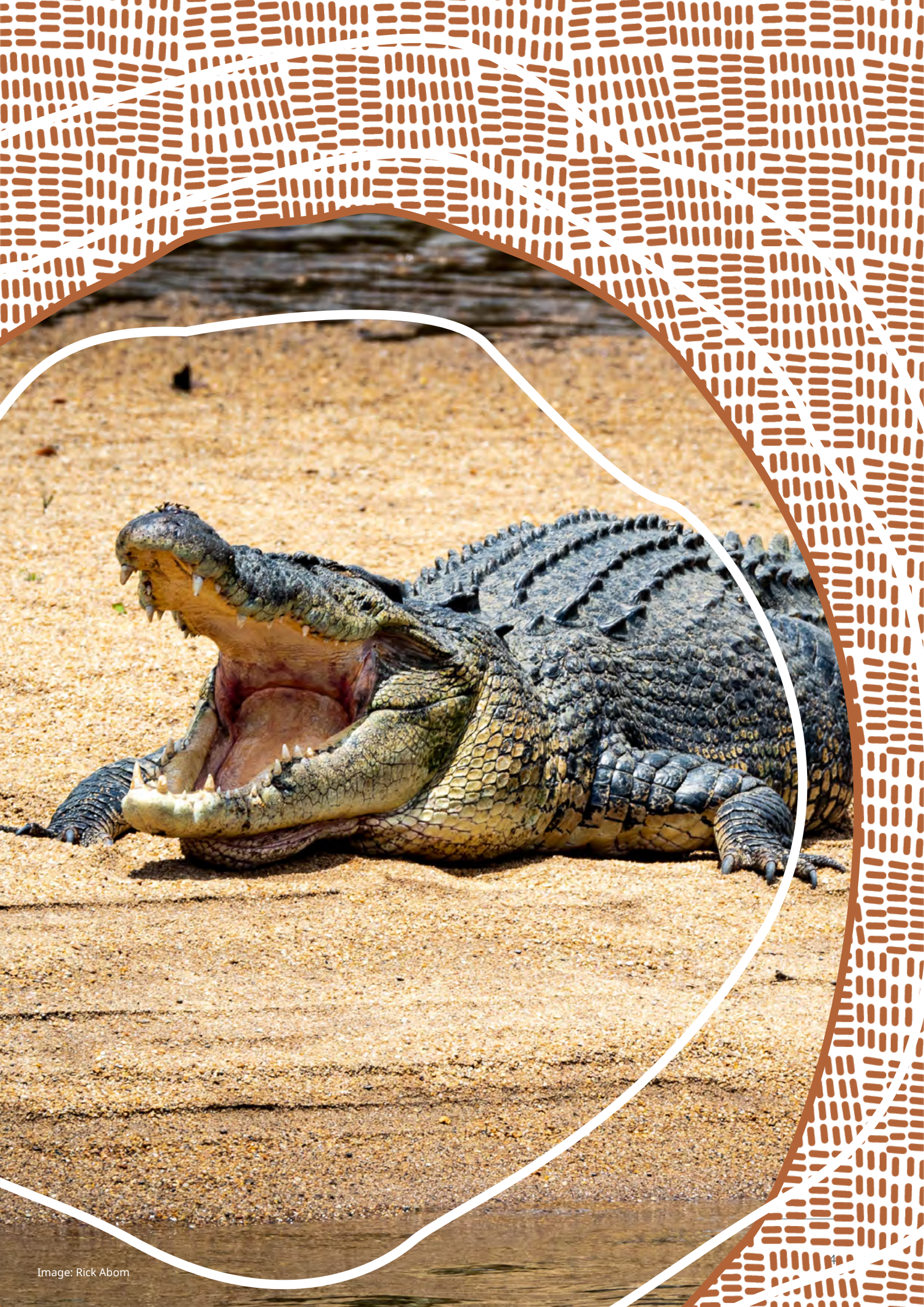


Image: Rick Abom

2 Strategic goals (Kakadu Research Strategy 2025–2035)

2.1 Vision

Under guidance from Traditional Owners, Kakadu has a comprehensive program of collaborative research that helps protect the Park's natural and cultural values and provides a range of benefits for Bininj/Mungguy.

2.2 Guiding principles from Kakadu Research Strategy 2025–2035

1. Focus on the research that Kakadu needs.
2. Involve Bininj/Mungguy in a range of ways.
3. Involve the Bininj/Mungguy who speak for that Country.
4. Follow cultural protocols based on Bininj/Mungguy law.
5. Provide local benefits for Bininj/Mungguy.
6. Use "two-way" science.
7. Share research findings.
8. Acknowledge Bininj/Mungguy's contributions.
9. Allow enough time and resources to work together.
10. Follow written agreements.

2.3 Strategic Sea Country goals

The Sea Country Strategy's goals align with the vision and principles of the Kakadu Research Strategy 2025–2035 and have been defined as:

Goal 1:
Deliver research and management that protects marine and coastal values

Goal 2:
Promote Indigenous leadership and knowledge in marine research

Goal 3:
Improve understanding of marine ecosystem change

Goal 4:
Strengthen land-sea connectivity in management and research

Goal 5:
Build enduring partnerships and research infrastructure

3 Development of the strategy and priorities

3.1 Engagement practice

Engagement with coastal Kakadu Traditional Owners (TOs) was guided by the Australian Institute of Aboriginal and Torres Strait Islander Studies (AIATSIS) Code of Ethics and conducted with the approval of the CDU Human Research Ethics Committee (# H23080). Knowledge was recorded with consent, and Traditional Owners engaged in this process are to retain ownership of Indigenous knowledge within this Strategy. Additionally, other participants involved in developing this strategy included Kakadu National Park staff. A total of 25 people were consulted during the development of this Strategy.

Principles embedded in the community engagement process were:

- **Indigenous self-determination:** Ensuring Traditional Owners have control over their knowledge and decision-making processes.
- **Respect and recognition:** Acknowledging Indigenous cultural authority, traditional knowledge, and connection to Sea Country.
- **Free, Prior, and Informed Consent (FPIC):** Securing TOs' consent at all stages of engagement. Signed consent was received from all participants.
- **Mutual benefit:** Ensuring Traditional Owners benefit from participation and that the strategy aligns with community aspirations.
- **Sustainability and cultural continuity:** Protecting Indigenous knowledge and ensuring long-term cultural sustainability.
- **Two-way knowledge sharing:** Respectfully integrating Indigenous and Western scientific knowledge systems.

3.2 Yarning-based engagement approach

A yarning-based methodology (see: Bessarab, D., & Ng'andu, B. (2010)) facilitated culturally appropriate and meaningful conversations with Traditional Owners. This approach fosters open dialogue and respects oral traditions as a legitimate form of knowledge-sharing.

3.2.1 Context for Yarning Sessions

The engagement was conducted on Country, where Traditional Owners were comfortable sharing knowledge. Sessions were led by the CDU researcher and supported by Kakadu staff. A relational approach was used whereby a Kakadu staff member brokered meeting arrangements and introductions, ensuring relationships were established before formal discussions.

Discussions were conducted in small groups or with individuals to ensure participants were comfortable sharing their thoughts and knowledge at a pace determined by the Traditional Owners. The engagement recognised that there may be differing perspectives between Traditional Owners, and existing Kakadu governance arrangements, cultural protocols, and consultation processes were followed to respectfully acknowledge and manage these differing views. Detailed governance processes are outside the scope of this Strategy.

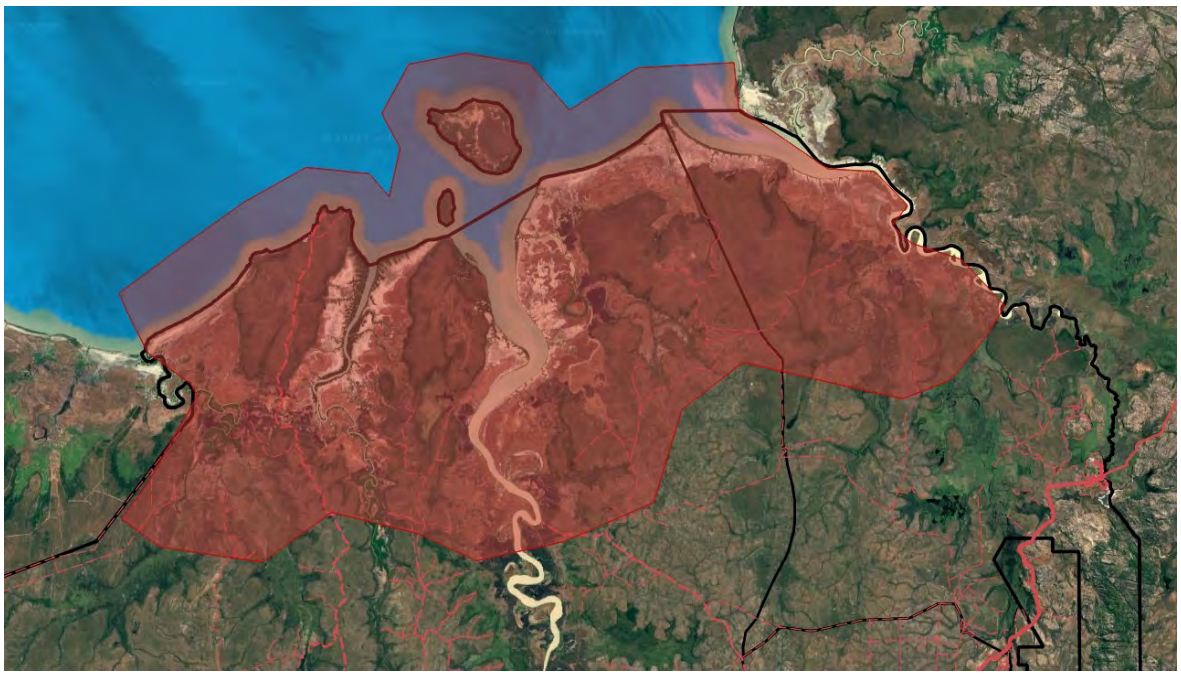


Figure 1. Map of the coastal Kakadu region referred to in this Strategy. (The red zone is the area of interest, the black line is the park boundary.)

3.2.2 Initiating conversations about Sea Country

Open-ended questions or question stems facilitated discussion and guided the yarning process. These included:

Connection to Sea Country

- Can you share a story about your connection to Sea Country?
- How have your ancestors cared for the sea here?
- What does looking after Sea Country mean to you and your family?

Changes over time

- Have you noticed any changes in the sea, tides, or sea life over time?
- What do you think explains changes in the ocean and coastline?
- Do you worry about the future of Sea Country?

Cultural and ecological knowledge

- What animals and plants are important in your Sea Country?
- Are there traditional laws or customs about fishing and use in Sea Country?
- How do seasonal changes guide the way your people interact with Country?

Management and co-Governance

- What does good marine management look like to you?
- How can Traditional Owners and the government work together to care for Sea Country?
- What are the most important things for the Kakadu Marine Strategy to respect and protect?
- If you could choose any project for Sea Country, what would it be about?

3.2.3 Understanding our yarns and developing themes

Thematic analysis was used on field notes to identify patterns (themes) within our yarning and discussions. Following this, data were systematically structured for recurring topics or ideas, often guided by cultural insights and knowledge relevant to Traditional Owners. Themes that capture the essence of the community's perspectives and experiences then emerge. Themes were reviewed, defined, and named, ensuring they accurately reflect Traditional Owners' data and voices.

The final step involves presenting the themes in a respectful way that honours the shared narratives. The high-level themes identified through consultations include:

- Sea Country management and protection
- Culturally important species
- Important places
- Feral animal and weed management
- Climate change

These themes were used to frame the Research Priorities identified during consultation.

4 Methods and approach

The Sea Country Strategy for Kakadu National Park is built upon the following goals, developed in alignment with the Kakadu Research Strategy 2025–2035. These goals reflect the aspirations of Traditional Owners, the management needs of Parks Australia, and the broader national interest in protecting Kakadu's marine and coastal environments.

Goal 1: Deliver research and management that protects marine and coastal values

Ensure research and management activities directly inform the protection of Kakadu's natural and cultural values, including estuarine ecosystems, culturally important species, and significant coastal sites.

Goal 2: Promote Indigenous leadership and knowledge in marine research

Support Indigenous-led and co-designed research that respects Bininj/Mungguy cultural protocols, knowledge systems, and governance structures.

Goal 3: Improve understanding of marine ecosystem change

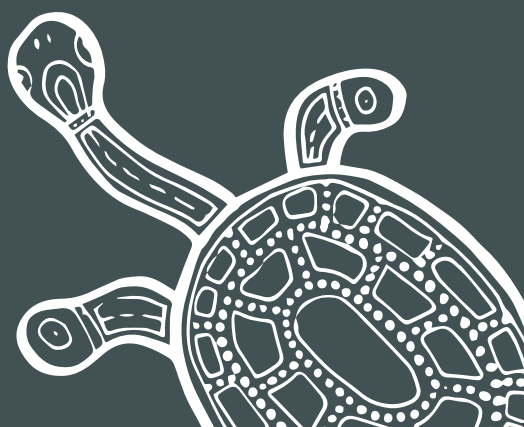
Build a robust evidence base on the status and projected future condition of Kakadu's marine and coastal environments in the context of climate change and other pressures.

Goal 4: Strengthen land-sea connectivity in management and research

Recognise and address the ecological and cultural interdependence of Kakadu's terrestrial, freshwater, and marine systems through integrated, cross-boundary research.

Goal 5: Build enduring partnerships and research infrastructure

Enhance collaboration between Parks Australia, Traditional Owners, government agencies, and research institutions while investing in research infrastructure and community capacity-building.



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5 Priorities and methodologies

The priorities in this strategy reflect community-identified needs and scientific knowledge gaps. They are designed to ensure Kakadu's marine and coastal ecosystems are understood, protected, and adaptively managed in the face of intensifying pressures.

These priorities will be reviewed and updated regularly in partnership with Traditional Owners through the Bininj/Mungguy Research Advisory Committee (BMRAC) and Kakadu Research and Management Advisory Committee (KRaMAC), particularly as new management plans, cultural mapping exercises, or policy directions emerge.

5.1 Sea Country management and protection

Traditional Owners from the coastal Kakadu area maintain a deep, intrinsic connection to Sea Country, emphasising its significance to cultural heritage, livelihoods, and ecological health. In the context of marine science, effective Sea Country management and protection strategies must honour this relationship by integrating Indigenous knowledge and practices with Western scientific methods. Such an approach not only respects Traditional Owners' understanding of ecosystems but also enhances marine conservation outcomes.

Co-management frameworks, which bring together Traditional Owners and scientists, are essential for sustainable monitoring, resource management, and habitat protection. This includes collaborative efforts to safeguard vital areas like seagrass beds, mangrove forests, and coral reefs – ecosystems critical to biodiversity and cultural identity. By aligning scientific research with Indigenous stewardship, Sea Country management can support ecosystem resilience and ensure that marine resources remain robust for future generations.

Priority activities for Sea Country management and protection in Kakadu National Park must be collaborative, culturally appropriate, and scientifically robust.

5.1.1 Understanding ecosystem health and impacts:

- **Baseline ecological and cultural assessments:** Conduct comprehensive baseline assessments of key marine and coastal ecosystems (e.g., seagrass beds, mangroves, coral reefs, intertidal zones) to establish a benchmark against which future changes can be measured. This should include Indigenous Knowledge about the historical condition of these areas.

- **Habitat mapping:** Develop detailed maps of key habitats and track changes in their extent and condition over time. This should include the mapping of culturally important sites within these habitats.
- **Water quality monitoring:** Monitor water quality parameters (e.g., salinity, temperature, turbidity, nutrient levels) in coastal and estuarine areas to assess the impacts of land-based runoff, climate change, and other stressors.
- **Species abundance and distribution:** Assess the abundance and distribution of key marine and coastal species, including culturally significant species, and monitor changes over time. Use both scientific surveys and Indigenous knowledge of species distribution and abundance.

5.1.2 Assessing the impacts of human activities:

- **Fishing pressure:** Assess the impacts of fishing pressure on target and non-target species, including the effectiveness of current fishing regulations. This should include an evaluation of traditional fishing practices and their sustainability.
- **Boat traffic:** Assess the impacts of boat traffic on marine and coastal habitats and wildlife, including disturbance of wildlife, and damage to sensitive habitats.

5.1.3 Developing and evaluating management strategies:

- **Co-management planning and strategies:** Develop and implement co-management strategies that integrate Indigenous Knowledge with Western scientific knowledge to manage Sea Country resources sustainably. Specifically, a Sea Country Management Plan was outlined by Traditional Owners to ensure values are protected in a way that is guided by cultural governance. This should be guided by Traditional Owner governance and driven by Indigenous and Western knowledge and science.
- **Adaptive management:** Develop an adaptive management framework to monitor the effectiveness of management actions, evaluate their impacts, and adjust strategies as needed. This framework should include periodic reviews with Traditional Owners.
- **Enforcement and compliance:** Evaluate the effectiveness of current enforcement and compliance measures and identify opportunities to improve compliance with existing regulations.
- **Marine protected area effectiveness:** Evaluate the effectiveness of existing marine protected areas in achieving conservation goals and identify opportunities for improvement.

Priority 1:

Baseline mapping and monitoring of marine ecosystems

Establish comprehensive baseline data to inform long-term monitoring, trend analysis and Sea Country planning.

Key actions:

- High-resolution mapping of seagrass meadows, mangrove forests, intertidal flats, estuaries, and coral outcrops.
- Bilingual mapping – Integration of Indigenous place names and knowledge in habitat maps.
- Co-develop a plan to better protect and manage Sea Country.

Methods:

- Remote sensing (e.g. drones, satellite imagery).
- Bininj-led field surveys and ecological yarning.
- GIS mapping tools with Bininj/Mungguy place data overlays.

5.2 Culturally important values

Reflecting the priorities identified by Kakadu's Traditional Owners, this Strategy emphasises the monitoring and understanding of culturally significant marine species in the face of ongoing ecological change. Key research areas include establishing robust baseline data on aquatic food resources; particularly species such as Barramundi, Golden Snapper, sea turtles, dugongs, and shellfish, e.g. mud mussels.

Focused surveys of turtle populations, including hatching success and foraging habitat use, are essential, as climate-related pressures like rising sea levels and increasing temperatures are already affecting hatchling survival, and skewed sex ratios are likely to impact long-term population viability.

The economic and cultural value of crocodiles to Bininj/Mungguy indicates the need for regular population assessments to support sustainable harvesting and management in a transparent and accessible form for Traditional Owners.

An integrated research approach – merging Indigenous knowledge systems with scientific methodologies – will be vital to track population dynamics, identify emerging ecological stressors, and guide responsive management strategies.

Ultimately, research on culturally significant species must be collaborative, respectful of Indigenous cultural authority, and scientifically robust. It must draw upon both traditional ecological knowledge and scientific methods to support the sustainable management of species central to the cultural identity, well-being, and livelihoods of Bininj/Mungguy in Kakadu's Sea Country.

5.2.1 Baseline population assessments and distribution:

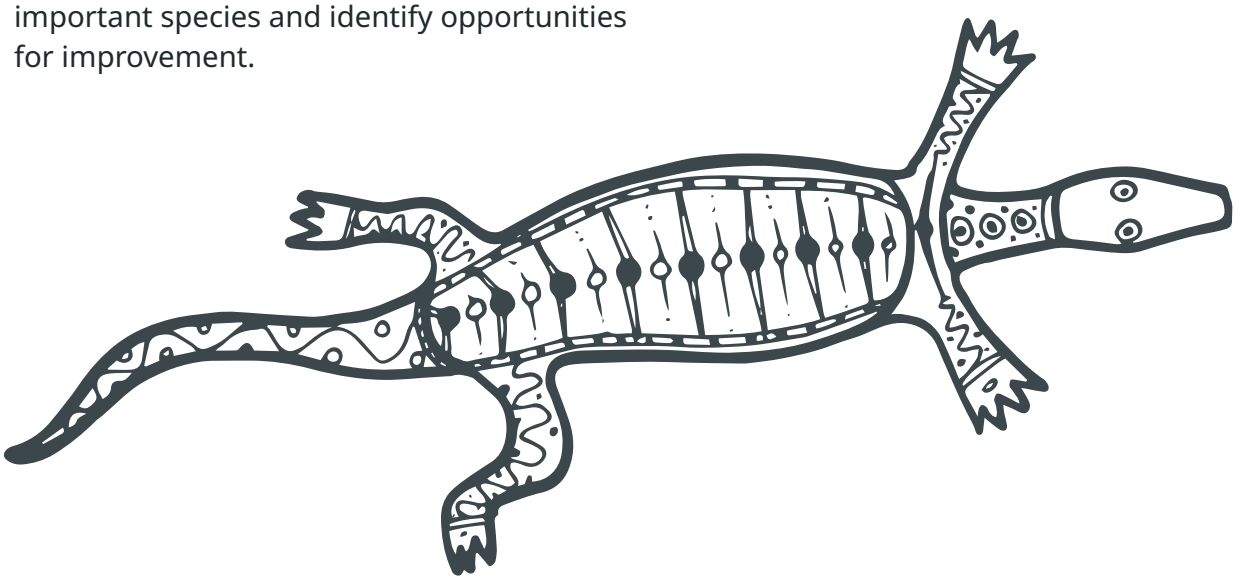
- **Species-specific surveys:** Conduct comprehensive surveys to assess the population size, distribution, and habitat use of key culturally important species (e.g., specific fish species, turtles, dugongs, shellfish, etc.). This should incorporate Indigenous Knowledge of species distribution, abundance, migration patterns and language names.
- **Indigenous Knowledge integration:** Actively engage Traditional Owners in data collection and interpretation, applying their knowledge of species distribution, habitat use, and traditional management practices.
- **Genetic analyses:** Where appropriate, conduct genetic analyses to assess population structure, gene flow, and genetic diversity of culturally important species, e.g. crocodiles, turtles, sawfish, barramundi and river sharks.

5.2.2 Sacred site protection and cultural heritage planning:

- **Habitat loss and degradation:** Assess the impacts of habitat loss and degradation (e.g., due to coastal erosion, sea-level rise, invasive species, altered fire regimes, pollution) on culturally important species and places.
- **Climate change impacts:** Assess the impacts of climate change (e.g., temperature, rainfall, and sea level) on the distribution, abundance, and behaviour of culturally important species.
- **Fishing and harvesting pressure:** Assess the impacts of fishing and harvesting (both commercial and recreational) on the abundance and distribution of culturally important species. This should include evaluating food security and traditional harvesting practices.
- **Predation and competition:** Identify and quantify the impacts of predation and competition from invasive species and other factors on culturally important species.
- **Cultural values:** Sacred sites and cultural values including places, stories, language, seasonal knowledge, harvesting areas and living cultural practices.

5.2.3 Partner to develop management strategies:

- **Sustainable harvesting strategies:** Develop and evaluate sustainable harvesting strategies for culturally important species that balance traditional practices with conservation goals. This requires close collaboration with Traditional Owners.
- **Habitat restoration:** Develop and implement habitat restoration projects to improve the quality and quantity of habitat for culturally important species. This should include restoring culturally significant sites.
- **Invasive species management:** Develop and implement strategies to control invasive species that threaten culturally important species.
- **Protected area management:** Evaluate the effectiveness of existing protected areas in protecting culturally important species and identify opportunities for improvement.



Priority 2:

Monitoring culturally and ecologically significant species

Track the health of key species and guide conservation actions.

Key actions:

- Monitor turtle nesting (flatback) and foraging (green), dugong foraging, river shark populations, barramundi spawning and recruitment.
- Identify key seasonal patterns and breeding sites.
- Assess climate-related impacts on hatchling success and migration.

Methods:

- Biologging, tagging and telemetry.
- Traditional Owner knowledge documentation.
- Shore-based observation and camera traps.
- Environmental DNA (eDNA) sampling.

5.3 Culturally important places

This Strategy acknowledges the importance of culturally significant sites along Kakadu's coast and aims to incorporate Traditional Owners' perspectives to support the protection and understanding of these areas. Research on salt pans, such as their ecological roles and any changes due to environmental pressures, will enhance knowledge of these unique landscapes.

Key locations, including Flatback Dreaming at Sandfly Beach, sacred middens like Munmarlary, and the dunes of Monass and Murrabibi, will be mapped and monitored in collaboration with Traditional Owners to document ecological and cultural values. Integrating archaeological studies, including dating of middens, can help trace the historical significance of these areas, connecting marine research with Kakadu's cultural heritage.

Monitoring the impact of coastal processes and climate change on these sites is necessary to ensure conservation efforts address ecological and cultural dimensions. Through collaborative research, this strategy supports a holistic understanding of these culturally important coastal places, aligning scientific inquiry with the stewardship values of Traditional Owners.

Priority activities for important places in Kakadu National Park must respect cultural sensitivities, prioritise collaboration with Traditional Owners, and focus on understanding and protecting these sites' cultural and ecological significance.

5.3.1 Documentation and mapping of culturally significant sites:

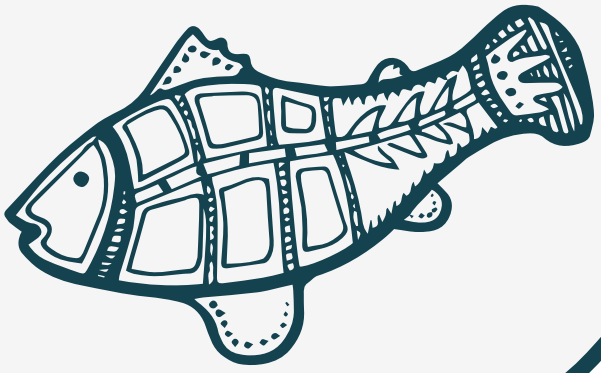
- **High-resolution mapping:** Create detailed maps of all known culturally significant sites, including middens, sacred sites, and other locations of cultural importance, using appropriate technologies (e.g., GIS, LiDAR, remote sensing) and incorporating Indigenous Knowledge. This needs to respect protocols for access and protection.
- **Oral history recording:** Document these sites' stories, traditions, and knowledge through careful and respectful oral history recordings and interviews with Elders and knowledge holders.
- **Archaeological investigations:** Conduct archaeological investigations at selected sites to understand their history, use, and significance. This should be done collaboratively with Traditional Owners, and non-destructive methods should be prioritised whenever possible.

5.3.2 Assessing the impacts of environmental change:

- **Coastal erosion and sea-level rise:** Investigate the impacts of coastal erosion, sea-level rise, and saltwater intrusion on coastal cultural sites, including middens and other sites close to the coast.
- **Climate change impacts:** Assess the effects of climate change on the vegetation, soils, and hydrology of culturally significant sites, considering potential effects on site integrity and accessibility. This might include changes in fire regimes and their impacts on sites.
- **Feral animal and weed impacts:** Assess the impacts of feral animals and weeds on the condition of culturally significant sites. This might include damage to vegetation, soil erosion, and disturbance of artefacts.

5.3.3 Developing management and protection strategies:

- **Site-specific management plans:** Develop site-specific management plans for each important place, incorporating findings from research and Indigenous knowledge, to prioritise protection from various threats.
- **Access and visitation management:** Develop strategies to manage access to and visitation of culturally significant sites to balance opportunities for cultural tourism and education with the need to protect sites and ensure respectful practices.
- **Community-based monitoring:** Establish Traditional Owner-led monitoring programs to track the condition of important places and detect any changes or threats. This includes training programs for monitors.



Priority 3:

Human activity and use impact assessment

Quantify and mitigate the impacts of fishing, tourism, and adjacent development on marine values.

Key actions:

- Monitor recreational fishing effort, boat traffic and anchor damage.
- Map and assess culturally sensitive sites impacted by visitation.
- Evaluate pollution sources (plastics, mining, runoff.

Methods:

- Yarning circles and ethnographic documentation.
- Cultural GIS tools and mobile data collection apps.
- Cross-generational knowledge transfer programs.
- Ethical protocols (FPIC, ICIP agreements, AIATSIS Code of Ethics).

Priority 4:

Cultural heritage and knowledge systems

Support the protection and documentation of cultural marine values.

Key actions:

- Identify and monitor sacred sites vulnerable to erosion and climate change.
- Record oral histories, Dreaming narratives, and seasonal calendars related to Sea Country.
- Develop participatory frameworks for cultural mapping.

Methods:

- Yarning circles and ethnographic documentation.
- Cultural GIS tools and mobile data collection apps.
- Cross-generational knowledge transfer programs.
- Ethical protocols (FPIC, ICIP agreements, AIATSIS Code of Ethics).

5.4 Important places

Addressing the impacts of feral animals and invasive weeds on Kakadu's wetland and sea country is crucial for sustainable management and restoration efforts. Traditional Owners report that buffalo and pigs are degrading wetland habitats, leading to altered water flow, increased erosion, and habitat loss for culturally significant species like turtles, magpie geese and fish.

The proliferation of invasive weeds, particularly para grass, has further transformed these environments, blocking waterways and disrupting life cycles, e.g., for turtles and fish, which depend on unobstructed water channels for breeding and foraging. Research will focus on monitoring and mitigating the impacts of feral animals and invasive weeds. Key efforts include implementing comprehensive surveillance programs for pigs and buffalo, paired with data-driven removal strategies, and assessing the extent and impact of weed invasion across floodplains.

Integrating blue carbon methodology, which accounts for the emissions reduction potential of wetlands, will allow for a broader understanding of how invasive hooved animals may alter carbon storage capacities. Together, these actions aim to support the restoration of Kakadu's wetland health, protect native biodiversity, and enhance ecosystem resilience in line with Traditional Owners' stewardship and vision for a healthy Country.

Priority activities for feral animal and weed management in Kakadu National Park must balance ecological restoration with cultural considerations and the needs of Traditional Owners. Some key areas:

5.4.1 Quantifying the impacts of feral animals:

- **Buffalo and pig impacts:** Detailed research to quantify the impacts of buffalo and pigs on water quality, vegetation, soil erosion, subsidence and culturally significant species (e.g., turtles, fish, and plants). This should include assessments of damage to culturally significant sites.
- **Spatial modelling:** Develop spatial models to predict the distribution and density of feral animals under different scenarios (e.g., changing climate, management interventions).
- **Economic valuation of impacts:** Quantify the economic cost of feral animal damage to infrastructure, agriculture, and tourism.

5.4.2 Evaluating the effectiveness of management strategies:

- **Control program evaluation:** Assess the effectiveness of current feral animal control programs (e.g., culling, trapping, exclusion fencing), including their impact on target and non-target species. This requires detailed monitoring before, during, and after control operations.
- **Cost-benefit analysis:** Conduct a comprehensive cost-benefit analysis of various feral animal management strategies to identify the most cost-effective approaches.
- **Community-based monitoring:** Engage Traditional Owners in ongoing monitoring to track population changes and assess the success of control efforts, complementing scientific monitoring.

5.4.3 Investigating the Impacts of Invasive Weeds:

- **Para grass distribution and spread:** Map the distribution and rate of spread of invasive weeds (e.g., para grass) and assess their impact on native vegetation, water resources, and culturally significant species.
- **Weed-species interactions:** Investigate the interactions between invasive weeds and native plants and animals, particularly those of cultural importance.
- **Weed control efficacy:** Assess the effectiveness of various weed control methods (e.g., herbicides, mechanical removal, biological control) on weed populations and their impact on native ecosystems. This also needs to evaluate impacts on culturally important resources.

5.4.4 Developing Integrated Management Strategies:

- **Integrated Pest Management (IPM):** Develop and implement IPM strategies that integrate various control methods (e.g., culling, trapping, herbicide application, biological control) and incorporate Indigenous Knowledge of traditional weed control methods.
- **Adaptive management:** Adopt an adaptive management framework to continuously evaluate the effectiveness of control programs and adjust strategies based on monitoring results and new information.
- **Collaborative practice:** Foster collaboration between Park managers, Traditional Owners, researchers, and other stakeholders to coordinate management efforts and ensure culturally appropriate approaches.

Priority 5:
Invasive species and restoration research

Understand the impacts of invasive species and assess the effectiveness of control and restoration strategies.

Key actions:

- Evaluate the effects of buffalo and pig activity on saltwater intrusion and wetland degradation.
- Monitor para grass and other weeds spreading into marine-freshwater interface zones.
- Explore blue carbon restoration and wetland rehabilitation techniques.

Methods:

- Exclusion fencing trials.
- Aerial spraying and biological control (e.g., Salvinia weevil).
- Carbon flux measurement and emissions analysis.
- Participatory restoration with Traditional Owner ranger groups.

5.5 Climate change

Traditional Owners have observed changes on Country in response to climate change, including upstream encroachment of saltwater species such as sea turtles and mud crabs, and the dieback of freshwater paperbarks and other vegetation. Their observations highlight the need for targeted mapping, monitoring, and accessible interpretation.

Research priorities will focus on monitoring sea level rise, saltwater intrusion, and seasonal shifts affecting ecosystems and culturally important species. Coastal mapping and beach profile studies will document habitat change over time, providing a scientific basis for tracking erosion, tidal reach, and mangrove migration.

The strategy also prioritises documenting Traditional Owner observations, histories, and adaptation strategies, and developing community-oriented educational resources, including videos, to communicate environmental change in a culturally meaningful way.

Research will integrate Indigenous seasonal indicators with scientific climate data to detect shifts in key species' behaviours and life cycles, such as the nesting patterns of magpie geese and flowering times of bush fruits.

Collaborative studies on the effects of saltwater intrusion on inland wetlands – particularly freshwater crayfish, water chestnut, turtles, and critical wetland vegetation – will improve understanding of ecosystem resilience. Through this integrated approach, the strategy seeks to provide actionable insights to help preserve biodiversity and cultural heritage during rapid environmental change.

Priority research activities for coastal climate change in Kakadu National Park should focus on understanding and mitigating impacts on both the natural environment and the cultural heritage of Traditional Owners.

5.5.1 Monitoring and predicting sea-level rise and saltwater intrusion:

- **High-resolution coastal mapping and monitoring:** Track changes in coastline, erosion rates, and the extent of saltwater intrusion into freshwater systems. This should include an analysis of historical data combined with predictive modelling.
- **Impacts on freshwater ecosystems**: Assess the vulnerability of freshwater wetlands, rivers, and billabongs to saltwater intrusion, focusing on the effects on culturally and ecologically significant species (e.g., freshwater fish, turtles, plants).
- **Monitoring key indicators:** Regular monitoring of key ecological indicators sensitive to saltwater intrusion (e.g., changes in vegetation communities, species distribution).

5.5.2 Assessing impacts on culturally significant species:

- **Turtle nesting sites:** Monitor the impacts of sea-level rise, temperature changes, and increased predation on sea turtle nesting sites, including egg survival rates and hatching success. Incorporate Indigenous Knowledge of turtle nesting behaviour and historical changes.
- **Dugong, green turtle, and seagrass habitats:** Research the impacts of climate change on benthic habitats and foraging turtle and dugong populations. This needs to incorporate Indigenous knowledge about dugong migration and feeding patterns.
- **Fish populations:** Monitor changes in the distribution and abundance of culturally significant fish species due to changes in water temperature, salinity, and habitat availability.
- **Mangrove health:** Assess the effects of sea-level rise, saltwater intrusion, and increased temperatures on mangrove forests, important coastal ecosystems supporting numerous species and providing cultural resources.

5.5.3 Understanding impacts on terrestrial ecosystems:

- **Paperbark forest dieback:** Investigate the cause and extent of paperbark forest dieback, a major indicator of climate change effects. Determine the impact on culturally significant sites and species.
- **Changes in fire regimes:** Investigate changes in fire frequency, intensity, and seasonality, analysing their impacts on vegetation communities, wildlife, and cultural sites.
- **Range shifts in flora and fauna:** Monitor shifts in the distribution and abundance of plant and animal species in response to temperature and rainfall changes, including species with cultural significance.

5.5.4 Developing adaptation strategies:

- **Community-led adaptation planning:** Facilitate the development of community-based adaptation plans informed by scientific findings and Indigenous Knowledge.
- **Protected area management:** Investigate strategies for adjusting protected area boundaries, water management, and fire management regimes to address climate change.
- **Economic diversification:** Explore how to diversify economic opportunities for communities in response to climate change impacts on traditional resources.

Priority 6:

Saltwater intrusion and climate resilience

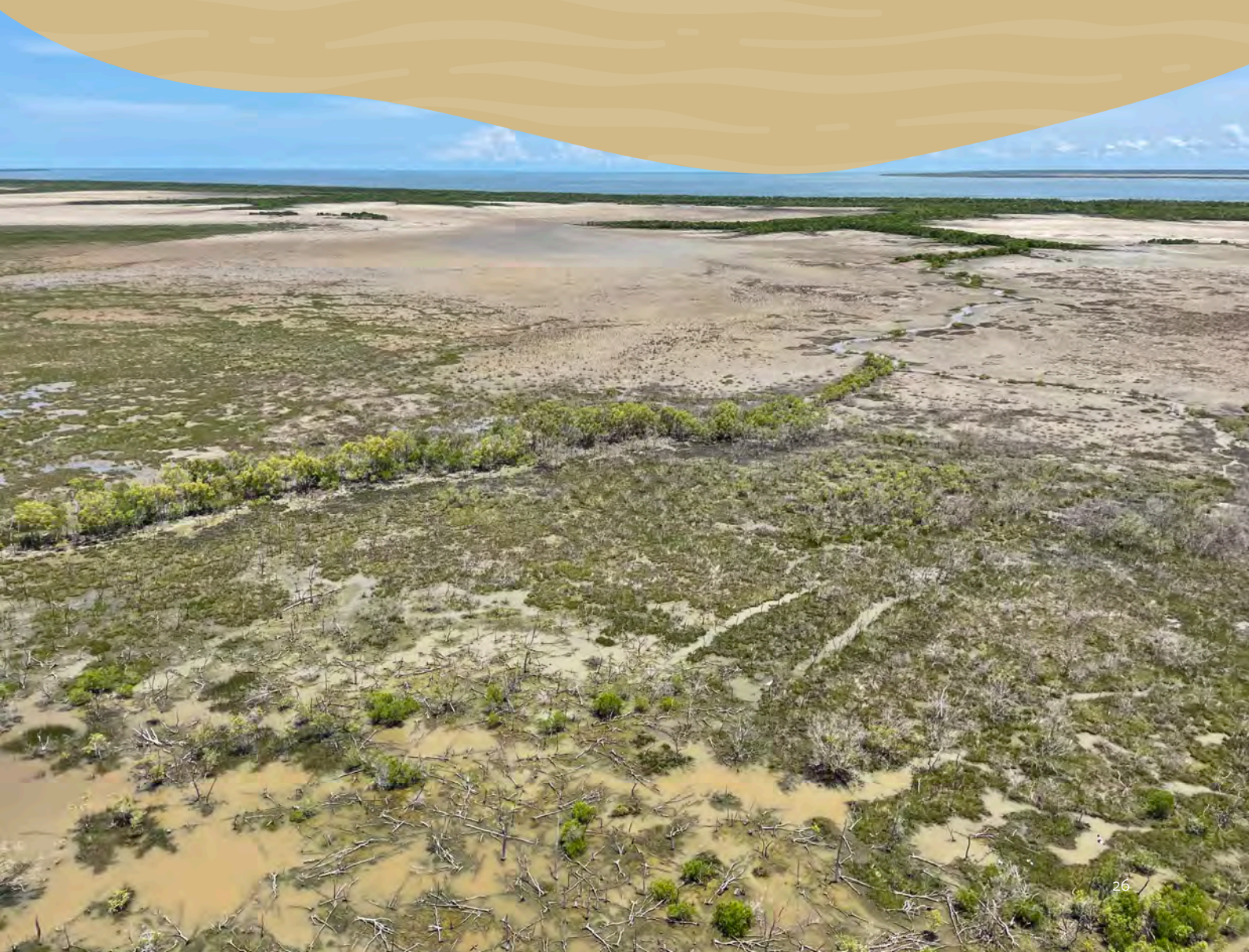
Understand the scope and future trajectory of saltwater impacts on freshwater wetlands and species.

Key actions:

- Develop predictive models of saltwater intrusion under sea-level rise scenarios.
- Assess the dieback of Melaleuca forests and freshwater transitions to saline systems.
- Track associated shifts in species composition and cultural access.

Methods:

- Time-series aerial imagery and remote sensing.
- Water quality sensors and salinity loggers.
- Soil and hydrological sampling.
- Cultural mapping.



6 Governance and implementation

6.1 Governance framework

The Sea Country Strategy will be implemented within the governance structures outlined in the Kakadu Research Strategy 2025–2035, including:

- **Bininj/Mungguy Research Advisory Committee (BMRAC):** Guiding priorities and ensuring cultural integrity.
- **Kakadu Research and Management Advisory Committee (KRaMAC):** Aligning research with park management needs.
- **Parks Australia:** Overseeing permit processes, coordination, and data management.

Traditional Owners will be involved at all stages – from agenda setting and data collection to co-authorship and communication of findings.

6.2 Implementation plan

- **Phase 1 (Year 1–2):** Establish governance processes, finalise priorities, secure funding, and commence high-priority baseline studies.
- **Phase 2 (Year 3–5):** Expand monitoring programs, deliver capacity-building initiatives, and integrate data into park management strategies.
- **Phase 3 (Year 5–10):** Evaluate effectiveness, refine research themes, and scale successful models of co-designed, culturally-led marine research.

Annual progress reports and a mid-term strategy review (Year 5) will support adaptive management.

6.3 Funding and investment

- National Environmental Science Program (NESP)
- Blue carbon and biodiversity markets
- Parks Australia core funding
- Philanthropic and university partnerships

7 Monitoring and evaluation framework

This framework outlines how the success of the Sea Country Strategy will be assessed over time. It builds on the Kakadu Research Strategy 2025–2035 and is designed to track progress across cultural, ecological, governance, and research impact indicators. The approach is grounded in Indigenous-led evaluation and two-way accountability.

7.1 Purpose

The Monitoring and Evaluation (M&E) Framework aims to:

- Track implementation of marine research priorities.
- Evaluate the effectiveness and cultural appropriateness of research activities.
- Identify improvements for research governance and delivery.
- Demonstrate outcomes for Bininj/Mungguy, biodiversity, and management decision-making.
- Ensure transparent reporting to Traditional Owners, partners, and the Commonwealth.

7.2 Guiding principles

Monitoring and evaluation will be conducted in a way that:

- Respects and is guided by Bininj/Mungguy values and governance.
- Promotes two-way science – bringing together Indigenous and Western knowledge systems.
- Reflects cultural safety and ethical practice.
- Is participatory, inclusive, accessible and responsive to community feedback.
- Provides timely, useful feedback to improve research quality and relevance.

7.3 Indicators and data sources

Theme	Sample indicators	Data sources
Participation and co-design	% of marine research projects involving Bininj in co-design or leadership. *Are research activities aligned with Bininj/ Mungguy priorities and management needs?*	Permit applications, project reports
	Number of Indigenous-led or co-authored outputs	Research publications, presentations
Knowledge integration	Evidence of two-way knowledge used in research design. *Has the strategy supported Indigenous research leadership and capability development?*	Interviews, evaluation surveys
	Culturally significant species/habitat included in studies.	Research summaries, BMRAC feedback
Research outputs and quality	Number and quality of peer-reviewed publications and reports. *Is the research methodologically sound, innovative, and contributing to knowledge gaps?*	Bibliographic tracking
	Data contributions to policy, management, or cultural strategies.	Management plans, policy documents
Benefit sharing	Bininj/Mungguy employment and training hours. *Are Bininj/Mungguy meaningfully engaged and benefiting from research?*	Project budgets, employment records
	Junior researcher or ranger pathways created.	Program evaluations, testimonials
Communication and sharing	Number of findings shared in culturally appropriate formats.	Videos, maps, posters, in-language resources
	Community feedback on understanding and use of research. *Based on feedback from Bininj/Mungguy, is the content accessible and engaging?*	Post-project evaluations, community consultations

Cultural integrity	Research following cultural protocols (e.g. sacred sites, gender access). *Are Indigenous protocols, FPIC, and cultural authority being upheld?*	Permit compliance reports, Traditional Owner feedback
Impact on management	Number of management actions or decisions informed by marine research. *Is research being used to inform policy, conservation, cultural heritage protection or planning?*	KNP management logs, KRaMAC minutes

7.4 Implementation and reporting

- **Annual implementation reviews:** A concise annual report presented to the Kakadu Board of Management, BMRAC, and KRaMAC tracking activities, outputs, and early outcomes.
- **Mid-term evaluation (Year 5):** Independent review in partnership with Traditional Owners to assess strategy effectiveness and recommend adaptations.
- **Final evaluation (Year 10):** A comprehensive assessment of outcomes, impacts, lessons learned, and forward-looking recommendations.

7.5 Roles and responsibilities

Stakeholder	Monitoring role
Parks Australia	Lead monitoring, coordination, and reporting. Maintain central data hub.
BMRAC	Provide oversight on cultural integrity and Indigenous priorities. Guide evaluation scope.
KRaMAC	Review management alignment and research utility.
Research Organisations	Submit timely reports, permit compliance, data sharing.
Traditional Owners	Participate in setting success criteria, indicator selection, and qualitative evaluations.

7.6 Tools and methods

- **Mixed-methods approach:** Combining qualitative interviews, storytelling, and yarning with quantitative analysis of metrics.
- **Community feedback loops:** On Country evaluation sessions with Bininj/Mungguy communities.
- **Digital dashboard (future):** Visual platform for tracking active marine research, data availability, and knowledge products.
- **Story maps and impact videos:** Multimedia formats to reflect research impact and community benefit.

8 Implementation and next steps

- **Continuous engagement:** Engagement will be ongoing rather than one-off.
- **Feedback mechanisms:** Traditional Owners will have opportunities to review and refine marine strategy activities and outcomes.
- **Employment and capacity building**: Opportunities for Indigenous rangers and community members to participate in marine and coastal initiatives.
- **Formal recognition of Indigenous Governance:** Ensuring Indigenous governance structures play a role in decision-making.

Appendix: Research priorities

Theme	Research priorities	Priority research questions for managing Country
Sea Country Management and Protection	*Baseline ecosystem and cultural mapping, water quality monitoring, co-management planning, impact of fishing pressure and boat traffic*	• Where do important coastal and benthic (underwater) habitats occur, and which areas require better protection? What are our options for improved protection? • How can we best support Aboriginal management of Country? • How can we better incorporate Aboriginal knowledge to manage sea Country? • Is long term water quality in rivers and the coastal system declining, how can this be monitored and what actions can be undertaken to make improvements?
Culturally Important Species	*Population and habitat surveys of turtles, dugongs, fish; evaluate harvesting and climate impacts; develop sustainable management strategies*	• Where are the most important areas for turtle nesting (flatback) and foraging (green), dugong foraging, river shark populations, and barramundi spawning and recruitment in Kakadu rivers and coastal waters? • What are the key seasonal patterns and breeding sites for culturally significant marine species? Are they changing, and how do we monitor that? • What are the most significant marine species for the local community? • What is the role of climate-related impacts on hatchling success and migration of culturally significant marine species? How can Kakadu best manage these threats? • What is population of river sharks and other culturally significant marine species and is there evidence of declines? • What are the impacts of commercial and recreational fishing effort, boat traffic, anchor damage, and pollution (plastics, mining, runoff) on culturally sensitive sites and marine values within Kakadu, and how can Parks best manage these threats?

Cultural Values and Heritage	*Map and document sacred sites and middens; assess impacts of erosion, access, and climate; develop cultural heritage management plans*	• Where are Kakadu's key cultural heritage places and values, including marked and unmarked sacred sites and cultural landscapes? • How can Parks better support development of participatory frameworks for cultural mapping? • What are the impacts of erosion, access, and climate on cultural heritage places and values in Sea Country, and how can the Park best protect and manage them?
Feral Animals and Weeds	*Quantify buffalo/ pig impacts; map para grass; assess and evaluate control measures; blue carbon and restoration potential*	• What is the relevance of blue carbon and nature positive restoration initiatives, and what are the options and restoration/rehabilitation techniques best suited to Kakadu? **Existing priorities:** • *How can we manage weeds to look after places and species that are important for Bininj/ Mungguy?* • *What tools can help us to plan better feral animal control?* • *What are acceptable levels of feral animal damage?* • *How is the Country recovering after feral animal control?*
Climate Change	*Monitor climate change impacts on natural, cultural, and community values; track Melaleuca dieback and turtle nesting; support Indigenous adaptation and resilience.*	• What new technologies (e.g. drones, remote sensing, GIS, photogrammetry, and digital cultural mapping) can improve documentation of changing and disappearing landscapes? • What are the impacts of sea-level rise and saltwater intrusion on Kakadu's natural, cultural, and community values, including Melaleuca dieback and culturally important places? • How are climate-driven changes to marine, coastal, and estuarine ecosystems affecting cultural access, livelihoods, wellbeing, and community activities? • How are Indigenous communities adapting to climate change, and how can Indigenous knowledge and community-led responses strengthen resilience?

Marine and Coastal

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