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CONSERVATION ACTION PLAN

for the southern atoll of the Cocos (Keeling) Islands

Prepared for the Director of National Parks by Sea Country Solutions Pty Ltd
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SeaCountry Solutions

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Rencana Tindakkan Pemeliharaan

Untuk kawasan pulu atas di Pulu Cocos (Keeling)

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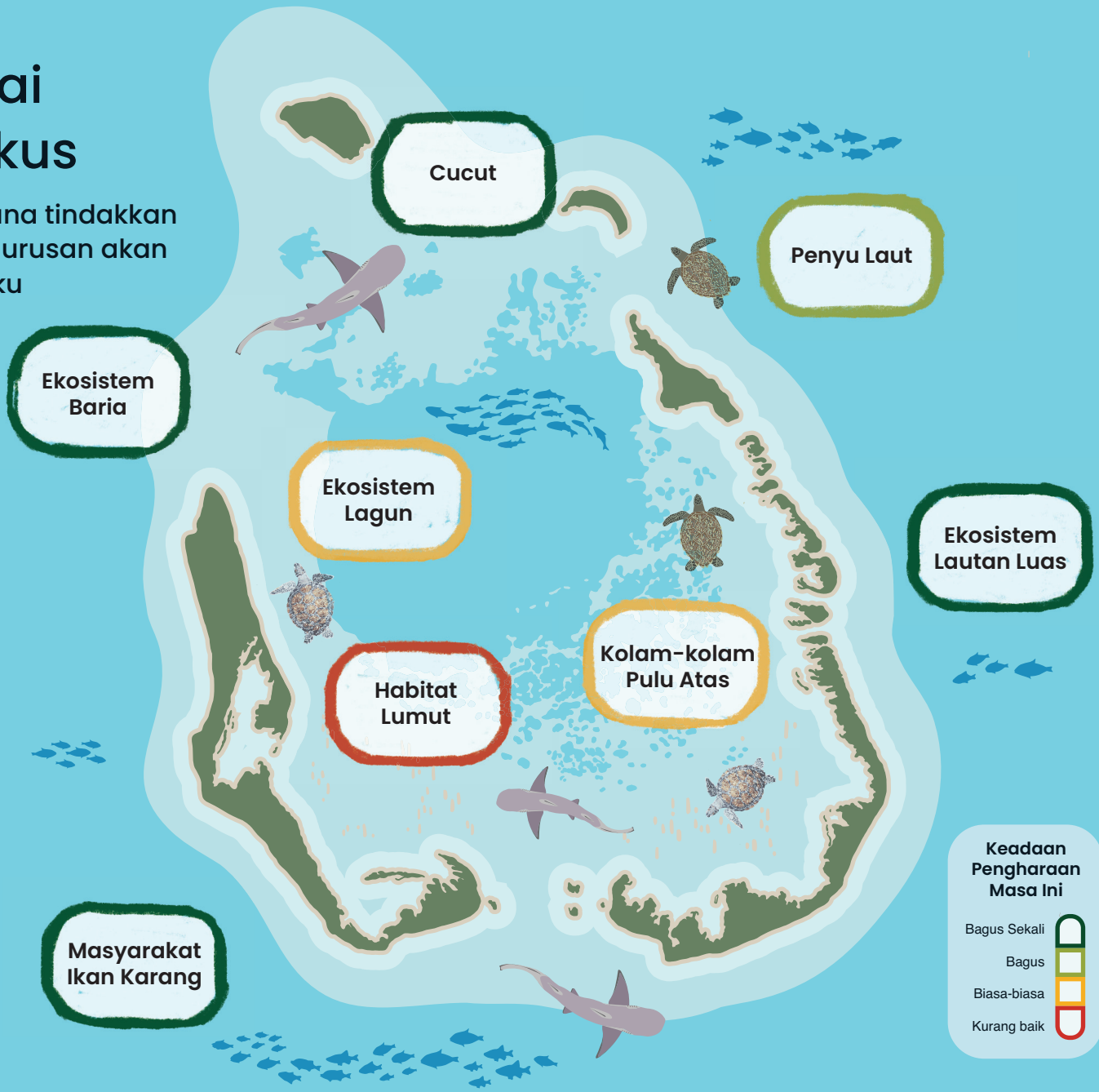
Rencana Tindakkan Pemeliharaan ini menunjukkan nilai utama, ancaman dan tindakkan pengurusan untuk membantu menjaga dan memelihara alami unik ini dimasa 10 tahun yang akan datang.

Nilai Fokus

Dimana tindakkan pengurusan akan belaku



Ancaman Utama

Aktiviti dan tekanan yang memberi ancaman terbesar terhadap nilai fokus

- Petukaran cuaca dan alam sekitaran
- Sampah lautan & pengotoran plastik
- Pertentangan manusia-cucut
- Perkembangan dan infrastruktur pantai
- Pengambilan berlebihan lumut
- Tekanan pemancingan
- Aktiviti rekreasi & pelancongan
- Jenis invasif & pest lautan

Strategi Pengurusan & Tindakkan

Untuk mengatasi ancaman utama dan perbaiki nilai fokus

Perbaikan lagun

Hasil: Kesembuhan dan penjagaan alami lagun yang sihat, terutama habitat yang bernilai tinggi dan serbis-serbis ekosistem.

- Pada 2027, membangunkan pengertian yang lebih baik terhadap keadaan fisikal dan hydrodynamiks didalam lagun dan petukaran sepanjang masa.
- Pada 2027, langkah-langkah untuk perbaiki mutu ayer didalam lagun dikenali dan ditempatkan.
- Pada 2032, menambahkan keluasan dan keadaan ekologikal habitat lumut didalam lagun.
- Pada 2032, memperbaiki keluasan, jenis berbagai dan keadaan ekologikal batu karang di kolam-kolam pulu atas.

Pelancongan dan rekreasi yang bertahan

Hasil: Mengurangi interaksi berbahaya dengan kehidupan laut.

- Pada 2027, pelancongan lautan dan aktiviti rekreasi, temasuk mancing, dijalankan secara selamat dan susuai terhadap ekologi.

Pengurusan jenis invasif

Hasil: Tidak ada jenis invasif atau pest dilautan yang masuk atau diperkembangan di pulu atas.

- Pada 2026, memastikan gangguan daripada jenis invasif lautan dan pest diurusi dengan berkesan untuk mengurangkan risiko pencerobohan dan perkembangan.

Sampah lautan dan pengurangan sampah

Hasil: pengurangan sampah lautan dan pengotoran plastik di pantai-pantai dan di lautan yang sekelilingi pulu atas.

- Pada 2027, mengurangi jumlah sampah lautan dan pengotoran plastik di kawasan pantai dan lautan dan membangunkan program pemindahan yang bertahan.

Perkongsian kerjasama

Hasil: Peningkatan penglibatan, inovasi, komunikasi, keberkesanan dan kecekapan dalam mencapai matlamat pengurusan.

- Pada 2025, menyatukan dengan berkesan pengetahuan orang tempatan dan scientifik untuk membimbing aktiviti science dan pengurusan.
- Pada 2032, penduduk, kumpulan dan organisasi Pulu Cocos (Keeling) berkemampuan, diberi kuasa dan terlibat untuk membantu melaksanakan aktiviti pendidikan, penyelidikan dan pengurusan.
- Pada 2027, membangunkan dan menerusi perkongsian kerjasama dengan stakeholders utama dan pihak penyelidikkan untuk memajukan matlamat pengurusan.

Keputusan terhadap pertentangan cucut

Hasil: interaksi negatif berkurangan mengenai interaksi manusia-cucut.

- Pada 2032, mengurangkan pertentangan manusia-cucut dengan berkesan dan memudahkan kemajuan ke kehidupan bersama.

Dapatkan salinan penuh Rencana Tindakkan Pemeliharaan di website Australian Marine Parks di:
www.parksaustralia.gov.au/marine

Conservation Action Plan

For the Southern Atoll of the Cocos (Keeling) Islands

This Conservation Action Plan identifies key values, threats and management actions to help protect and conserve this unique environment over the next 10 years.

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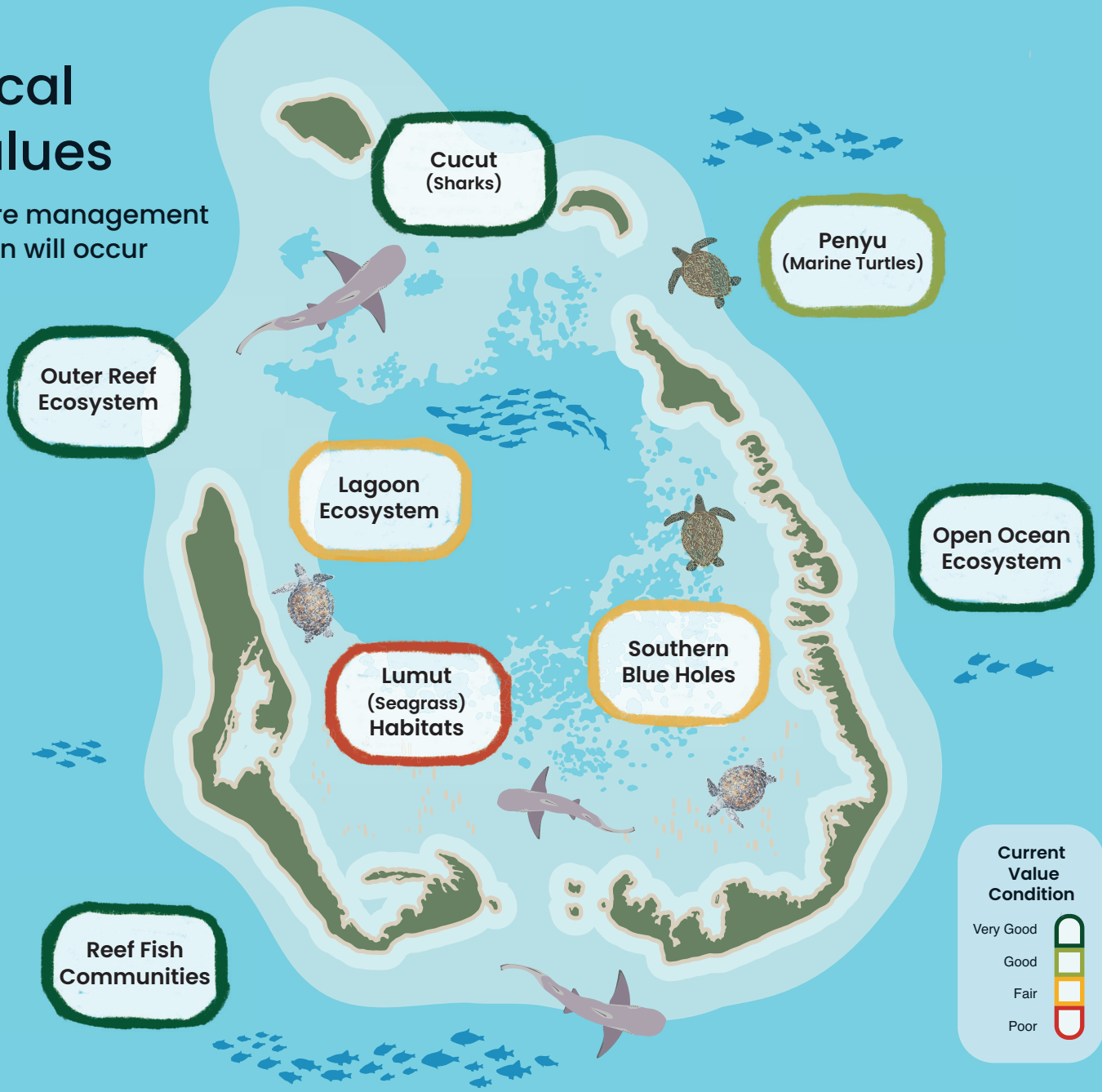
Focal Values

Where management action will occur



Key Threats

Activities and pressures that pose the greatest threat to the focal values

- Climate and environmental change
- Marine debris & plastic pollution
- Human-shark conflict
- Coastal development & infrastructure
- Overgrazing of seagrass
- Fishing pressure
- Recreational & tourism activities
- Marine invasive & pest species

Management Strategies & Actions

To address key threats and improve focal values

Lagoon restoration

Outcome: Recovery and maintenance of healthy lagoon environment, particularly high-value habitats and ecosystem services.

- By 2027, develop an improved understanding of the physical conditions and hydrodynamics within the lagoon and expected changes over time.
- By 2027, measures to improve water quality within the lagoon identified and in place.
- By 2032, increase the extent and ecological condition of seagrass habitats within the lagoon.
- By 2032, improve the extent, diversity and ecological condition of coral reefs in the southern blue holes.

Marine debris and plastic reduction

Outcome: Less marine debris and plastic pollution on beaches and in the ocean around the southern atoll.

- By 2027, reduce the amount of marine debris and plastic pollution in coastal and marine areas and establish a sustainable removal program.

Shark conflict resolution

Outcome: Fewer negative human-shark interactions.

- By 2032, effectively mitigate human-shark conflict and facilitate a transition toward co-existence.

Sustainable tourism and recreation

Outcome: Fewer harmful interactions with marine life.

- By 2027, marine tourism and recreational activities, including fishing, are conducted in a safe an ecologically-appropriate manner.

Invasive species management

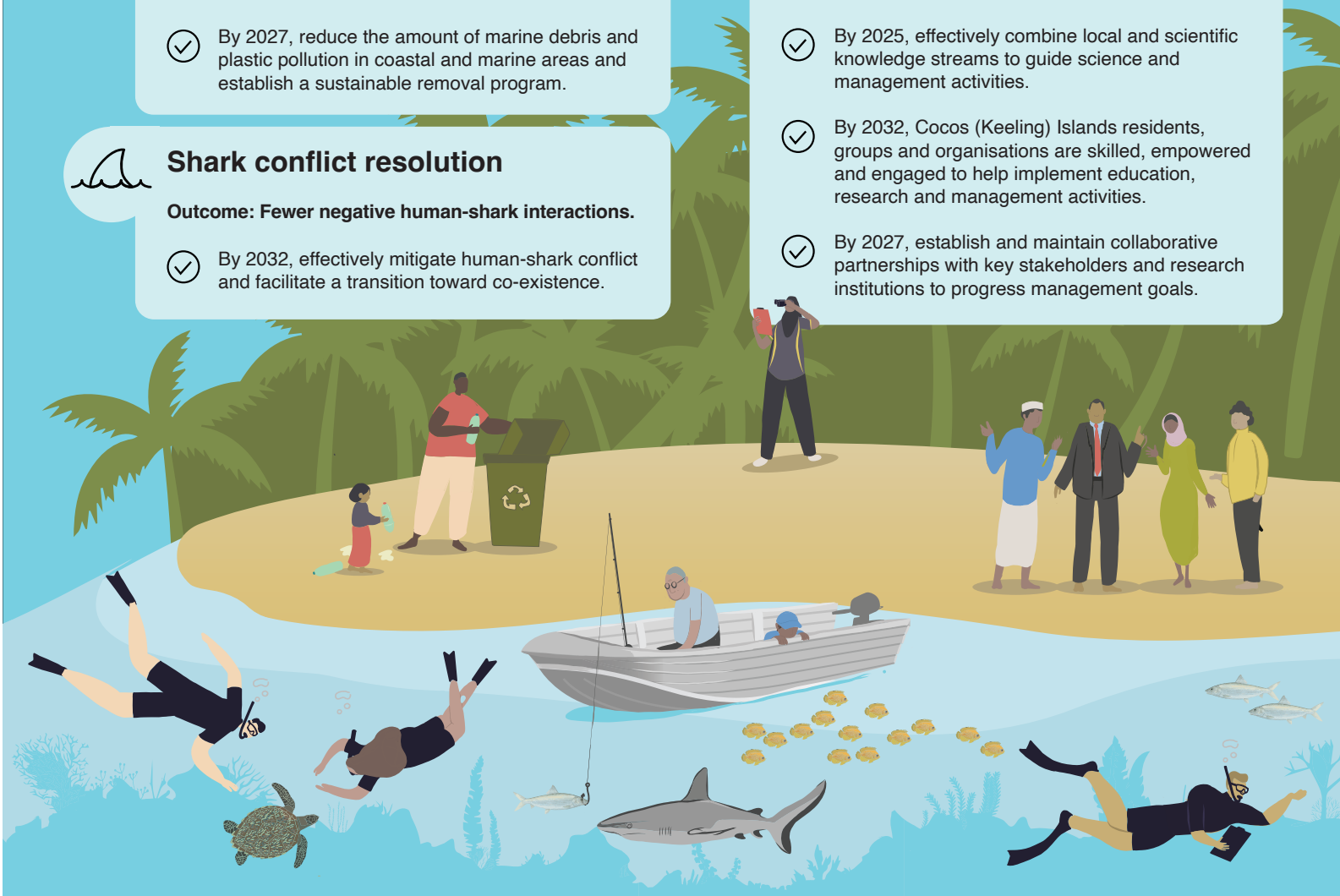
Outcome: No marine invasive or pest species introduced or established at the southern atoll.

- By 2026, ensure the impact of marine invasive and pest species is effectively managed to minimise the risk of incursion and establishment.

Collaborative partnerships

Outcome: Increased engagement, innovation, communication, effectiveness and efficiency in achieving management goals.

- By 2025, effectively combine local and scientific knowledge streams to guide science and management activities.
- By 2032, Cocos (Keeling) Islands residents, groups and organisations are skilled, empowered and engaged to help implement education, research and management activities.
- By 2027, establish and maintain collaborative partnerships with key stakeholders and research institutions to progress management goals.



Find a full copy of the Conservation Action Plan on the Australian Marine Parks website:
www.parksaustralia.gov.au/marine

Table of Contents

About this plan

Context

In March 2022, the Australian Government established the Cocos (Keeling) Islands Marine Park to help protect the unique marine life found around the remote Cocos (Keeling) Islands.

This marine park encompasses and protects an area of over 467,054 square kilometres (km) in the Indian Ocean[a] and is home to diverse and distinct habitats and species, including threatened and migratory species, as well as endemic species found nowhere else on earth.

The purpose of the marine park is to provide for:

- The protection and conservation of the biodiversity and other natural, cultural and heritage values; and
- Ecologically sustainable use that support positive social and economic outcomes.

About the islands

The Cocos (Keeling) Islands consists of two atolls, comprising 27 tropical low-lying coral islands.

The Cocos (Keeling) Islands have a rich and unique marine environment, containing a mix of species from both the Indian and Pacific Oceans, as well as hybrid and endemic species, which are found nowhere else on the planet. The inshore and lagoon waters also include important seagrass and coral reef habitats, which support a range of marine species, such as dolphins, turtles and sharks, as well as ecologically and locally important fish and invertebrate populations.[1]

The northern atoll – known as North Keeling Island or *Pulu Keeling* – and surrounding waters are part of the Pulu Keeling National Park. This area is an internationally recognised seabird rookery and provides important habitat for threatened species such as green turtles and robber crabs.[2] The national park adjoins the new marine park.

The southern atoll, known as South Keeling Islands, is home to around 550 people, with a mix of Malay and Australian culture. Most residents are Cocos Malay and are the descendants of the first people brought to the islands in the early 1800s. The Cocos Malay people have a vibrant and unique culture, with a strong connection to the ocean and islands.

The majority[b] of the inshore waters around the southern atoll lie within the marine park and are a yellow (Habitat Protection) zone. This means that fishing is allowed, however, activities that disturb the seafloor – like mining or dredging – are prohibited.

The location and zoning of the marine park was co-designed with the local community and recognises the significant cultural, social and economic value of the marine environment. The Cocos Malay people rely on the ocean and lagoon as a source of food, with many species – such as gong gong (spider conch, *Lambis lambis*) – utilised in cultural events and celebrations. The ocean also provides a source of recreation, with residents and visitors drawn to the area for fishing, boating, snorkelling, diving, surfing, kite surfing, kayaking and swimming.

Purpose

The southern atoll's marine environment is an important source of food and nutrition, recreation and employment for residents and visitors.

This area has undergone critical ecological changes in the last 20 years, including the substantial loss of seagrass habitats, reduced live coral cover and increased sedimentation in the southern blue holes, and multiple 'die off' events impacting fish and invertebrate communities in the lagoon.

Broad and strong action, informed by targeted research and monitoring, is needed to maintain and conserve this important ecosystem.

This plan was developed to identify and help focus management actions at the Cocos (Keeling) Islands' southern atoll, to achieve the greatest conservation gain and support ongoing ecologically sustainable use.

[a] A map of the Cocos (Keeling) Islands Marine Park is available from: https://parksaustralia.gov.au/marine/pub/maps/cocos-keeling-islands-marine-park-map-zoning-2022.pdf

[b] The marine park does not include the inter-island guiding ferry route and port refuge area, as well as other small areas around the islands.

Using an adapted conservation action planning (CAP) process, **we identify six management strategies, comprising 11 objectives, designed to tackle those activities and pressures that pose the greatest threat to the marine natural values of the southern atoll**.

While this plan was developed for Parks Australia and focuses on the marine park area, it is designed to be a holistic plan that can also be used by other marine managers, researchers, stakeholders and the broader Cocos community to guide activities, identify priority projects and foster collaboration.

The identified strategies comprise high priority actions to address key threats and improve the state of focal values. These strategies will be implemented based on urgency, opportunity, and resourcing.

Given its broad scope and the interconnected nature of marine values and threats, **effective implementation of this plan will require strong cooperation and collaborative partnerships with the Cocos community and other stakeholders**. This includes local government, Commonwealth agencies, local business owners, conservation organisations, community groups and research institutions.

Note, this plan does not replace the Cocos (Keeling) Islands Marine Park Management Plan, which, at the time of this plan's completion, is being developed in accordance with the *Environmental Protection and Biodiversity Conservation (EPBC) Act 1999*.

Instead, this plan should be viewed as complementary to the management plan, with the management strategies and actions identified in this plan used to directly guide and inform conservation management activities at the southern atoll.

Overall approach

The approach taken to develop this action plan is based on the Conservation Action Planning (CAP) methodology developed by The Nature Conservancy[3] and has been adapted to better align with the local context, project scope and goals.

We used a two-way knowledge approach, which combined scientific and local knowledge to develop a comprehensive understanding of local marine values, key concerns and threats, knowledge gaps and potential solutions. This approach included multiple small group and one-on-one meetings with marine scientists with relevant local experience and community members[c]. Members from the project team conducted a site visit in August 2022. Learnings from this visit, including information from informal conversations with residents and personal observations of the marine environment, were also used to inform this Action Plan.

In line with CAP methodology, we first identified a small number of "focal values", which are representative of the marine natural values found at the southern atoll and are the focus of management efforts in this action plan. This was an iterative process, with the final focal values identified based on their ecological characteristics, threats and participant advice.

Next, using input from scientists and local community members, we assessed the current condition, or overall health, and desired condition of each focal value in 10 years' time (referred to as the "goal condition").

We then identified and assessed key threats to these values, based on the scientific literature and local knowledge. This process focused on those activities and anthropogenic pressures that directly have caused, are causing or may cause the degradation, destruction, and/or impairment of marine values. Threats were assessed separately for each focal value (on a value-by-value basis).

We then developed management strategies, comprising measurable objectives and actions, to combat key threats and progress the management goals identified in this plan.

In the final section of this report, we outline practical indicators and monitoring techniques that can be used to support the adaptive management of the southern atoll's marine environment.

Focal values

Identifying "focal values"

The first step in the conservation action planning process is to identify a small number of focal values for management.

These values can be ecosystems, ecological communities or species and should

[c] See Appendix A for list of individuals and organisations consulted as part of this process.

collectively represent the marine biodiversity of a region. These focal values form the basis for setting goals, carrying out actions and measuring management effectiveness.

The assumption behind this approach is that by managing representative examples of broad-scale ecosystems and communities, most values will also be addressed.

We used an iterative process to identify focal values for the southern atoll. First, we compiled a comprehensive list of the marine natural values, based on *Natural Values of the Inshore Waters of Australia's Indian Ocean Territories - Christmas and Cocos (Keeling) Islands* [1] and previous community consultation[4].

A focal value can be associated with multiple nested values (e.g. habitats, species assemblages or individual species). In line with CAP methodology, we grouped together values that would benefit from similar conservation strategies because they:

- Co-occur across the seascape,
- Share similar ecological processes, and
- Share similar threats.

We then screened for species or communities that are not well "nested" within the broader focal values and/or require specific management attention, such as:

- Species or groups with special conservation or management requirements due to distinct locations, ecological processes or threats;
- 'Keystone species' that drive ecological processes; or
- Other species that may not be well nested.

We also considered those values that were highly threatened or provided strategic or broader value – for example, by promoting partnerships with key stakeholders.

The initial list of potential focal values was shared with participants during interviews, with participants asked to provide feedback on the groupings. This process was used to further refine the list of focal values.

We identified eight focal values for the southern atoll:

- Open ocean ecosystem
- Outer reef ecosystem
- Lagoon ecosystem
- Southern blue holes
- *Lumut* (seagrass) habitats
- *Cucut* (sharks)
- *Penyu* (marine turtles)
- Reef fish communities

Each of these focal values has multiple nested values (e.g. habitats, species assemblages or individual species). Similarly, nested values may be linked to more than one focal value – for example, corals are nested in the outer reef, lagoon and southern blue holes. A list of the nested values captured within each focal value is provided in Appendix B.

Assessing value condition

The next step in the CAP process is to assess the current condition, or overall health, and desired condition of each focal value in 10 years' time (referred to as the 'goal condition'). This coarse assessment is used to identify which values are most in need of immediate action and provides a basis for monitoring progress over time.

During consultation sessions, we asked participants to rate the current and desired future (in 10 years' time) condition of focal values using the following criteria[3]:

Very good
Functioning at an ecologically desirable status, requires little human intervention.

Good
Functioning within the acceptable range of variation, may require some human intervention.

Fair
Outside the range of acceptable variation and requires human intervention. If unchecked, will be vulnerable to serious degradation.

Poor
Unacceptable; if the value remains in this condition for an extended period of time, it will make restoration or preventing extirpation practically impossible.

We also asked participants specifically about the goal condition for 10 years' time, as well as their advice on how to achieve this, which was used to inform strategy development.

We recognise that for some values, these goals are ambitious and will require decisive

action. Similarly, we recognise that the full restoration of some values (where feasible) may have timeframes beyond the life of this plan.

Participants were also asked to describe the value's trend over time – whether it is increasing/improving, decreasing/deteriorating or stable. Participants were then asked to explain *why* they chose a particular rating and trend, citing evidence from previous research and/or personal observations.

This approach helped to summarise and document knowledge and assumptions about each value, as well as identify any knowledge gaps.

Most participants chose to discuss between one and three focal values, with which they were most familiar or knowledgeable. At least one scientific expert was consulted for each focal value.

There was very high consensus among participants on the current and desired condition of the focal values. In the occasion where there was a discrepancy among participants' viewpoints, the authors evaluated the provided evidence for the value's attributes, reviewed the condition in relation to other values, and drew on their own expertise and recent observations at the atoll to determine the current condition.

Open ocean ecosystem

The southern atoll is surrounded by open ocean that supports a community of pelagic species. Depths range from 0 to 6000 m, resulting in a range of habitats due to differences in light attenuation, temperature and food availability.

These habitats support large predatory fish, small pelagic fish, oceanic sharks, rays, marine mammals, sea snakes, turtles and sea birds[2,5].

The open ocean is important because many shallow water species travel through this environment at some life stage. Most reef fishes, corals and other benthic invertebrates have a larval stage that disperses through the ocean, thereby connecting the shallow water communities of the northern and southern atolls. Conditions in the open ocean strongly affect larval survivorship, which in turn determines the replenishment rate of species living on inshore habitats at the southern atoll.

The oceanic waters adjacent to the southern atoll are a popular fishing area for residents and visiting tourists, who target large pelagic species like sailfish, wahoo and tuna.

Unlike other parts in the Indian Ocean, the southern atoll has been relatively protected from industrial commercial fishing activities. Accordingly, this area provides an important refuge for many species that have been overfished elsewhere, including *sirik kuning* (yellowfin tuna, *Thunnus albacares*).

Current condition

Very good and **stable**
Ecologically desirable condition, requires minimal intervention

Evidence:

- Diverse pelagic assemblage
- High biomass of pelagic fishes[6]
- High catch rate of target fish species
- Supports a diverse seabird community[2]

2032 Goal

Maintained at ‘very good’

Outer reef ecosystem

Encircling the southern atoll is the outer reef ecosystem. This area covers over 4000 hectares and comprises 35 per cent of the shallow water habitats at the southern atoll[1]. It contains important shallow reef habitats and an extensive reef slope that extends to mesophotic depths (up to 150 m). This ecosystem is connected to the inner lagoon via a series of channels.

The outer reef sustains important species including sharks, manta rays, pipefish, turtles, crayfish, sea cucumbers and giant clams (*Tridacna* sp.). This area also supports the highest diversity of fishes on the southern atoll, including high abundances of hybrid and endemic fishes, such as the Cocos and lemonpeel angelfishes (*Centropyge colini* and *C. flavissima*, respectively).

The outer reef flat extends seaward from the foreshore to the surf zone. This shallow reef zone encircles most of the atoll and includes coral, sand and seagrass habitats.

Shallow areas receive high light and wave energy and are dominated by sessile (non-moving) organisms, including hard corals, soft corals, algae and sponge beds. These habitats support diverse marine communities, including species that are not found anywhere else in Australia[1]. These areas are highly accessible and are often utilised for recreation and fishing purposes.

Coral cover on the outer reef remains high (> 30 %)[7] and has increased over the last 15 years[1]. Corals at the southern atoll experienced minor bleaching, with no obvious mortality, during the recent 2016 global mass coral bleaching event[8, 9]. Corals are also susceptible to coral disease, with both white syndrome[10] and growth anomalies[11] recorded.

However, these ecosystems are extremely vulnerable to changing environmental conditions, due to the atoll's remoteness and reliance on local recruits for recovery.

Hard coral communities on the outer reef contribute significantly to the local carbonate budget within the lagoon through carbonate production (via reef accretion) and the deposition of carbonate sediment during extreme weather events[12].

The reef slope sustains a high abundance of species that are targeted by fishers[13]. *Ikan hijau* (humphead Māori wrasse, *C. undulatus*), *dongol* (bumphead parrotfish, *B. muricatum*) and *gelek burik* (squaretail coral trout, *P. areolatus*), aggregate along the outer reef slope, suggesting this may be an important spawning area[1].

Mesophotic reefs (30 to 150 m depth) are dominated by seawhips and gorgonians. Little is known about these habitats and communities, although fishing data indicate an interesting assemblage including deepwater cods, jobfishes, sepat and thresher sharks[1].

Current condition

Very good and **stable**
Ecologically desirable condition, requires minimal intervention

Evidence:

- High and increasing live coral cover[7]
- High coral diversity[14,15]
- Minor coral bleaching[8, 9]
- Crown-of-thorns are rare[7]
- Some coral disease[10, 11]
- Absence of giant clams (*Tridacna gigas* and *T. durasa*), potentially locally extinct[16]
- Stable densities of giant clam (*T. maxima*)[16]
- Diverse and abundant fish communities[17, 18, 19]
- High abundance of endemic and hybrid species[1]

Critical knowledge gaps:

- Species inhabiting mesophotic reefs

2032 Goal

Maintained at 'very good'

Lagoon ecosystem

The extensive lagoon ecosystem at the southern atoll includes a variety of habitats: beaches, sand flats, mud flats, coral reefs and bommies, coral rubble, macroalgae and seagrasses beds. These habitats support a high diversity of invertebrate and fish species.

Approximately 600 mollusc and 200 crustaceans have been recorded at the southern atoll, with the majority found in the lagoon[20, 21]. This includes large invertebrates that are often targeted by fishers, such as *udang* (painted crayfish, *Panulirus* spp.), *rajugan* (mud crabs, *Scylla* sp.), *kima* (Tridacnid clams), octopus and gong gong (spider conch, *L. lambis*). Ghost and hermit crabs also inhabit the intertidal areas.

The lagoon is an important fishing area for species such as *bandang* (bonefish, *Albula oligolepis*), *bodas* (silveries, *Gerres* sp.), *kakap* (emperors, *Lethrinus* spp.) and *belanak* (mullet, *Mugilidae* spp.). There are anecdotal reports from residents of changes in fish abundance – with some species increasing (such as bonefish), while others have declined (such as rabbitfish) in recent years. The lagoon also provides important nursery areas for some species that inhabit the outer reef.

Through natural processes, the lagoon is slowly filling with sediment transported through the southern passages. This infilling is likely to affect water movement in the lagoon. As seen at North Keeling, this process can cause rapid loss of habitats and species[22].

Water quality over the past 20 years has declined in the lagoon, including increased turbidity[23] and episodes of low dissolved oxygen associated with "die-off" events[24, 25, 26]. Consequently, there have been significant changes in some habitats, such as declines in seagrass and associated macroalgae (e.g. *Caulerpa* spp.)[23] and smothering of intertidal areas with silt.

Monitoring data indicate significant declines in coral cover inside the lagoon, with very low coral cover currently (< 10 %)[1]. This decline may have severe consequences for the more than 300 species of fish that utilise the complex coral reef habitats in the lagoon.

These changes have cascading effects on the animals that rely on these habitats.

Current condition

Fair and **declining**
Unacceptable condition, needs intervention to recover

Evidence:

- Increased turbidity, particularly around western edges of lagoon
- New silt deposits along south-eastern intertidal areas
- Increasing periodic declines in macroalgae cover (e.g. *Caulerpa, Padina*, and *Acanthophora* species)[27]
- Outbreak of coral growth anomalies in northern lagoon[11]
- Stable densities of giant clam (*Tridacna maxima*) in northern lagoon[16]
- Varying abundances of recreationally important fish species
- Variable gong gong abundance between years[27]

Critical knowledge gaps:

- Changes in hydrodynamics, sediment infilling and lagoon flushing and related ecological impacts

2032 Goal

Recovered to 'good' and continuing to improve

Photo: K Thomas Travaille

Southern blue holes

The southern blue holes are an ecologically important habitat interspersed across the sandy habitats of the southern lagoon. These habitats provide complexity and depth in an otherwise shallow and uniform environment.

Culturally, the blue holes are important to Cocos Malay fishers, who have names for each individual blue hole and associate different holes with particular species.

Although the holes vary in diameter (from five to 100 m) and depth (from three to 10 m), they have a typical structure with extensive massive and branching corals along the margins and coral rubble in the centre. The coral growth on the edges provides the primary habitat structure and complexity, while the deeper rubble areas support a unique and diverse community of small corals[1]. Cabbage corals were previously abundant on the edges but are now rare.

The blue holes remain submerged during low tide and provide important habitats for a range of species – green turtles are often found resting under boulders and overhangs, while juvenile grey reef sharks, *ikan hijau* (humphead Māori wrasse, *C. undulatus*), *dongol* (bumphead parrotfish, *B. muricatum*) and *gelek burik* (coral trout, *Plectropomus* spp.) use this as a nursery area[1]. Small-bodied coral reef fish, eels, and invertebrates, such as *udang* (painted crayfish, *Panulirus* spp.), and *kima* (tridacnid clams), are also found in this area.

Along with the rest of the southern lagoon, the blue holes have been subject to multiple "die off" events[24, 25, 26] as a result of reduced flushing, freshwater inundation, and high water temperatures. Consequently, live coral cover has diminished by more than 90% in the last 10 years[1, 26]. While the remaining live corals are important to recovery, the dead coral skeletons have been covered in an alga (*Lobophora variegata*), which may affect coral settlement and growth.

Through natural processes, the blue holes also experience infilling of sediment from the south, and this is expected to continue[12]. Compared to the shallow southern holes, the holes towards the central lagoon are generally deeper and less affected by die-off events. The more central holes also have higher coral cover and fish diversity[1].

Current condition

Fair and **declining**
Unacceptable condition, needs intervention to recover

Evidence:

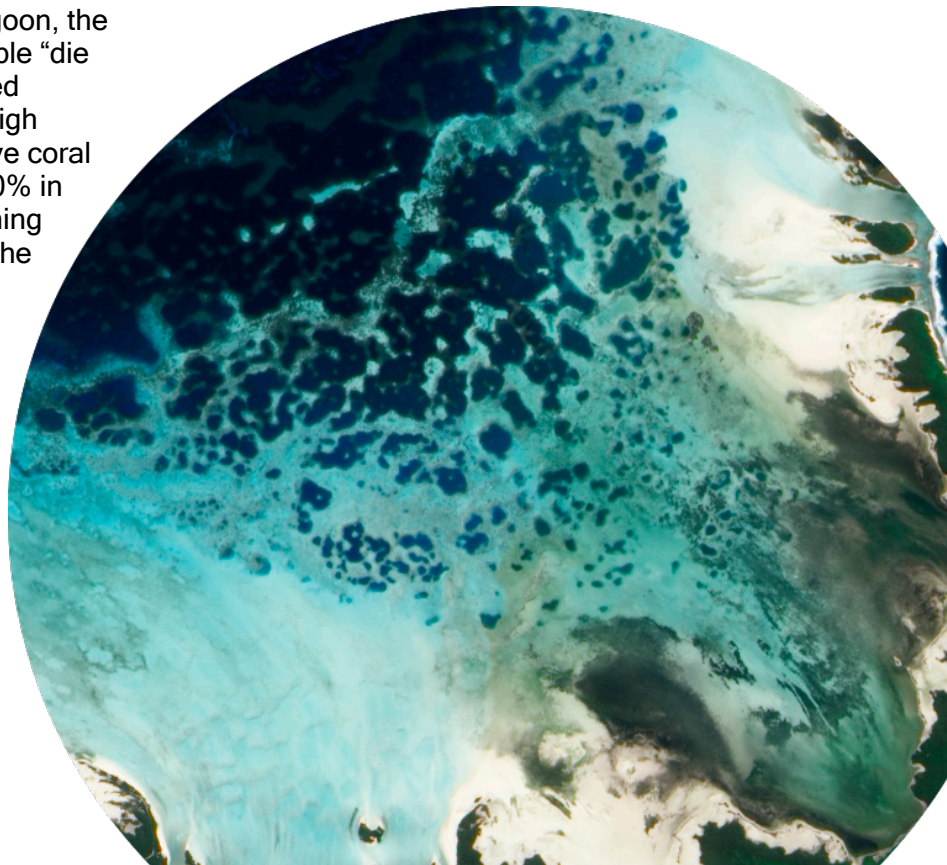
- Multiple massive "die off" events affecting fish, invertebrates, corals, seagrasses and macroalgae[24, 25, 26]
- Over 90% decline in live coral cover[1, 26]
- Variable gong gong abundance, but below historical levels[27]
- Varying abundances of fish (e.g. declines in coral-associated species)

Critical knowledge gaps:

- Changes in hydrodynamics, sediment infilling and lagoon flushing and related ecological impacts
- Relationship between algal (*Lobophora* sp.) growth on coral recovery

2032 Goal:

Recovered to 'good' and continuing to improve



Lumut (Seagrass) habitats

Seagrass habitats, known locally as *lumut*, provide key ecological benefits including nursery habitat for fish species, a food source for herbivores, sediment stabilisation, nutrient filtration to improve water quality, carbon sequestration and coastal buffering through reduced wave energy.

Over 70 species of fish from 26 families have been recorded in seagrass habitats[28] at the southern atoll, and these habitats play an important ecological role for listed marine pipefish species, as well as key fisheries species, such as *kakap* (emperors, *Lethrinus* spp.), *buntal* (pufferfish), *rajugan* (mud crab, *Scylla* sp.) and *gerita* (night octopus, *Callistoctopus ornatus*).The seagrass also provides important feeding and resting habitat for turtles, with green turtles particularly reliant on seagrass for food[29].

There are three species of seagrasses that have been found at the southern atoll – *Thalassia hemprichii* (historically the most abundant), *Syringodium isoetifolium*, and *Thalassodendron ciliatum*[30]. In the last 20 years, however, there has been a massive decline in the extent of shallow seagrass cover within the lagoon – such that less than approx. 20% of the historical extent remains. This decline followed the development of the Rumah Baru jetty and coincided with multiple lagoon-wide die-off events in 2007 through 2016[23]. The status of deeper seagrass beds in the central lagoon is currently unknown.

The substantial loss of seagrass has potentially altered the broader lagoon ecosystem, with likely impacts on fish, turtles and invertebrate communities that rely on seagrass habitats as nursery areas, food sources and foraging areas.

Current condition

Poor and **declining**
Needs urgent action, or may not be able to recover

Evidence:

- Estimated 80% reduction in shallow seagrass cover (extent) within lagoon[23]
- Reduced blade length and shoot density in remnant patches[31]

Critical knowledge gaps:

- Reproductive viability of remnant seagrass
- Extent of current seagrass habitats, including deeper seagrasses
- Magnitude of turtle and fish grazing pressure
- Biological and ecological impacts of seagrass loss (e.g. on fish, invertebrate and turtle populations)
- Changes in hydrodynamics, sediment infilling and lagoon flushing and related ecological impacts on remaining seagrass habitats

2032 Goal

Recovered to 'good' and continuing to improve

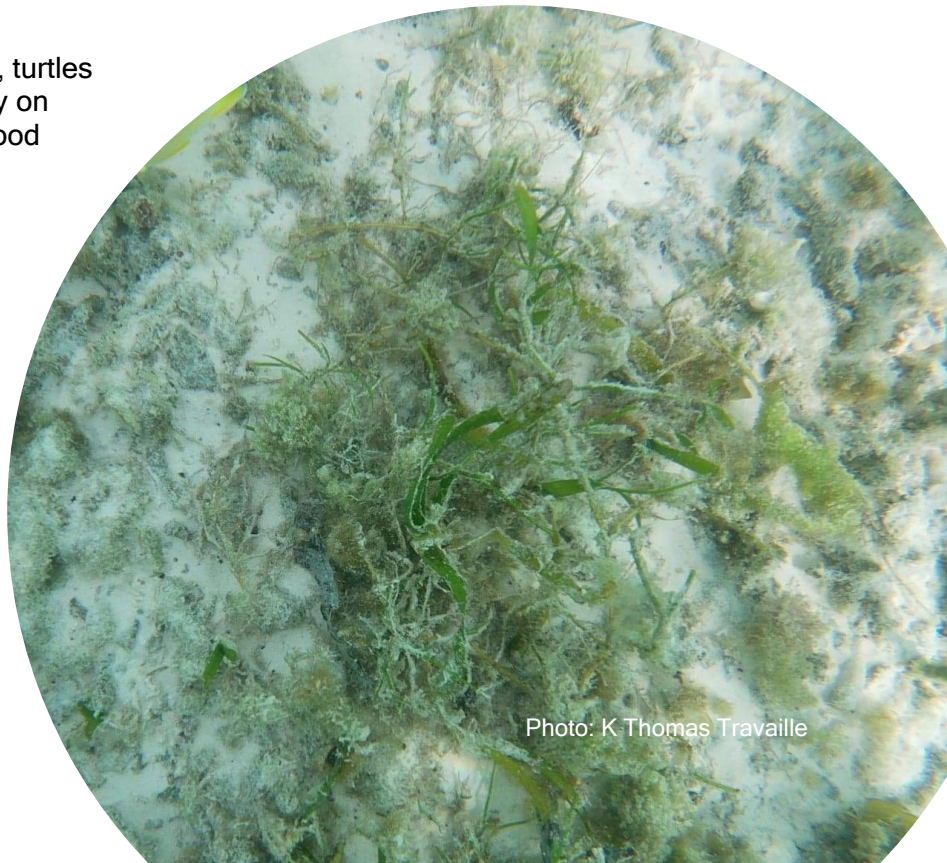


Photo: K Thomas Travaille

Cucut (Sharks)

Eight species of sharks have been recorded in waters of the southern atoll[17]. The most abundant include blacktip *(Carcharhinus melanopterus),* whitetip *(Triaenodon obesus)* and grey reef sharks *(C. amblyrhynchos*). These species are commonly found in the shallow lagoon, blue holes and outer reef areas[19].

Less abundant shark species that visit the southern atoll include silky sharks (*C. falciformis*), tiger sharks (*Galeocerdo cuvier*) and scalloped hammerheads (*Sphyrna lewini*)[1].

Reef sharks are likely to play a key role in the southern atoll system, predating on smaller fish and invertebrates and moderating prey behaviour[32].

Recently, residents have reported that reef sharks are more frequently encountered around the atoll and are increasingly aggressive. In particular, the community has noticed increased rates of shark depredation (where a shark partially or completely consumes a fisher's catch before it can be landed) and post-release predation (where a fish is consumed by sharks after being released) when fishing.

There have also been incidents of unprovoked negative shark encounters with swimmers.

Current condition

Very good and **increasing**
Ecologically desirable condition, may require some intervention

Evidence:

- High shark abundance[33, 19]
- High levels of shark depredation and post-release predation
- Reports of increasingly aggressive shark behaviour

Critical knowledge gaps:

- Extent of shark depredation and post-release predation
- Patterns in shark behaviour
- Effective mitigation techniques to reduce interactions

2032 Goal

Maintained at 'very good'

Penyu (Marine turtles)

Five species of marine turtles, known locally as *penyu*, have been recorded at the southern atoll, although only green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) turtles are regularly encountered[29].

Many of the green turtles in the southern atoll comprise a genetically distinct resident population that nest on North Keeling Island, and more rarely, on the southern atoll. Other green turtles are visitors that were born, and will return to nest at, locations in NW Australia and Malaysia[34].

Green turtles are commonly found in the shallow waters along the western and south-eastern edges of the lagoon. Their high abundance is linked to the previously abundant seagrass beds, which form their primary food source[29]. Green turtles can also be found resting and foraging on the outer reef.

Hawksbill turtles frequent the lagoon and outer reef area for foraging and resting. The southern atoll plays a critical role in the hawksbill lifecycle, with juveniles using the area to feed, shelter and grow before leaving to nest in the central and western Indian Ocean[35, 36, 37].

Since seagrass cover has declined, green turtles have been seen more frequently in shallow waters – potentially because they are spending increasing time in these areas looking for food. Given their dietary reliance on seagrass, it is expected that the health of individual turtles and turtle populations may begin to decline.

Current condition

Good and **declining (?)**
Acceptable condition, may require some intervention

Evidence:

- High abundance of foraging turtles[29]
- High individual health[29]
- Stable levels of green turtle nesting, although relatively low success[29]
- Increasing encounters with turtles in shallow waters
- Expect to start to see a decline in turtle abundance and/or growth rates, as populations adjust to reduced seagrass availability

Critical knowledge gaps:

- Status of turtle populations and trends in individual growth and health
- Impacts of seagrass loss on turtle populations
- Adjusted carrying capacity, given reduced seagrass availability

2032 Goal

Restabilised in 'good' condition

Reef fish communities

The southern atoll supports a diverse community of reef fishes. More than 600 fish species from 84 families have been observed, and the majority inhabit coral reefs. The families with greatest number of species include wrasses, gobies, damselfishes and cods[17].

The islands also support endemic fishes, including the Cocos and lemonpeel angelfishes, as well as the highest levels of hybrid fishes in the world[38].

These communities reflect the diverse habitats available and the unique geographic position of the islands – where Pacific and Indian Ocean species overlap[39]. Habitats utilised by reef fishes include the inner lagoon, coral bommies, blue holes and exposed outer reef areas.

Many reef fishes are important fisheries species and have long been fished by the local community.

Given the atoll's isolation, reef fish populations are largely self-sustaining, with abundance driven by local larval production and recruitment. This isolation increases the vulnerability of fish populations, as they rely on local populations or long-distance sources for recovery.

Over twenty years ago, the populations of two *gelek burik* species (coral trout, *Plectropomus areolatus* and *P. laevis*) rapidly declined and were no longer seen[40]. The square-tailed trout (*P. aerolatus*) population has now recovered, with high numbers found within the lagoon and on the outer reef[1]. However, the blue spotted coral trout (*P. laevis*) has not recovered.

Reef fishes are also vulnerable to changes in local habitat availability. While the southern atoll has escaped the global coral bleaching events that have negatively impacted reef fishes elsewhere[9], the loss of seagrass and coral decline in the southern lagoon is likely to impact fishes, particularly those that depend on seagrass as a nursery area.

Current condition

Very good and **stable**
Ecologically desirable condition, requires minimal intervention

Evidence:

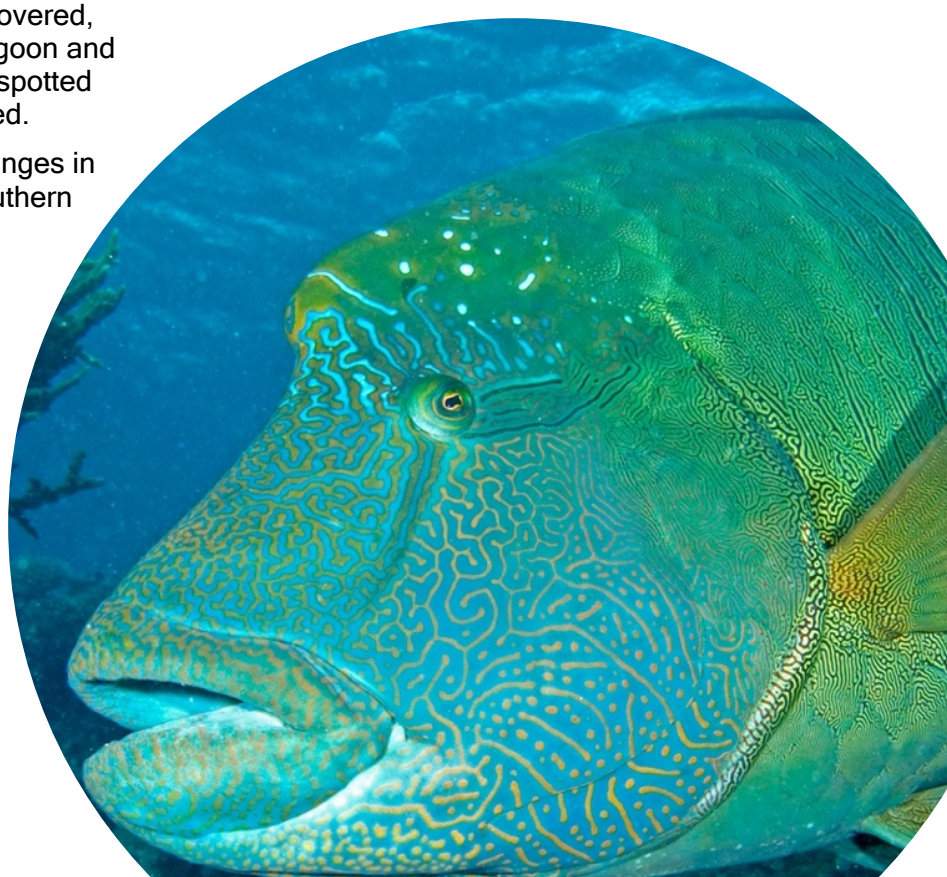
- Diverse fish assemblage[17]
- Relatively high catch rates of target species
- High abundance of hybrid and endemic species[38]
- Relatively stable abundance of key species across years[33]
- Evidence of squaretail coral trout recovery, but no evidence of blue spotted coral trout recovery[1]

Critical knowledge gaps:

- Stock status of key recreationally fished species
- Impacts of seagrass and coral habitat loss on reef fish populations

2032 Goal

Maintained at 'very good'



Key threats

Identifying key threats

The next step in the CAP process is to identify key threats to the focal values. This helps to focus management action where it is most needed.

Threats are activities, anthropogenic pressures or natural disturbances that immediately harm or negatively affect a marine value. Importantly, natural disturbances may also be compounded by human activities – for example, an increase in extreme storm events due to climate change. These threats can be currently active or likely to occur in the next ten years. Historical threats, which are no longer active, were not included.

Threats were identified and assessed by CAP participants during the consultation process. Specifically, we asked participants: *What do you think is the greatest threat to this focal value?*

We then asked participants to characterise the impact(s) of each threat on the focal value, as well as identify the drivers of the threat, if known. This information was later used to guide strategy development.

Identified threats were tabulated and cross referenced with the published literature and the Conservation Measures Partnership's (CMP) Conservation Direct Threats Classification[41] for accuracy and completeness. To determine which threats posed the greatest risk, we considered the frequency in which a threat was identified by participants as the 'greatest threat' to marine values and the scale and intensity of present and/or likely future impacts.

Using this process, we identified eight key threats for the southern atoll marine environment:

- Climate and environmental change
- Marine debris and plastic pollution
- Human-shark conflict
- Coastal development and infrastructure
- Overgrazing of seagrass
- Fishing pressure
- Recreational and tourism activities
- Marine invasive and pest species

We recognise that threats also exist and may need to be considered in future activities.

Climate and environmental change

The marine values at the southern atoll are under pressure from sustained and ongoing changes in environmental conditions, partly influenced by anthropogenic climate change – notably, changes in hydrological and wind regimes and rising water temperatures.

The lagoon has been subject to multiple "die-off" events throughout history affecting fish, invertebrates, corals, seagrasses and macroalgae. These events generally coincide with unusually warm temperatures and calm, westerly wind conditions – resulting in reduced flushing, elevated water temperatures and reduced dissolved oxygen in the southern lagoon and blue holes areas[24, 25, 26]. If these conditions become dominant, it is likely that mass die-off events within the lagoon will increase in their frequency and severity.

Recently, there has also been increased sedimentation within the lagoon, resulting in a layer of thick, anoxic silt/mud along the south-eastern lagoon edge. While infilling is a natural atoll process, the drivers and impacts of this recent increased sedimentation are currently unknown.

It is also unknown how climate change will affect the hydrodynamics that drive sedimentation and lagoon infilling. Changes to this natural infilling process will also, in turn, affect flushing and water quality in the lagoon.

More broadly, marine ecosystems in the Indian Ocean are under pressure from increasing water temperatures and extreme heat events, which cause coral bleaching. While hard corals at the southern atoll have demonstrated some resilience to heat stress[16], this pressure is predicted to increase into the future. Where coral bleaching events have caused mass coral mortality at other isolated atolls, recovery has been slow[42].

Managing the effects of this environmental change will require a better understanding of the links between environmental conditions, such as air and sea surface temperature (SST), wind direction and strength, sedimentation rates, sea-level rise and climate events such as El Niño-Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD), and their impacts to the species and ecosystems at the southern atoll. This information is critical for forecasting stress events to inform management responses.

Marine debris and plastic pollution

Marine debris and plastic pollution are an on-going threat to the marine environment at the southern atoll.

In 2017, an estimated 238 tonnes (over 400 million pieces) of anthropogenic marine debris were washed ashore and deposited at Cocos (Keeling) Islands, with local accumulation 'hotspots' on the exposed, ocean-facing beaches on South Island. Nearly all these debris were plastic items, including shoes and 'single use' items, such as drink bottles, straws and toothbrushes[43].

Marine debris poses a threat to marine species and ecosystems through direct entanglement and ingestion[44], as well as exposure to harmful plastic-related chemicals and microbes (bacteria, fungi, viruses, etc)[45]. Marine debris can also act as a vector for invasive or pest species.

Most plastic debris at Cocos (Keeling) Islands originate overseas, primarily from Indonesia[46], with only a very small fraction derived locally.

Effectively managing this threat will require a multi-pronged approach: acting to remove debris from the coastal and marine environment, developing a sustainable means of disposal, and working to reduce the entry of plastic items into the ocean at the source.

Human–shark conflict

Human-shark conflict is a growing threat to the shark assemblage and fish populations at the southern atoll.

The Cocos (Keeling) Islands has a high abundance of reef sharks, with participants noting increasing numbers of sharks in recent years. Additionally, there are reports that sharks are becoming more aggressive – resulting in increasing human-shark interactions and conflict.

The primary conflict at the southern atoll arises from shark depredation, post-release predation, and to a lesser degree – human safety and unprovoked shark bite incidents. As a result of these interactions, there is an increasingly negative attitude and perception of sharks at the southern atoll.

On the other hand, sharks are also a draw for tourists – with visitors actively feeding and interacting with sharks for entertainment.

While these activities can help promote positive shark attitudes, if not properly managed, they may also result in direct injury or harm to sharks or indirectly contribute towards negative human-shark encounters, for example where sharks are actively fed in areas where people regularly swim.

Managing this threat will require a better understanding of nature and extent of human-shark conflicts at the southern atoll, as well as their ecological, social and economic impacts and how these work with or against management goals.

Coastal development and infrastructure

Coastal facilities and infrastructure, including ports, inter-island ferry services and commercial development, helps support the local population. The islands also provide a strategic location for protecting Australian Government interests in the region and are used as a base for critical infrastructure.

Coastal infrastructure also plays a role in mitigating coastal hazards, such as inundation and erosion. For example, retaining walls have been constructed to help stabilise and protect coastal areas, such as the ocean-facing shoreline in front of West Island Settlement and Trannies Beach and the lagoon-facing shoreline in front of Home Island Settlement[47].

While coastal and marine infrastructure provides economic and social benefits, it can also have a negative impact on marine values. For example, the development of Rumah Baru facilities was a key contributor to the loss of seagrass habitats in the development area and adjacent lagoon[23].

Currently, key activities identified as threats to focal values include vessel movements (e.g. the inter-island ferry), the maintenance of shipping lines, and new development projects, such as the expansion of the airport runway to accommodate larger aircraft (Defence Project 8219).

These activities can impact marine ecosystems through the direct physical removal or harm of species and habitats, as well as reduce light availability, smother habitats or disturb animals in the vicinity as a result of increased sediment (re)suspension and deposition.

Effectively managing these activities will require consideration of any direct impacts on biodiversity within the activity 'footprint', as well as flow-on effects to other pressures (e.g. invasive species, pollution, recreational activities, fishing pressure) through the importation of materials and machinery to the activity site and the expanded workforce population during construction and maintenance activities.

Overgrazing of seagrass

Following the substantial decline in cover over the last two decades[23]. seagrass recovery has been limited, in part, by the overgrazing of seagrass by native herbivores, such as turtles and fish. This is a due to the current imbalance between the low level of natural seagrass production versus the rate of seagrass removal, and associated disturbance to seagrass habitats from foraging activities. For example, turtles and fish (e.g. bonefish, goatfish) have been observed digging in seagrass areas, which can damage or dislodge seagrass rhizomes.

Managing this threat may require limiting grazing and physical disturbances (e.g. using exclusion devices[d]) to support seagrass recovery, until such a time that some form of balance is achieved between seagrass production and consumption.

As seagrass is a key food source for green turtles at the southern atoll[29], it is important to ensure that management actions do not result in unacceptable impacts to this protected species[e]. Accordingly, we recommend that the status of turtle populations, carrying capacity at the islands, and the effects from overgrazing and associated management on turtle populations are assessed and monitored.

[d] Initial pilot studies at the southern atoll using small cages have indicated significantly higher above-ground seagrass biomass where turtles are excluded (Sea country Solutions and Cocos Marine Care, unpublished data).

[e] Marine turtles in Australia are protected under the *Environment Protection and Biodiversity Conservation Act 1999.* Under this Act, both hawksbill and green turtles are listed as 'vulnerable'.

Fishing pressure

Fishing is one of the primary recreational activities at the atoll for many residents, especially among the Cocos Malay community who rely on fish to meet food security and nutritional needs. Fish and invertebrates, such as gong gong, also play a key role in cultural and religious ceremonies.

There is no significant commercial fishing at the Cocos (Keeling) Islands, although a small number of fishers are permitted to sell their recreational catch on-island, to help meet local needs and tourism demand. There are also limits to the amount of fish, *kima* and gong gong that may be taken off-island, for example, to give to family and friends in mainland Australia.

There is growing interest in 'catch and release' fishing, particularly for *bandang* (bonefish), and sport fishing tours targeting pelagic species, such as giant trevally, dogtooth tuna and sailfish.

New recreational fishing rules, including bag and size limits, were developed with the local community, and subsequently adopted by the Australian Government in early 2022[f]. These rules are based on over 10 years of scientific research and form the basis of new collaborative fisheries management at the southern atoll.

Recreational fishing pressure is currently limited by the low local population size, export limits, and limited number of fishing tour operators at the islands; however, impact from fishing may change if pressure increases or new activities emerge.

While the offshore waters around the atoll are closed to fishing, migratory pelagic fish particularly yellowfin tuna – are under severe pressure from industrial fishing fleets operating elsewhere in the Indian Ocean. Addressing this threat will require ongoing surveillance and enforcement of marine park boundary to keep out illegal fishing, while engaging at the regional level to promote sustainable management.

[f] For more information visit: https://www.infrastructure.gov.au/territories-regions-cities/territories/indian-ocean-territories/cocos-keeling-islands/fishing-rules

Recreational and tourism activities

Many residents and visitors are attracted to the southern atoll for the marine biodiversity and actively engage with the marine environment and species. This includes activities such as beach and reef walking, boating, kayaking, surfing, kitesurfing, diving, snorkelling and swimming. There are also a small number of tour operators, who offer SCUBA diving, snorkelling, kayaking and fishing experiences.

While marine recreational activities provide important social and economic benefits, they can also be harmful to marine habitats and species – particularly in high use areas. For example, there have been reports of potentially unsafe and/or inappropriate interactions, which may negatively impact marine biodiversity – such as anchoring on sensitive habitats (causing physical harm), encouraging tourists to feed sharks (contributing toward human-shark conflicts), walking or standing on corals (causing physical damage to coral habitats), or catching marine animals to take a 'selfie' (causing physical harm to the animal and/or people involved).

Currently, the low population size and relatively low visitor numbers – even with increased tourism during the COVID-19 pandemic – help to limit adverse impacts from marine recreational activities. However, the high concentration of visitors at certain sites, such as 'the Rip', Direction Island and Pulu Maria, can lead to substantial localised impacts on species and habitats.

Effectively managing this threat will require working with community members and tourists to raise awareness about local marine values and environmental issues and encourage safe and sustainable behaviours.

Marine invasive and pest species

Marine invasive and pest species present an ongoing threat to marine biodiversity at the southern atoll. These species are commonly transported and introduced into marine areas through biofouling and ballast water.

The Western Australian Department of Primary Industries and Regional Development (DPIRD) has been monitoring the southern atoll waters for introduced marine pest species since 2018. The most recent marine biosecurity surveillance survey (in 2021) found no evidence of introduced marine pest species at Cocos (Keeling) Islands. Similarly, no species displaying significant invasive characteristics, such as hyperabundance, were observed[48].

However, given its unique biodiversity, isolated nature and proximity to high-risk areas in south-east Asia, this threat should continue to be managed and monitored to minimise the likelihood of invasive species being introduced or becoming established.

Management strategies and actions

Strategy development

The next step in the CAP process involves defining priority management objectives and identifying strategies and actions to achieve these goals.

Management strategies and objectives focus on those areas where urgent action is needed to:

- directly improve the condition of marine values,
- address key threats, and/or
- enable these activities (e.g. through collaboration or research).

We identified 11 priority management objectives for the southern atoll.

We next identified strategies and actions – that is, the pathways and steps needed to achieve management objectives. As part of this process, we considered the causal factors underlying key threats, as well as potential hurdles and opportunities for advancing objectives.

Potential strategies were evaluated and further developed using program logic, which use a stepwise approach to test and document the logic of a strategy. These visual diagrams help show the relationship between the strategy, associated threats and the expected results of specific actions, as well as how these come together to produce the desired outcomes. Program logic can also be used to identify initial monitoring indicators or project milestones. A copy of the program logic for each strategy is provided below.

We considered a broad range of actions, including those identified by scientific experts, local community members and other stakeholders. Strategies were also evaluated in terms of their impact, feasibility and cost.

We recommend six strategies and related actions to achieve the 11 identified management objectives:

Lagoon restoration

Marine debris and plastic reduction

Shark conflict resolution

Sustainable tourism and recreation

Invasive species management

Collaborative partnerships

Given the interconnected nature of the marine environment and coastal communities, many of the identified strategies will require collaborative partnerships with other stakeholders, including local government, Commonwealth government, NGOs, researchers/academics, and the private sector, to be effective. Strategies and actions will be prioritised for implementation based on urgency, opportunity, and resourcing capacity.

These strategies represent a 'starting point' – we anticipate that, over time, new opportunities may arise, or the most effective course of action may change, as new information becomes available.

This action plan should be revisited on a regular basis (e.g. annually) to review progress and update strategic actions, as required.

Strategy 1: Lagoon restoration

Outcome: Recovery and maintenance of healthy lagoon environment, particularly high-value habitats and related ecosystem services

Objective 1: By 2027, develop an improved understanding of the physical conditions and hydrodynamics within the lagoon and changes over time

Actions[g]:

(a) Assess lagoon bathymetry and hydrodynamics

(b) Measure and model sediment budgets and lagoon infilling

(c) Assess paleo-dynamics of coral communities to establish patterns of past disturbance and recovery dynamics within the lagoon

(d) Establish environmental monitoring program to track key variables (e.g. water temperature, salinity, hydrodynamics, sedimentation)

(e) Develop predictive model to forecast potential stress events (e.g. die off conditions) and guide proactive management responses

Potential indicators[h]:

- Water depth
- Sedimentation and infilling rates
- Water flow rates and circulation
- Wind and current direction and intensity
- Water temperature (surface and at-depth)
- Salinity
- Frequency of 'die off' events over time

Objective 2: By 2027, measures to improve water quality in the lagoon are identified and in place

Actions:

(a) Establish lagoon water quality targets and monitoring program

(b) With partners, develop practical guidelines to reduce physical impacts from development projects, coastal facilities and services

Potential indicators:

- Turbidity
- Dissolved oxygen
- Nutrient levels (e.g. nitrogen and phosphorus)
- Number of operators who have adopted guidelines
- Types of measures implemented

Objective 3: By 2032, increase the extent and ecological condition of seagrass habitats within the lagoon

Actions:

(a) Document and assess current seagrass distribution and condition

(b) Assess and monitor turtle populations and their relationship to seagrass (e.g. effects of seagrass loss on

Potential indicators:

- Seagrass distribution and area (km^2) of seagrass habitat
- Seagrass shoot density and canopy height
- Type and extent of restoration activities

[g] The included actions are not exhaustive, and it is possible that some actions have been overlooked or that alternative pathways exist.

[h] Indicators are provided as an example of the types of management activities, impacts of actions on threats, and/or conservation outcomes that may be measured for each strategy. Actual indicators used will depend on management actions and resourcing.

turtles, seagrass consumption levels by turtles)

(c) Develop seagrass restoration plan and implement recovery actions

(d) Develop long-term seagrass monitoring program to guide restoration and management

- Evidence of seagrass reproduction
- Green and hawksbill turtle abundance
- Turtle growth and maturation rates
- Juvenile fish abundance in seagrass area

Objective 4: By 2032, improve extent, diversity and ecological condition of coral reefs in the southern blue holes

Actions:

(a) Document and assess the state of coral reefs in the southern blue holes

(b) Develop Blue Holes coral recovery plan and implement actions

(c) Develop long-term blue holes monitoring program to guide management

Potential indicators:

- Extent of live coral cover
- Coral species diversity
- 3D structure
- Extent of potentially detrimental macroalgae (e.g. *Lobophora variegata)*
- Associated fish diversity
- Associated juvenile fish abundance
- Type and extent of restoration activities undertaken, as outlined in plan

Threats addressed:

- Climate change
- Overgrazing of seagrass
- Coastal infrastructure and development

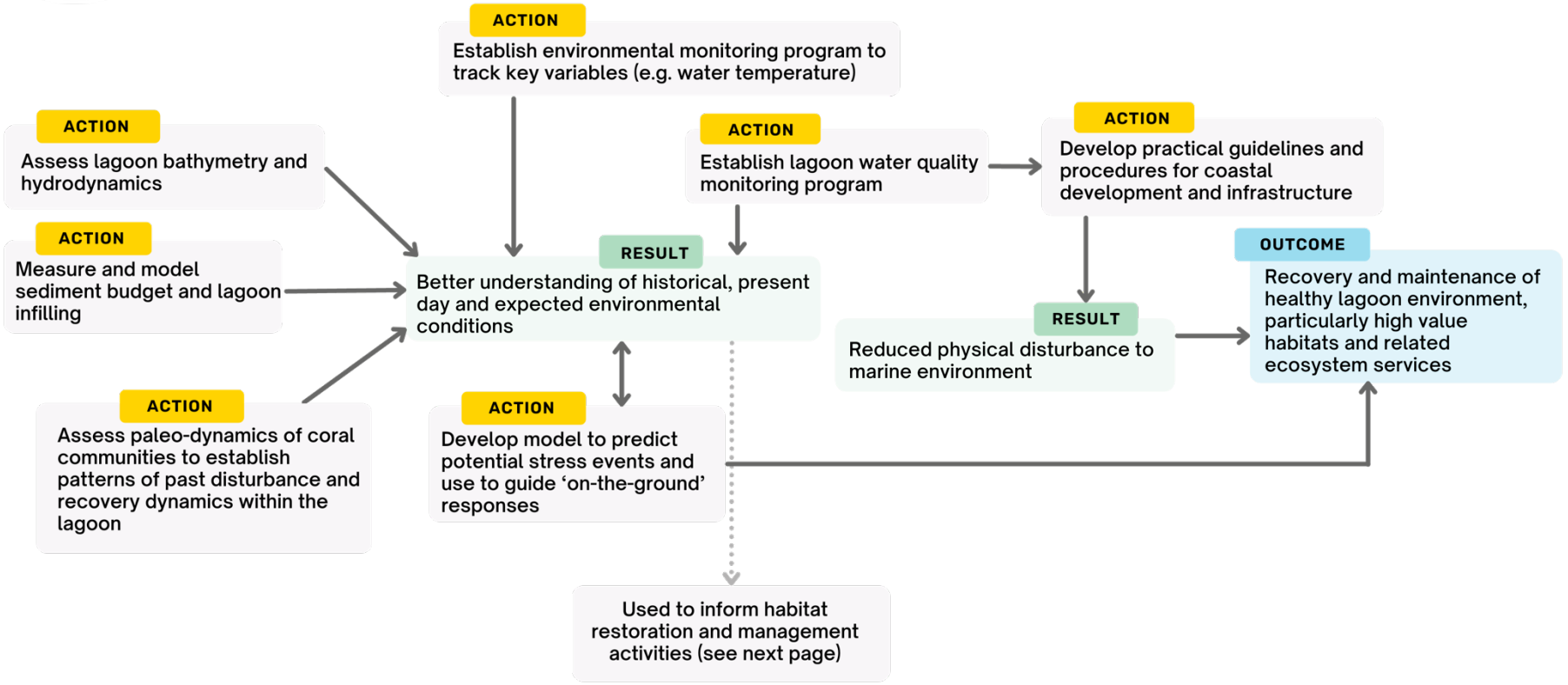
Associated focal values:

- Lagoon ecosystem
- Southern blue holes
- *Lumut* (Seagrass) habitats
- *Penyu* (marine turtles)

Lagoon restoration (continued on next page)

OBJECTIVE 1 **By 2027, develop an improved understanding of the physical conditions and hydrodynamics within the lagoon and changes over time**

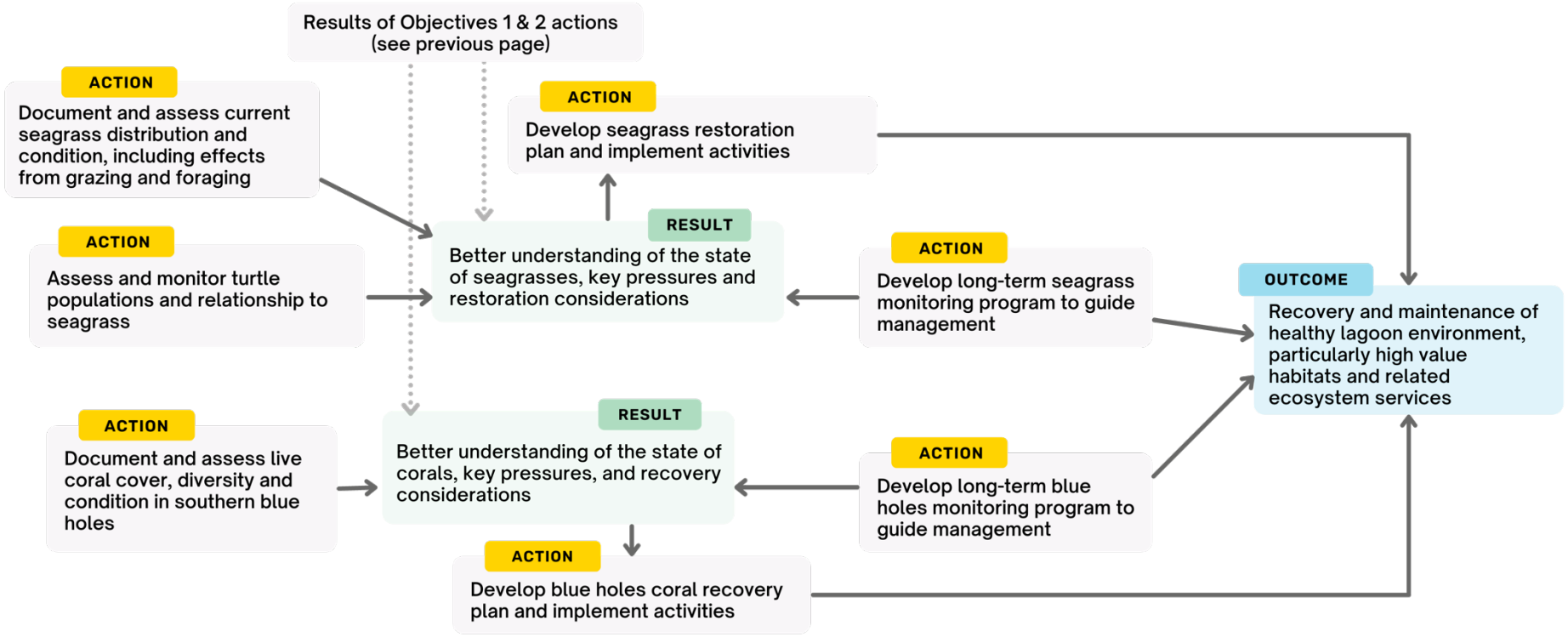
OBJECTIVE 2 **By 2027, measures to improve water quality in the lagoon are identified and in place**



Lagoon restoration (continued from previous page)

OBJECTIVE 3 **By 2032, increase the extent and ecological condition of seagrass habitats within the lagoon**

OBJECTIVE 4 **By 2032, improve extent, diversity and ecological condition of coral reefs in the southern blue holes**



Strategy 2: Marine debris and plastic reduction

Outcome: Less marine debris and plastic pollution on beaches and in the ocean around the southern atoll

Objective 5: By 2027, reduce the amount of marine debris and plastic pollution in coastal and marine areas and establish a sustainable removal program

Actions:

(a) With local partners, regularly remove marine debris, including micro-debris, from marine and coastal areas

(b) With local partners, develop 'citizen science' program to sort and catalogue recovered debris

(c) Monitor and assess impacts of marine debris on marine biodiversity

(d) Reduce local marine debris by educating tourists and community about impacts of marine debris and plastic pollution and promoting responsible plastic use and disposal

(e) With local partners, develop and support sustainable plastic recovery and recycling program

(f) Where relevant, contribute to supporting broader, including national, efforts to minimise marine debris in source regions (e.g. Indonesia)

Potential indicators:

- Number of 'clean up' events
- Amount of debris removed from coastal and marine areas (weight and/or number of items)
- Number of volunteers at debris sorting and cataloguing events
- Types of debris collected
- Levels of exposure, entanglements, ingestion, accumulation of plastic additives, etc. in marine life
- Resident and visitor awareness, attitudes and behaviour regarding plastic waste
- Number of unique visits to webpages about responsible plastic use at the islands
- Amount of marine plastic recovered and/or recycled on-island
- Evidence of support for broader efforts to reduce marine debris
- Estimated levels of marine debris found in coastal and marine areas (amount and type)

Threats addressed:

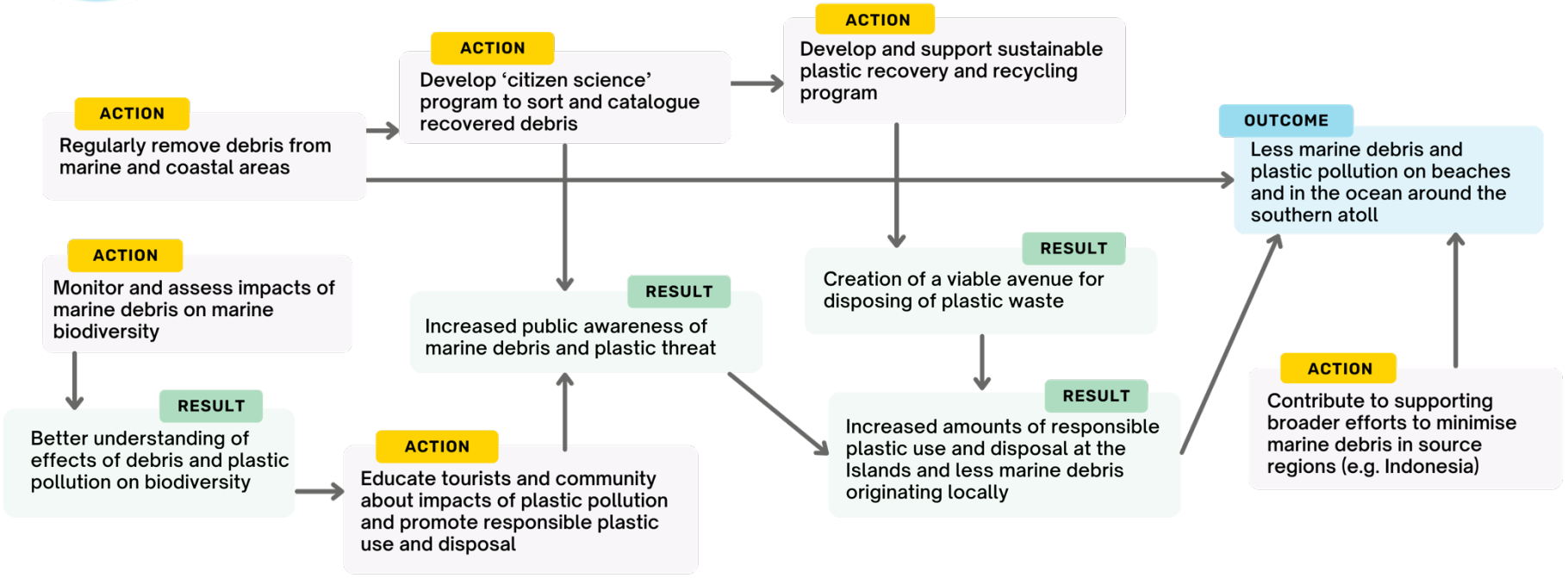
- Marine debris and plastic pollution
- Invasive marine species and pests

Associated focal values:

- Open ocean ecosystem
- Outer reef ecosystem
- Lagoon ecosystem
- Southern blue holes
- *Lumut* (Seagrass) habitats
- *Penyu* (Marine turtles)
- *Cucut* (Sharks)
- Reef fish communities

Marine debris and plastic reduction

OBJECTIVE 5 **By 2027, reduce the amount of marine debris and plastic pollution in coastal and marine areas and establish a sustainable removal program**



Strategy 3: Shark conflict resolution

Outcome: Fewer negative human-shark interactions

Objective 6: By 2032, effectively mitigate human-shark conflict and facilitate a shift toward coexistence

Actions:

(a) Undertake targeted research on the nature and extent of human-shark conflict

(b) With local partners, co-develop and trial interventions to reduce conflict, based on research findings (e.g. use of deterrent devices, appropriate disposal of fish waste)

(c) Support adoption of effective interaction and conflict mitigation techniques

(d) Undertake community and tourist education and awareness campaign regarding value of sharks and 'best practice' for interactions

(e) Monitor changes shark interactions and community perceptions and attitudes toward sharks

Potential indicators:

- Shark depredation and post-release predation rates
- Number of negative shark interactions reported (with adverse impacts to humans or sharks)
- Number of direct complaints to managers about sharks
- Evidence of support for mitigation techniques
- Reach of educational activities and materials (e.g. number of social media impressions, website visits, etc.)
- Community attitudes and perceptions regarding sharks and shark conflict

Threats addressed:

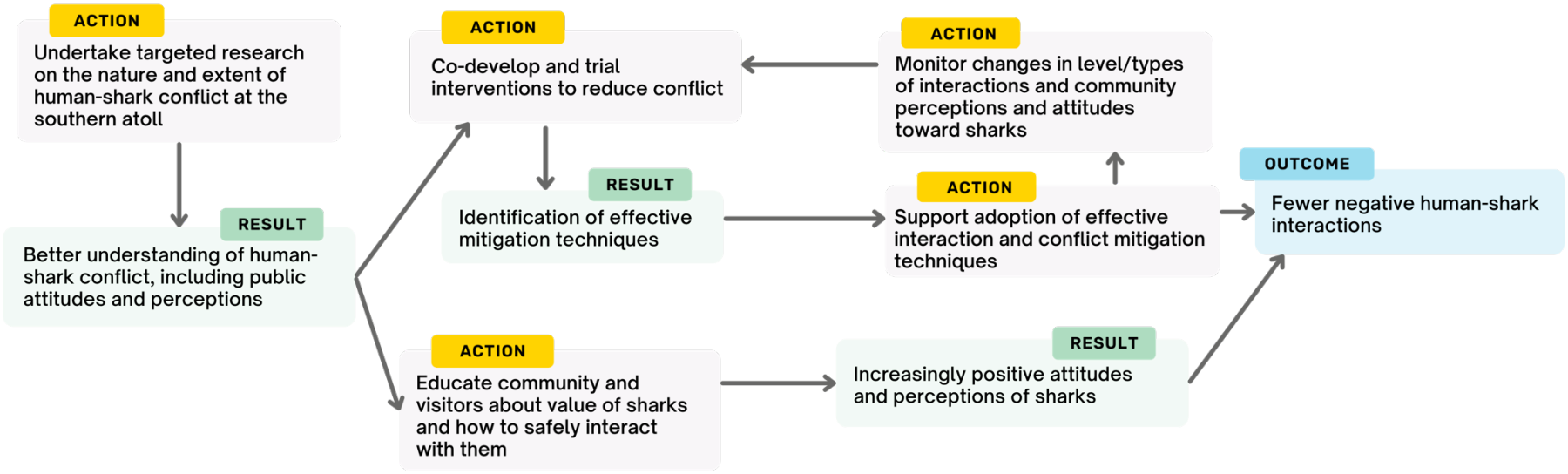
- Human-shark conflict
- Recreational and tourism activities

Associated focal values:

- *Cucut* (Sharks)
- Reef fish communities

Shark conflict resolution

OBJECTIVE 6 **By 2032, effectively mitigate human-shark conflict and facilitate a shift toward coexistence**



Strategy 4: Sustainable tourism and recreation

Outcome: Fewer harmful interactions with marine life

Objective 7: By 2027, marine tourism and recreational activities, including fishing, are conducted in a safe and ecologically-appropriate manner

Actions:

(a) Identify priority sites and species that are negatively impacted by recreational activities and likely causes (to guide and inform other actions)

(b) With local partners, develop minimal impact guidelines for recreational and tourism use to reduce negative impacts

(c) Support safe and responsible tourism and recreational activities, for example, by providing infrastructure and signage, supporting opportunities for eco-tourism accreditation by tour operators

(d) Undertake education and awareness-raising activities targeted at tourism operators, visitors and local community promoting marine values and safe and environmentally responsible behaviour

Potential indicators:

- Extent of damage to marine values from tourism or recreational activities/condition of values[i]
- Number of operators/businesses who have committed to voluntarily adopting the guidelines
- Proportion of tour operators with eco-accreditation
- Engagement with social media posts about safe and appropriate behaviour
- Distribution and engagement of communication materials (e.g. video views, social media engagement, etc.)
- Number of reports to managers about harmful interactions with marine life

Threats addressed:

- Recreational and tourism activities
- Human-shark conflict
- Fishing pressure
- Marine debris and plastic pollution

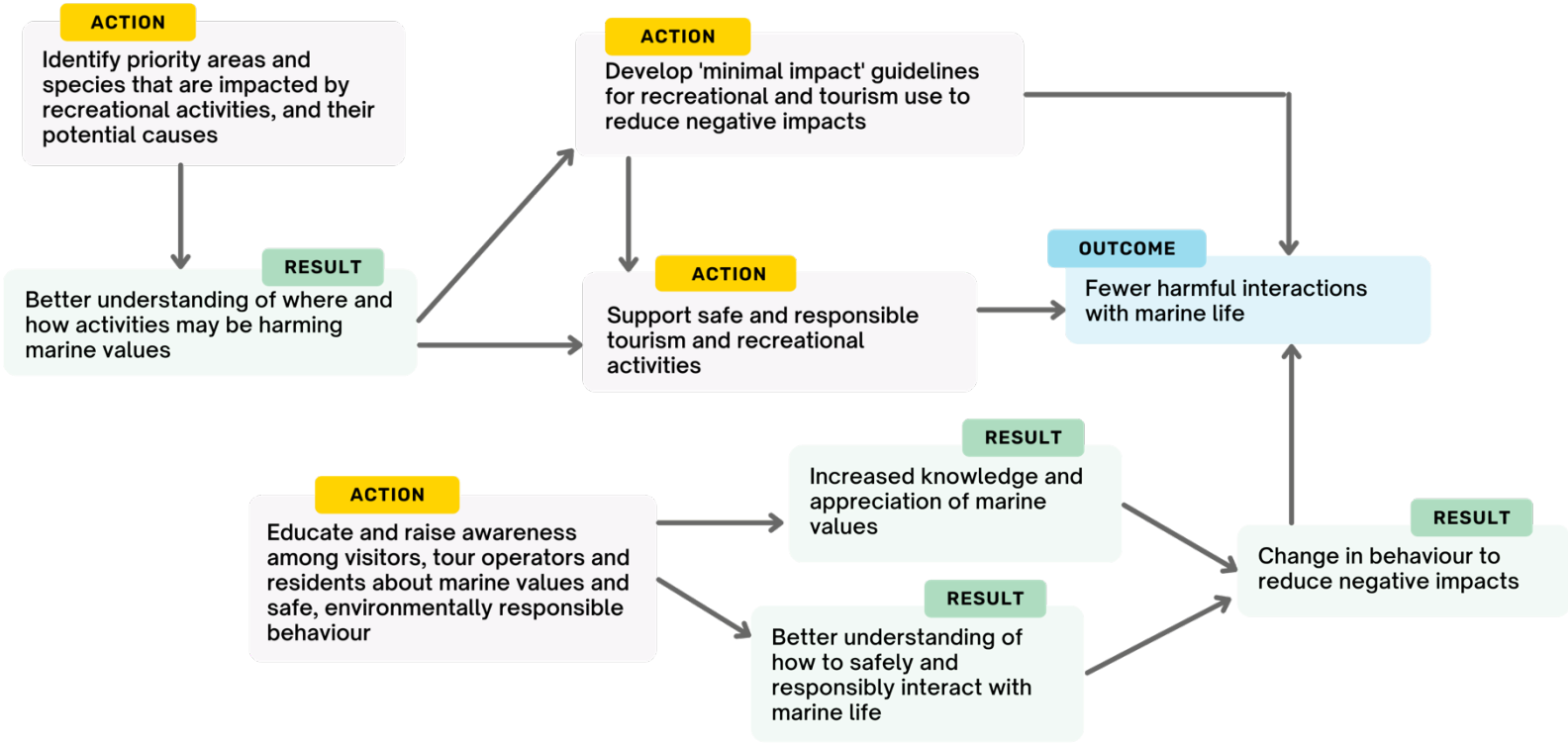
Associated focal values:

- Open ocean ecosystem
- Outer reef ecosystem
- Lagoon ecosystem
- Southern Blue Holes
- *Lumut* (Seagrass) habitats
- *Penyu* (Marine turtles)
- *Cucut* (Sharks)
- Reef fish communities

[i] This may include the use of indicators identified for other Objectives (e.g. seagrass extent and density, turtle health, etc.).

Sustainable tourism and recreation

OBJECTIVE 7 **By 2027, marine tourism and recreational activities, including fishing, are conducted in a safe and ecologically-appropriate manner**



Strategy 5: Invasive species management

Outcome: No marine invasive and pest species introduced or established at the southern atoll

Objective 8: By 2026, ensure the impact of marine invasive and pest species is effectively managed to minimise the risk of incursion and establishment

Actions:

(a) Work with partners to control high risk vectors for introduction (e.g. ballast water, biofouling, marine debris)

(b) Support marine biosecurity compliance and education activities

(c) Undertake regular surveillance of 'high risk' areas

(d) Ensure resources are available to rapidly respond to and control outbreaks

(e) Develop systems to support community members to identify, report and respond to potential invasive species

Potential indicators:

- Number of surveillance surveys undertaken across islands
- Proportion of surveillance checks with instances of non-compliance with local marine biosecurity requirement
- Number of marine invasive and pest species identified / outbreak responses
- Extent of training provided for community members (e.g. skills shared, attendance levels)
- Publication and adoption of response protocols for outbreaks by responsible agencies
- Number of reports of potential invasive species by community members
- Reach of educational materials (e.g. social media impressions, website visits, etc.)

Threats addressed:

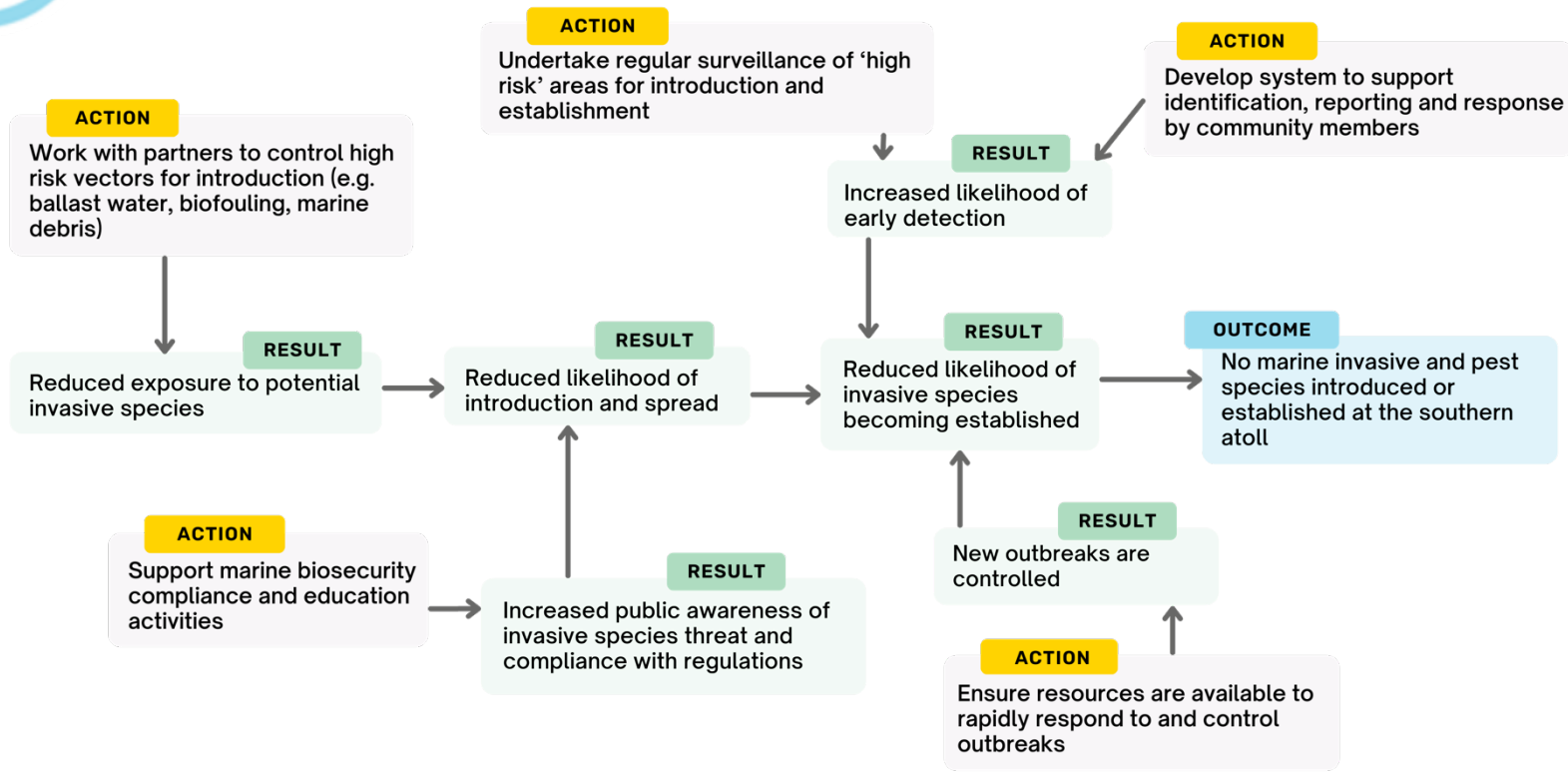
- Marine invasive and pest species

Associated focal values:

- Open ocean ecosystem
- Outer reef ecosystem
- Lagoon ecosystem
- Southern blue holes
- *Lumut* (Seagrass) habitats
- *Penyu* (Marine turtles)
- *Cucut* (Sharks)
- Reef fish communities

Marine invasive species management

OBJECTIVE 8 **By 2026, ensure the impact of marine invasive and pest species is effectively managed to minimise the risk of incursion and establishment**



Strategy 6: Collaborative partnerships

Outcome: Increased engagement, innovation, communication, effectiveness and efficiency in achieving management goals

Objective 9: By 2025, effectively combine local and scientific knowledge streams to guide science and management activities

Actions:

(a) Develop pathway(s) for sharing and incorporating local knowledge into science and management

(b) Support inclusion of local knowledge and practices in science and management projects

Potential indicators:

- Number of meetings between scientists, managers and community members to discuss proposed or upcoming projects
- Evidence of local knowledge use and incorporation (e.g. to inform research questions, methods/approach, or management objectives)
- Proportion of projects that incorporate or utilise local knowledge (where relevant)

Objective 10: By 2032, Cocos (Keeling) Islands residents, groups and organisations are skilled, empowered and engaged to help implement education, research and management activities

Actions:

(a) Develop and deliver on-going training programs for residents to build capacity to participate in management, research and monitoring activities

(b) Establish 'day payment' protocols or casual positions for residents engaged in science and management activities

(c) Engage residents and local groups to undertake research and monitoring, in partnership with scientists and managers

Potential indicators:

- Number projects in which community members were engaged for monitoring and research activities and participation levels
- Number of residents employed to help with management and science activities
- Annual expenditure towards local employment

Objective 11: By 2027, establish and maintain collaborative partnerships with key stakeholders and research institutions to progress management goals

Actions:

(a) Seek input and advice from relevant experts to guide specialist activities (e.g. seagrass and coral restoration, shark conflict resolution, community engagement)

(b) Establish regular forums for stakeholders to exchange information and share concerns and

Potential indicators:

- Number and diversity of people consulted or participating in projects
- Evidence of regular meetings and participation levels (e.g. meeting minutes, attendee types/ representation)
- Number of collaborative projects

ideas (e.g. marine park advisory committee)

(c) Continue to build positive working relationships between relevant bodies responsible for marine park and fisheries management (e.g. Parks Australia, DITRDCA, Cocos Marine Care)

(d) Establish partnerships with relevant stakeholders and research institutions

underway or completed

- Number of partnership agreements established
- Publication of joint reports, etc.

Threats addressed:

- Climate change
- Marine debris and plastic pollution
- Human-shark conflict
- Fishing pressure
- Coastal infrastructure and development
- Overgrazing of seagrass
- Recreational and tourism activities
- Marine invasive and pest species

Associated focal values:

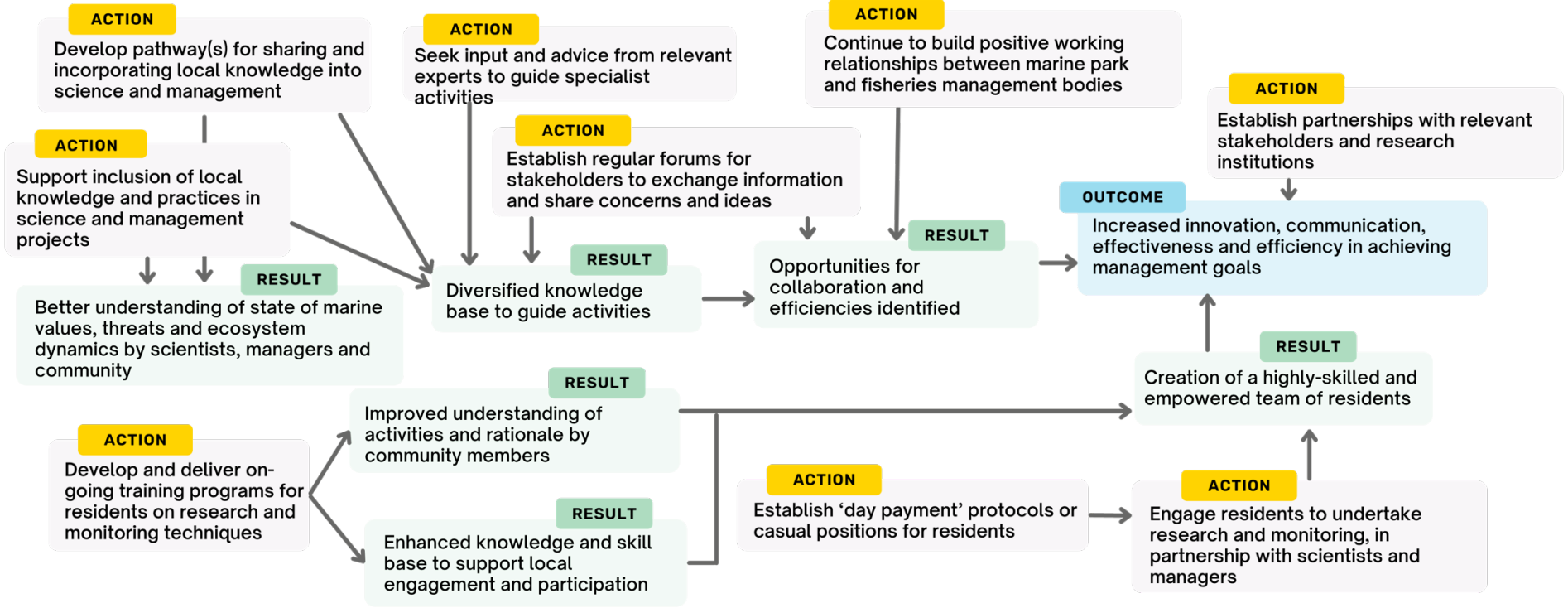
- Open ocean ecosystem
- Outer reef ecosystem
- Lagoon ecosystem
- Southern blue holes
- *Lumut* (Seagrass) habitats
- *Penyu* (Marine turtles)
- *Cucut* (Sharks)
- Reef fish communities

Collaborative partnerships

OBJECTIVE 9 **By 2025, effectively combine local and scientific knowledge streams to guide science and management activities**

OBJECTIVE 10 **By 2032, Cocos (Keeling) Islands residents, groups and organisations are skilled, empowered and engaged to help implement education, research and management activities**

OBJECTIVE 11 **By 2027, establish and maintain collaborative partnerships with key stakeholders and research institutions to progress management goals**



Monitoring and evaluation guide

Monitoring, evaluation and reporting allows Parks Australia to quantify the effectiveness of implementing the prioritised management strategies and supports continuous improvement through an adaptive, evidence-based approach.

This guide will be used to help support the preparation of a science plan and comprehensive Monitoring, Evaluation and Reporting plan for the Cocos (Keeling) Islands Marine Park, particularly activities at the southern atoll.

The following indicators and measurement approaches were developed in collaboration with relevant experts; however, a detailed scoping and planning process should be completed prior to undertaking each activity to ensure any new information or techniques are considered and utilised, where appropriate.

Table 1 High level monitoring guide for the Conservation Action Plan for the Cocos (Keeling) Islands southern atoll Identified potential indicators and measurement methods are provided as a starting point and should be further explored and developed prior to implementing management strategies. Indicators may measure the quantity or quality of management activities (activity indicators), the impacts of actions on key threats (threat indicators), and/or conservation outcomes (outcome indicators). * indicates an opportunity for community participation, engagement or leadership.

Objective	Action	Potential indicator(s)	Measurement method(s)
Objective 1: By 2027, develop an improved understanding of the physical conditions and hydrodynamics within the lagoon and changes over time	(a) Assess lagoon bathymetry and hydrodynamics	• Lagoon depth • Water flow rates and circulation • Wind and current direction and intensity	• Once-off bathymetry assessment, using satellite imagery and ground-truthing • Seasonal collection of current, wind and lagoon circulation data • Hydrodynamic modelling
	(b) Measure and model sediment budgets and lagoon infilling	• Sediment characteristics and volume • Sediment production and transport • Infilling rates	• Field study to characterise sediment types and distribution • Sediment budget analysis and modelling
	(c) Assess paleo-dynamics of coral communities to establish patterns of past disturbance and recovery dynamics within the lagoon	• Coral growth rates • Historical frequency of 'die-off' events	• Coral core analysis (e.g. using x-rays, stabile isotopes) and reconstruction of environmental conditions
	(d) Establish environmental monitoring program to track key variables	• Water temperature (surface and at-depth) • Salinity	• Seasonal collection of environmental indicators (e.g. using temperature loggers, multiparameter water meter, current meter)

Objective	Action	Potential indicator(s)	Measurement method(s)
		• Dissolved oxygen • Water flow rates and circulation • Wind direction and intensity • Sedimentation and infilling • Frequency of 'die off' events • Types and extent of monitoring activities undertaken	• Hydrodynamic modelling • Once-off assessment of historical accretion using satellite imagery and sediment cores • Quantify annual activities
	(e) Develop predictive model to forecast potential stress events (e.g. die off conditions) and guide proactive management responses	• Model production and use	• Evidence of model use and resulting management action (if any)
Objective 2: By 2027, measures to improve water quality within the lagoon are identified and in place	(a) Establish lagoon water quality targets and monitoring program	• Turbidity • Dissolved oxygen • Nutrient (e.g. nitrogen, phosphorus) levels • Types and extent of monitoring activities undertaken	• Seasonal collection of water quality indicator data, e.g. using multiparameter water meter • Quantify annual activities
	(b) With partners, develop practical guidelines to reduce physical impacts from development projects, coastal facilities and services	• Number of operators who have adopted guidelines • Types of measures implemented	• Once-off survey of operators about practices • *Direct observation of practices
Objective 3: By 2032, increase the extent and ecological condition of seagrass habitats within the lagoon	(a) Document and assess current seagrass distribution, condition and grazing impacts	• Seagrass distribution • Area (km^2) of seagrass habitat • Seagrass shoot density and canopy height • Evidence of reproductive capacity (e.g. seeding) • Level of grazing pressure (e.g. seagrass density and condition	• *Once-off field survey of seagrass habitats • *Monitoring of seagrass inside/outside turtle exclusion areas (where implemented)

Objective	Action	Potential indicator(s)	Measurement method(s)
		inside/outside exclusion devices)	
	(b) Assess and monitor turtle populations and their relationship to seagrass (e.g. effects of seagrass loss on turtles, seagrass consumption levels by turtles)	• Green and hawksbill turtle abundance • Turtle growth and maturation rates • Individual turtle health	• *Regular (2-3 yearly) surveys to estimate size of foraging turtle populations • *Annual survey to assess turtle population and individual health (e.g. using mark-recapture)
	(c) Develop seagrass restoration plan and implement recovery actions	• Publication of Seagrass Restoration Plan and annual updates • Type and extent of restoration activities undertaken, as outlined in plan	• Quantify annual activities and outcomes
	(d) Establish long-term seagrass annual monitoring program, to guide restoration and management	• Seagrass distribution • Area (km^2) of seagrass habitat • Seagrass shoot density and canopy height • Fish abundance in seagrass areas • Changes in environmental variables • Magnitude of grazing pressure	• Annual field survey of seagrass habitats and associated biodiversity • Environmental monitoring and modelling (as above)
Objective 4: By 2032, improve extent, diversity and ecological condition of coral reefs in the southern blue holes	(a) Document and assess the state of coral reefs in the southern blue holes	• Extent of live coral cover • Coral species diversity • 3D structure • Historical growth rate and recovery patterns • Extent of potentially detrimental macroalgae (e.g. *L. variegata*) • Associated fish diversity and abundance	• Once-off survey using underwater visual census • Coral core analysis (e.g. x-ray, luminescence)
	(b) Develop Blue Holes coral recovery plan and implement	• Publication of Coral Recovery Plan and annual updates	• Quantify annual activities and outcomes

Objective	Action	Potential indicator(s)	Measurement method(s)
	actions	• Type and extent of recovery activities undertaken, as outlined in plan	
	(c) Establish long-term blue holes annual monitoring program to guide management	• Extent of live coral diversity • Coral diversity • 3D structure • Extent of potentially detrimental macroalgae (e.g. *L. variegata*) • Associated fish diversity and abundance	• Annual survey using underwater visual census
Objective 5: By 2027, reduce the amount of marine debris and plastic pollution in coastal and marine areas	(a) *With local partners, regularly remove marine debris, including micro-debris, from marine and coastal areas	• Number of 'clean up' events • Amount of debris removed from coastal and marine areas (weight and/or number of items) • Estimated levels of marine debris found in coastal and marine areas (amount and type)	• *Quantify annual clean-up activities and outcomes
	(b) *With local partners, develop 'citizen science' program to sort and catalogue recovered debris	• Number of volunteers at sorting and cataloguing events • Types of debris collected	• *Quantify annual sorting activities, participation and outcomes
	(c) Monitor and assess impacts of marine debris on marine biodiversity	• Levels of exposure, ingestion, accumulation of plastic additives in marine life • Number of animal entanglements with debris	• Dietary studies (e.g. sea birds) • Biochemical analyses of blood or tissue samples (e.g. turtles, sea birds, fish, invertebrates) • Quantify reports of animal entanglements and their effects
	(d) Reduce local marine debris by educating tourists and community about impacts of marine debris and plastic pollution and promoting	• Resident and visitor awareness, attitudes and behaviour regarding plastic waste • Number of unique visits to	• Annual survey of residents and visitors • Website metrics

Objective	Action	Potential indicator(s)	Measurement method(s)
	responsible plastic use and disposal	webpages about responsible plastic use at the islands	
	(e) *With local partners, develop and support sustainable plastic recovery and recycling program	• Establishment of recycling facilities (e.g. a mobile Shruder recycling station) • Amount of marine plastic recovered and/or recycled on-island	• *Quantify annual amount of products recycled and their end use
	(f) Where relevant, contribute to supporting broader, including national, efforts to minimise marine debris in source regions, such as Indonesia	• Evidence of support for broader efforts to reduce marine debris	• Quantify annual activities
Objective 6: By 2032, effectively mitigate human-shark conflict and facilitate a shift toward coexistence	(a) Undertake targeted research on the nature and extent of human-shark conflict	• Publication of research findings	• Quantify research activities and outputs
	(b) *With local partners, co-develop and trial interventions to reduce conflict, based on research findings (e.g. use of deterrent devices, appropriate disposal of fish waste)	• Shark depredation and post release predation rates • Number of negative shark interactions reported (adverse impacts to humans or sharks) • Number of direct complaints to managers about sharks	• *Recreational fishing surveys[j] • Quantify annual reports to local and national staff
	(c) Support adoption of effective interaction and conflict mitigation techniques	• Evidence of support (e.g. subsidised gear, training activities, signage installation)	• Quantify support activities and outcomes
	(d) Undertake community and tourist education and awareness campaign regarding value of sharks and 'best	• Evidence of production and distribution of education materials (e.g. signs, flyers) • Reach of education activities (e.g.	• Quantify education activities and outcomes • Social media impressions

[j] Recreational fishing data, including levels of shark depredation, are currently being collected by Cocos Marine Care and Sea Country Solutions

Objective	Action	Potential indicator(s)	Measurement method(s)
	practice' for interactions	number of social media impressions, website visits, etc.)	• Website metrics
	(e) Monitor changes shark interactions and community perceptions and attitudes toward sharks	• Number of interactions reported • Shark depredation and post-release predation rates • Community attitudes and perceptions regrading sharks and shark conflict	• *Recreational fishing surveys • Quantify annual reports to local and national staff • Baseline and regular 'pulse' surveys of residents
Objective 7: By 2027, marine tourism and recreational activities are conducted in a safe and ecologically-appropriate manner	(a) Identify priority sites and species that are impacted by recreational activities and likely causes (to guide and inform other actions)	• Extent of damage or harm to marine values • Number of instances of 'unsafe or inappropriate' behaviour observed or reported	• TBC (based on identified impacts) • Quantify annual reports
	(b) With local partners, develop minimal impact guidelines for recreational and tourism use to reduce negative impacts	• Voluntary adoption of guidelines by operators, residents and tourists • Participation in 'best practice' training • Extent of damage or harm to marine values and/or evidence of recovery	• Evidence of adoption (observation, self-reporting by tour operators) • Targeted monitoring of priority sites and/or species
	(c) Support safe and responsible recreational activities, e.g. by providing infrastructure or education materials, supporting opportunities for eco-tourism accreditation	• Type/extent of infrastructure provided • Number and location of signs installed • Reach of signage (e.g. number of people who pass or read sign)	• Quantify annual activities and outcomes • Proportion of tourism operators with eco-accreditation
	(d) Undertake education and awareness-raising activities targeted at tourism operators, visitors and local community promoting marine values and safe and environmentally	• Evidence of production and distribution of education materials (e.g. signs, flyers) • Reach of education activities (e.g. number of social media impressions,	• Quantify annual activities and outcomes • Social media impressions • Website metrics

Objective	Action		Potential indicator(s)	Measurement method(s)
		responsible behaviour	website visits, etc.)	
Objective 8: By 2026, ensure the impact of marine invasive and pest species is managed to minimise the risk of incursion and establishment	(a)	Work with partners to control high risk vectors for introduction (e.g. ballast water, biofouling, marine debris)	• Proportion of surveillance checks with instances of non-compliance with local marine biosecurity requirements • Nature of incidents	• Quantify annual compliance statistics (e.g. compliance checks and incidents)
	(b)	Support marine biosecurity compliance and education activities	• Evidence of production and distribution of education materials (e.g. signs, flyers) • Reach of education activities (e.g. number of social media impressions, website visits, etc.)	• Quantify annual activities and outcomes
	(c)	Undertake regular surveillance of 'high risk' areas, such as Rumah Baru, offloading sites, and exposed outer beaches	• Number of surveillance surveys undertaken across islands • Number of marine invasive and pest species identified or outbreak responses	• Biennial surveillance surveys (e.g. using visual surveys, phytoplankton tows, eDNA and shoreline surveillance; see DPIRD 2021)
	(d)	Ensure resources are available to rapidly respond to and control outbreaks	• Required resources identified • Publication and adoption of response protocols for outbreaks by responsible agencies	• Quantify resources and demonstrate alignment with response protocol
	(e)	* Develop systems to support community members to identify, report and respond to potential invasive species	• Extent of training provided (e.g. skills shared, number of sessions, attendance levels) • Number of reports of potential invasive species by community members	• *Quantify annual activities, reports and outcomes
Objective 9: By 2025, effectively combine local and scientific	(a)	Develop pathway(s) for sharing and incorporating local knowledge into science and management	• Number of meetings with scientists, managers and community members to discuss proposed or upcoming projects	• Quantify annual engagement activities • Self-reporting by research partners

Objective	Action	Potential indicator(s)	Measurement method(s)
knowledge streams to guide science and management activities	(b) Support inclusion of local knowledge and practices in science and management projects	• Evidence of local knowledge use and incorporation (e.g. to inform research questions, methods/approach, or management objectives) • Proportion of projects that incorporate or utilise local knowledge (where relevant)	• Self-reporting by research partners • Community feedback (informal reporting)
Objective 10: By 2032, Cocos (Keeling) Islands residents, groups and organisations are skilled, empowered and engaged to help implement education, research and management activities	(a) * Develop and deliver on-going training programs for residents to build capacity to participate in management, research and monitoring activities	• Number and type of training activities provided and attendance levels	• Quantify annual activities and outcomes, including activities by research partners
	(b) Establish 'day payment' protocols or casual positions for residents engaged for research management activities	• Annual expenditure towards local employment	• Quantify annual activities, including activities by research partners
	(c) * Engage residents and local groups to undertake research and monitoring, in partnership with scientists and managers	• Number projects in which community members were engaged for monitoring and research activities and participation levels • Number of residents employed	• Quantify annual activities, including activities by research partners • Participant testimonials
Objective 11: By 2027, establish and maintain collaborative partnerships with key stakeholders and research institutions to progress management goals	(a) Seek input and advice from relevant experts to guide specialist activities (e.g. seagrass and coral restoration, shark conflict resolution, community engagement)	• Number and diversity of people consulted or participating in projects	• Internal contact management and project reporting
	(b) Establish regular forums for stakeholders to exchange information and share concerns and ideas (e.g. marine park	• Evidence of meetings and participation levels (e.g. meeting minutes, attendee types/representation)	• Quantify annual activities and outcomes

Objective	Action	Potential indicator(s)	Measurement method(s)
	advisory committee)		
	(c) Continue to build positive working relationships between relevant bodies responsible for marine park and fisheries management (e.g. Parks Australia, DITRDCA, Cocos Marine Care)	• Evidence of meetings and engagement (e.g. meeting minutes, correspondence) • Number of collaborative projects underway or completed	• Internal partnership reporting • Quantify annual activities and outcomes
	(d) Establish partnerships with relevant stakeholders and research institutions	• Number of partnership agreements established • Publication of joint reports, etc.	• Internal partnership reporting • Quantify annual activities and outcomes

Appendix A – List of participants

Name	Organisation
Matthew Anderson	Parks Australia
Dr Sahira Bell	WA Dept of Biodiversity, Conservation and Attractions
Dr Tom Bridge	Queensland Museum
Joanna Buckee	TLA Environmental
Liza Dicks	Sea Shepherd, Marine Debris program
Mike Dicks	Sea Shepherd
Badlu Feyrel	Cocos Marine Care
Trish Flores	Parks Australia, Pulu Keeling National Park
Dr Euan Harvey	Curtin University
Matthew Hewitt	WA Dept. of Primary Industries and Regional Development (Aquatic Biosecurity)
Dr JP Hobbs	University of Queensland
Dr Steffan Howe	Parks Australia, Science and Management Effectiveness
Jamil Ibram	Cocos Marine Care
Kylie James	Cocos Island Adventure Tours
Shakirin Keegan	Cocos Marine Care
Hisham Macrea	Cocos Marine Care
Dr Jessica Meeuwig	University of Western Australia
Aindil Minkom	Cocos Marine Care
Isa Minkom	Cocos Marine Care
Michael Misso	Parks Australia
Dr Jeremy Prince	Biospherics Pty Ltd
Dr Zoe Richards	Western Australian Museum / Curtin University
Dr Scott Smithers	James Cook University
Dr Claire Wellington	WA Dept. of Primary Industries and Regional Development (Aquatic Biosecurity)
Allyn White	Parks Australia
Dr Scott Whiting	WA Dept of Biodiversity, Conservation and Attractions

Appendix B – Focal and nested values

The marine natural values of the Cocos (Keeling) Islands southern atoll were nested within the eight focal values, based on their location, threats and ecological processes. Examples of the marine natural values encompassed within each focal value are provided below.

Natural values are based on those identified and recommended for formal recognition as Key Ecological Features (KEFs) and Biologically-Important Areas (BIAs) in *Natural Values of the Inshore Waters of Australia's Indian Ocean Territories - Christmas & the Cocos (Keeling) Islands*)[1].

* Indicates that a value is also considered a separate focal value for this report

Open ocean ecosystem[k]

Key species: dolphins, sharks*, turtles*, seabirds, cetaceans, manta rays

Area of biological importance for sharks, pelagic fishes, seabirds, cetaceans, manta rays; enables larval dispersal of reef associated species

Outer reef ecosystem

Key species: pipefishes, sharks*, manta rays, turtles*, crayfish and slipper lobsters, emperors and snappers*, humphead Māori wrasse*, deepwater fishes, including endemic and hybrid fishes*

Habitats include reef pavement, rubble patches, and seagrass beds* (on West Is.), with reef crest dominated by turfing and coralline algae, with soft and hard corals in deeper areas. Reef slope habitats include scleractinian corals, soft corals and fan corals.

Area of biological importance for dolphins, pipefish, sharks, manta rays, turtles, coral trout, bumphead parrotfish, humphead Māori wrasse, crayfish/slipper lobster, snappers and emperors, deepwater fishes (e.g. cods, jobfishes, sepat) and resident pelagic species (e.g. dogtooth tuna)

Lagoon ecosystem

Key species: sharks*, turtles*, manta rays, dugong, gong gong, pipefish, dolphins, other fishes including coral trout* and significant reef species*

Habitats include beaches, sand flats, rubble beds, seagrasses*, and muddy-silty areas, dense macroalgae, rubble banks, sand banks, small isolated coral bommies, dead coral patches, and the southern blue holes*. Also includes deeper 'blue holes' in the central lagoon.

Area of biological importance for reef sharks, turtles, reef- and seagrass-associated pipefish, gong gong, coral trout, bumphead parrotfish, humphead Māori wrasse, snappers and emperors

Southern blue holes

Key species: pipefishes, gong gong, humphead Māori wrasse*, coral trout*

Blues holes are interspersed with shallow lagoon **habitats including** sand flats, algae patches, coral rubble beds and live coral bommies. Blue holes have corals around the margins, with coral rubble and silt in centre of blue holes.

Area of biological importance for grey reef sharks*, gong gong, coral trout*, bumphead parrotfish*, and humphead Māori wrasse*

Seagrass habitats

Key species: pipefishes, turtles*, sharks*, invertebrates, and juveniles of some fishes*

Important areas: found on outer reef (off West Is.) and inside lagoon

Area of biological importance for turtles, pipefish, juvenile blacktip reef sharks, ecologically important species such as mud crabs and night octopus, important fisheries species, e.g.

[k] Note, open ocean ecosystem was not included in *Natural Values of the Inshore Waters of Australia's Indian Ocean Territories - Christmas & the Cocos (Keeling) Islands*). Details of key species and biological importance are inferred based on expert knowledge.

pufferfish, grassy emperor

Marine turtles

Key species: Green and hawksbill turtles

Important areas: lagoon ecosystem, outer reef ecosystem, seagrass habitats, open ocean ecosystem

Sharks

Key species: Blacktip, whitetip and grey reef sharks; silky sharks, tiger sharks, hammerheads

Important areas: outer reef ecosystem, seagrass habitats, lagoon ecosystem, southern blue holes, open ocean ecosystem

Reef fish communities

Key species: Emperors and snappers, coral trout, humphead Māori wrasse, bumphead parrotfish, endemic and hybrid species

Important areas: outer reef ecosystem, lagoon ecosystem, seagrass habitats, southern blue holes

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