Chapter 1- Overview:-background and implementation of the WAMSI Kimberley Node Turtle Project

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1. Introduction

Marine turtles are of significant value to a wide cross section of stakeholders throughout the community, with these values extending to those with no indirect contact, or irregular interactions with turtles (Campbell 2002). Turtles have high intrinsic values similar to those bestowed on other wildlife and megafauna (Catlin et al 2013) and this iconic status is the reason they are often used as flagships for marine conservation and management. Coastal Aboriginal people in northern Australia have a deep, complex and significant connection with marine turtles which makes them highly valued for cultural, spiritual, and subsistence reasons (O'Conner 1999). They are used for food, represented in rock art and stories and are part of the natural world to which traditional owners are custodians. These high values are represented in saltwater country plans by Indigenous groups across the Kimberley (Kimberley Land Council 2010, Wunambal Gaambera Aboriginal Corporation 2010, Balanggarra Aboriginal Corporation 2011, Dambimangari Aboriginal Corporation 2012, Bardi Jawi Niimidiman Aboriginal Corporation 2013, KaraJarri Traditional Lands Association 2014). For other stakeholders, turtles hold other values. For some, turtles hold economic values by attracting tourists and visitors to an area, e.g. rookeries at Mon Repos in Queensland (Tidsell and Wilson 2001) and Exmouth in Western Australia (Ningaloo Turtle Program). All turtles have high conservation values and are all listed on the IUCN Red List as Vulnerable, Endangered or Critically Endangered, except the flatback which is listed as Data Deficient. They are also protected under the Convention on the Conservation of Migratory Species of Wild Animals (CMS) and the Convention of International Trade in Endangered Species of Wild Fauna and Flora (CITES). All species that inhabit Australian waters are listed as threatened under the Commonwealth's Environment and Biodiversity Conservation Act 1999 and under Western Australia's Biodiversity Conservation Act 2016. This high conservation value often relates to high political value which often makes them a priority for management actions. Turtles rank highly under the Ecosystem Service concept defined in the Millennium Ecosystem Assessment (2005) with turtles providing three of the four services: Supporting services (nutrient recycling), Provisioning (food) and Cultural Services including culture (stories, art), spiritual (religion, natural value), recreational (tourism) (Troëng and Drews, 2004) and science and education.

All in all, these highly diverse values mean that marine turtles are prioritised for management and conservation actions.

1.1 Kimberley Marine Turtle Project Development

The Kimberley Marine Turtle Project was developed and shaped by the existing knowledge and knowledge gaps described in the following chapters.

Scattered information on the distribution and relative abundance of nesting from various sources meant that a regional approach of systematically surveying all sandy beaches for nesting turtles would provide a regional scale understanding of nesting for the Kimberley. The location of nesting beaches and the relative abundance of nesting turtles is the basic level of information required to assess the potential impact of pressures and highlight key locations for management. Sampling at multiple rookeries allows connectivity to be explored through genetic analyses and ultimately define the genetic stocks or management units. Previous genetic studies confirm that multiple genetic management units of marine turtles occur throughout Australian and south-east Asia with major sampling gaps in the Kimberley region resulting in unknown boundaries. It is recognised that within the Kimberley the endemic flatback turtle displays summer nesting in the west and winter nesting in the east, yet it remains unknown if that pattern reflects incubation physiology determined by thermal conditions or different genetic

stocks. The most widespread and influential pressure facing turtles in the Kimberley is climate change. Increased temperatures can skew sex ratios to predominately female, increase embryo mortality and potentially shift the distribution of nesting spatially or seasonally. It is recognised that there is already existing knowledge held by traditional onground managers and custodians in the Kimberley. For this reason, engagement, collaboration, joint planning and employment was an important component of this project.

These major gaps of knowledge frame four primary components of the WAMSI turtle study: 1) to map the distribution of nesting beaches in space and time; 2) define nesting stocks of green and flatback turtles: 3) develop an understanding of their thermal biology and the implications of climate change and 4) ensure Indigenous involvement through engagement, employment, participation, planning and training.

1.2 Aims/Research Questions:

The aims of the project were:

- Determine distribution, abundance, seasonality, and the duration and peak of nesting season for Kimberley marine turtles;
- Collect biological information on key population parameters from key nesting beaches;
- Clarify stock management units and identify connectivity to foraging areas using genetic markers;
- Select beaches and techniques to allow long term monitoring and trend detection;
- Investigate critical physiological thresholds of embryos that can be used to predict the impact of climate change on population viability; and
- Develop systems for cross cultural transfer of knowledge (integration with other themes), participation and training.
- Integrate existing on ground works by community groups

2. Project Implementation

2.1 Partners

The WAMSI partners in this project where Department of Biodiversity, Conservation and Attractions (DBCA), University of Western Australia and CSIRO. Additional partners were sought in areas where additional scientific skills were required and included Griffith University (genetics) and Pendoley Environmental (aerial survey). Collaboration with Indigenous managers and custodians included: Miriuwong Gajerrong, Dambimangarri, Nyangumarta, Ngarla, Nyul Nyul, Bardi Jawi, Wunambal Gaambera, Balanggarra, KaraJarri and Yawuru. A partnership with Conservation Volunteers Australia was formed with DBCA beyond the life of WAMSI to continue monitoring turtles at Eco Beach on Yawuru country.

2.2 Planning and Engagement processes

Collaboration with Indigenous Owners was an important part of this project from the beginning with further details included in Chapter 5. Face to face project planning meetings were initially conducted across the Kimberley and included the district offices of DBCA at Broome and Kununurra and several of the Indigenous groups. We engaged with the Kimberley Land Council through the Research Ethics and Access Committee (REAC) to ensure that all formal engagement processes were in place. Standard Animal Ethics and Wildlife Permits were obtained as standard protocol. Multiple meetings with DBCA planners were also conducted to ensure that information collected for this project was relevant to the Kimberley Marine Park Planning process.

3. Knowledge Uptake and Communication Outputs

3.1 Key methods for uptake of Knowledge

Ensuring knowledge uptake of the project results to management was a key driver for all WAMSI projects and the Turtle Project attempted to achieve through many processes (see Table 1.1). During the term of this project *the Marine Turtle Recovery Plan for Australia* (Department of Environment and Conservation 2011) was being developed by the Commonwealth Department of Environment and Energy using consultation with a group of

experts from across the country. The WAMSI project provided advice into this process through three members who were WAMSI project partners which ensured that current knowledge obtained from the WAMSI project was input into the final recovery plan released in 2017. The Turtle Project also remain in constant contact with the DBCA marine park planning team to ensure up to date knowledge was available for the Kimberley Marine Park planning process (DBCA 2013, DBCA 2014, DBCA 2016a, b,c). Other DBCA turtle projects were kept informed of the WAMSI turtle Project which ensured there was transfer of information between projects such as Cable Beach flatback turtles, Eighty Mile Beach turtle surveys and tracking project, Cape Domett flatback project and the WA Turtle Stranding program. Close links with the Kimberley Conservation Strategy during the project ensured that efficiencies were gained, especially through Indigenous training (DBCA 2011). The Northwest Shelf Flatback Turtle Conservation Program (DBCA) co-funding provided to this project enabled this program to deliver on a turtle information on a Kimberley-wide scale (DBCA 2017). This partnership allowed objectives of both projects to be met but also allowed easy knowledge transfer. Two-way knowledge transfer between this project and Indigenous collaborators provided mutual benefit. For the project it meant broader and deeper knowledge of the Kimberley to plan and interpret survey information and for the Indigenous managers it filled gaps in their existing knowledge and provided a regional context. On-ground training built capacity for current and future projects. Ongoing relationships between the WAMSI Turtle project and KISSP (now ISWAG) means that the turtle project will continue to have a legacy in the Kimberley. During the project information was shared between other WAMSI Kimberley projects to ensure integration and efficiencies were achieved (see Table 1.2). This information exchange led to an agreement that DBCA NWSFTCP could co-fund the WAMSI Benthic Biodiversity Project to deliver additional habitat information for flatback turtles. The WASMI Turtle Project results will also delivery information in a wider context via the Australian Government to the Indian Ocean and South East Asia Sea Turtle MOU and to the IUCN marine turtle specialist group via current individual membership. Knowledge transfer direct to the science community was also achieved through communication outputs including peer reviewed publications and numerous presentations.

Table 1 Knowledge uptake pathways of the WAMSI turtle projects

Commonwealth	• Australian Marine Turtle Recovery Plan
State	• Kimberley Conservation Strategy • North West Shelf Flatback Turtle Conservation Program (NWSFTCP) • DBCA WA Marine Monitoring Program and field manuals • DBCA Marine Fauna Stranding program • DBCA Western Australia Marine Turtle Project • DBCA Marine Park Planning • DBCA Marine Park management • Delivery of information directly to Indigenous managers • Direct Training of Indigenous rangers and DBCA rangers • Continued involvement with KISSP/ISWAG
International	• Indian Ocean South East Asian Memorandum of Understanding (IOSEA-MOU) • IUCN-Marine Turtle Specialist Group

Table 2. Information transfer between WAMSI projects

Other WAMSI Project	How information was shared
1.2.1 Benthic biodiversity –	Led partnership negotiations to provide additional DBCA funds to map benthic turtle habitat in the Kimberley.
1.1.1 Key ecological processes	Provided information for modelling.
1.2.3 Saltwater crocodiles	Provided information and local knowledge regarding surveys and assisted with introductions to Traditional Owners
1.2.4 Dolphins	Arranged for turtle samples to be taken by dolphin project staff during a field camp on Lacrosse Island.
1.2.5 Dugong	Shared field trips and engagement session with dugong project coordinator. Indirect links through Indigenous communities which hold dugongs and turtles as high value assets.
1.3.1 Geomorphology	Turtle projects provided coastal aerial photos.
1.5 Indigenous Knowledge	Assisted with workshops, input into protocols and provided funds for the continuation of Kimberley Saltwater Science Project. Direct feedback of turtle project to this KISSP
2.1.1 Human use	Collaborated to obtain LiDaR survey data for Eighty Mile Beach and shared a student.
2.1.2 Social values	shared knowledge of contacts and participated in stakeholder surveys
2.2.4 Seagrass	Assisted in transferring marine turtle research techniques such as sampling and satellite tracking.

3.2 Knock-on opportunities created from Turtle Project

There were four main knock-on opportunities developed through this project. The first was the information exchange between WAMSI projects that led to DBCA NWSFTCP co-funding some of the benthic mapping in the Kimberley. The second the ongoing collaborative relationship with Indigenous groups that will lead to future collaborative projects with mutual benefits. The third is the ongoing involvement of Turtle Project members with the KISSP members (now ISWAG) to continue planning for turtle projects in the future, including a regional approach to turtles in the Kimberley. The fourth has been the development of a close working relationship between DBCA science staff and DBCA regional staff to ensure that turtle priorities are included in Marine Park activities.

3.3 Communication Outputs

This project produced numerous communication outputs which included an honours and PhD thesis, popular newsletter articles, media via print and radio and scientific presentations and publications (Table 1.3, detail of outputs in Appendix 1). Scientific communication highlights included: twenty-nine presentations to managers, community groups, traditional owner, WAMSI, and the scientific community; two theses; two peer reviewed publications; one book chapter; and several other draft papers pending submission (see Appendix 1).

Table 3. Summary of Communication Activities

Communication Activity	Total (as of Dec 2017)
Peer reviewed publications	3
Popular publications (i.e. Landscope, newsletter, etc)	2
Conference Presentation	18
Presentations/Meetings with DBCA managers	17
Presentations/Meetings with Traditional Owners or representatives of Aboriginal Corporations	44
Presentations/Meetings with other stakeholders (i.e. industry, tourism)	0
Presentations to general public	2
Media releases	0
Radio interviews	6
Newspaper articles	14
Theses	2
Posters	2
Data sharing	2

3.4 Addressing Original Research Questions

This project directly addressed the following questions outlined in the Kimberley Marine Research Program Science Plan and in the project Agreement.

Table 4. Responses to original questions

Key Questions **Informed Responses**
What is the distribution and relative abundance of turtle nesting across the Kimberley? Flatback turtles nesting is widespread across the islands and mainland beaches east of Dampier Peninsula in winter with Cape Domett supporting the highest densities; summer nesting along Eighty Mile Beach –Wallal Downs and Anna Plains have high-medium density in summer. More than 20+ Kimberley islands have medium-low density. Green turtles: extensive summer nesting across the Kimberley on ocean facing beaches, but extended nesting season with no clear peak. The Lacepede Islands supports very high density, followed by Maret, Cassini, Parry Island. Sir Graham Moore Island has high-medium density. More than 20+ islands have medium-low density. Hawksbill turtles: track counts revealed low density nesting in Vansittart Bay including Eclipse Islands. Further local anecdotal evidence for Sir Graham Moore and Scorpion Island. Historical records of Maccassan traders mention tortoiseshell harvested on Jones Island. WAMSI surveys included Mary Island tracks, Troughton carcass of female on land). Hawksbill nesting requires further investigation to place in context with the Northern Territory and Pilbara nesting aggregations. Olive ridley turtles: sparse nesting by single females, largely April-May. TO knowledge and DBCA records include sparse nesting in Camden Sound at Langii, Darcy Island, Cape Leveque. Olive ridley nesting is sparse in WA at a western distribution margin of a range centred in the Northern Territory at Tiwi Islands or across he Timor Sea in Indonesia. Loggerhead turtles: no nesting in Kimberley. Leatherback turtles: no nesting in Kimberley
Where and when do marine turtles use beaches for nesting? (PRI) Flatback turtles: winter nesting spreads east of Dampier Peninsula; summer nesting spreads west and south of Dampier Peninsula. Cape Domett is high density in winter, Eighty Mile Beach –Wallal and Anna Plains have high-medium density in summer. More than 20+ islands with medium-low density. Green turtles: low density summer nesting occurs across the Kimberley on ocean facing beaches with an extended nesting season. Lacepede Islands is very high density, followed by Maret, Cassini, Parry Island, Sir Graham Moore at high density. More than 20+ islands have medium-low density. Hawksbill turtles: Distribution as above with nesting season likely to occur in Austral spring Olive ridley turtles: sparse nesting by single females, largely April-May. TO knowledge or DBCA records include sparse nesting in Camden Sound at Langii, Darcy Island, Cape Leveque. Loggerhead turtles: no nesting in Kimberley. Leatherback turtles: no nesting in Kimberley.
What are the appropriate spatial management units for marine turtles in the Kimberley? (PRI) Management units are based on genetic stocks which group rookeries that have genetic frequent genetic exchange. Flatback turtles (5 known): Pilbara summer, Eighty Mile summer (newly identified), Eco Beach summer (newly identified), Maret Island winter (newly identified), Cape Domett winter. Samples in King Sound are not yet

analysed. A boundary of summer and winter nesting overlap is on the Dampier Peninsula.

Green turtles: Northwest Shelf, Lacepede Islands (newly identified), Ashmore Reef, Scott-Browse, Cocos

Olive ridley turtles (Western Northern Territory stock)

Hawksbill turtles (East Indian Ocean)

Loggerhead turtles (Southeast Indian Ocean)

Leatherback turtles (unknown, but likely NE Indian Ocean, or W Pacific)

It is important to note that the Kimberley is likely to support foraging turtles of mixed stock and these areas will also include turtles from rookeries outside the Kimberley including international rookeries.

What environmental factors are 'driving' the above distribution patterns and population characteristics of nesting turtles in the Kimberley?

This question was beyond the scope of the study so not addressed fully. However, over evolutionary time scales, turtle nesting distribution aligns with those areas that provide good incubating conditions for eggs. For some beaches, turtle nesting patterns have predictable associations of higher activity during spring tides with dark nights to lower activity during neap tides with bright lunar illumination. This has not been tested during this study. With green turtle nesting, there are alternating peaks of high and low nesting seasons driven by oceanic cycles during El Nino conditions with an 18-month time lag, hypothesized to be driven by more and lesser productive periods of sea grass production.

How will nesting turtles in the Kimberley respond to increasing temperatures caused by global climate change?

Global climate change will raise incubation temperatures to unprecedented levels and these changes will have considerable regional variation. Marine turtles in the Kimberley have the potential to respond through both spatial and temporal shifts in nesting. Current summer nesting flatback and green populations may shift nesting to earlier or later in the season to avoid lethal and sex-ratio skewing temperatures. Winter nesting populations have a limited capacity to shift nesting phenology, and climate predictions suggest highly female-skewed sex-ratios and substantial mortality. Response in these populations may require poleward shifting of nesting location, or molecular evolution to ensure persistence.

How are marine turtles connected within and outside the Kimberley (Genetics only)?

This project was not designed to answer this question entirely, but the genetic stock identification from this project allows for links to be made across regional scales. Turtle foraging grounds comprise turtles from multiple stocks (mixed stock) and further sampling of these areas would be required to make connections using genetics. Previous tracking studies and flipper tags returns of green, hawksbill, loggerhead, flatback and olive ridley turtles show that the Kimberley is highly connected to the Pilbara of WA, the Northern Territory, Queensland and Indonesia.

What pressures and impacts from natural or anthropogenic factors are identified in a risk assessment framework on turtle life history stages?

Risk assessments have been conducted for the Marine Parks and the pressures vary across the Kimberley. Natural factors include predation of nests by crabs, dingoes, foxes, and goannas; juveniles by predatory birds, fish or sharks, adults taken by large crocodiles at a beach. Anthropogenic factors vary along the coast with urban centres such as Broome experiencing local pollution, boat strikes and disturbance. Indigenous take of green turtles occurs in some places along the Kimberley but is localised. Turtle eggs are taken opportunistically at some rookeries but the level of take appears small. Anthropogenic factors would usually include light management

on nesting beaches, but this is an insignificant factor with the undeveloped natural beaches of the Kimberley. Offshore and nearshore developments for oil and gas pose a risk of contamination or seismic exploration. Vessel traffic from existing or proposed ports and marinas and dredging may pose negative effects. Fishing bycatch is currently limited since trawl fleets use the bycatch excluder devices. Anthropogenic driven climate change poses a risk to rookeries and foraging grounds.

What are appropriate technologies to identify the foraging primary areas and diets that sustain marine turtle populations?

Satellite telemetry studies are a primary approach to identify the foraging grounds. Concurrent studies of Kimberley flatbacks include 15 tracked for Cape Domett, 2-5 for North Kimberley, 23 tracked for Eighty Mile Beach. Previous tracking studies included 23 flatbacks at Eco Beach, 11 flatbacks and 11 greens from the Lacepede Islands, and 21 greens and 7 flatbacks for the Maret Islands (Waayers et al. in press). Stable isotope studies in conjunction with CSIRO and US NMFS and necropsies of fresh carcasses by Murdoch Univ. are yielding preliminary results on foods that sustain marine turtles. Related studies are conducted in collaboration with WAMSI Benthic Biodiversity Project to map the benthic communities in known flatback foraging areas. Previous flipper tagging studies have shown links between rookeries and foraging grounds through the recovery of tags, for example the Lacepede Islands nesting green turtles are linked to foraging grounds throughout the Northern Territory.

What cost-effective methods can be developed to enable effective condition monitoring of turtle species at the nesting grounds?

Relative abundance estimates of an index nesting population require nightly or daily track monitoring for a minimum of two weeks at midseason by either on-ground staff, drone surveys, or camera trapping (methods chosen depending upon density and remoteness). Not all beaches need to be monitoring and the selection of beaches will depend on a combination of biological importance and field and operational logistics. Monitoring is already underway for flatbacks on Cape Domett, Eighty Mile Beach and Cable Beach, but needs to be reinstituted for the green turtle nesting on Lacepede Islands.

More in depth demographic information at nesting beaches required marked individuals and monitoring the fate of marked nests. This required considerable effort.

What are the fundamental factors that make a beach attractive/unattractive to nesting turtles? And how do we use this information to be able to take into account beaches yet to be mapped?

This question was beyond the scope of the study and not addressed, or addressed fully. Generally an unobstructed approach from deeper water, and a stable sand substrate above high tides are features of nesting beaches. A broad generality is that green turtles select the seaward sides of islands, and the flatbacks select the mainland beaches or landward sides of offshore islands. Nearly every patch of dry sand might be considered turtle habitat. Adequate beach slope and sand porosity enable good drainage. GIS habitat mapping approaches such as OzCoasts on Geoscience Australia can use onground data, merged with validated data sets make predictive models.

How do we manage traditional harvest/ take (including take from other countries)? What models are used in NT and have these been useful?

This question was beyond the scope of the study and not addressed, or addressed fully. It should be recognised that Indigenous people have been harvesting turtles and managing turtle harvest for tens of thousands of years. Whether further management is required is still debateable, but understand hunting in the context of wider anthropogenic threats is advisable. No useable models are available from the NT. Indigenous groups in the Kimberley currently integrate western science knowledge with traditional knowledge to understand and make

decisions about harvest. Most groups recognise the political issues sometimes associated with hunting and groups in the Kimberley are working towards better two-way knowledge of cultural practices to ensure the wider community has a better understanding. Management is a question of scale. At a population or stock level, management should be at a regional scale, while individual groups may have more local management issues as a priority. It is important that stakeholders recognised different management scales. A local Kimberley turtle-dugong harvest workshop was hosted by Indigenous residents in June 2017 and input was provided by DBCA.

Are there protocols and methodologies to determine real vs false nesting that we should use?

A primary way is by using trained observers on selected beaches. Ground truthing of the aerial surveys with concurrent on-ground surveys is also important. U-turn tracks without any thrown sand are clearly not nests. Characteristics that aid the specific track and, body pit, and fill characteristics. It should be noted that there is always some degree of error and estimating this error is important. Error can be estimated by planning for dedicated surveys at night where researchers watch turtle lay on not lay and compare these with daytime surveys.

Does Sediment deposition from out of the Ord - Cape Dommet – have an impact on nesting beaches

Question was beyond the scope of the study and not addressed. It seems unlikely since finer silts and muds remain suspended by the dramatic Kimberley tidal amplitudes to be eventually deposited offshore, whereas coarser sand grains would be deposited nearshore. Geoscience Australia has defined marine and coastal datasets online for the predicted offshore mud, sand, and gravel content of Australia's Northwest Shelf in an online marine sediment database (MARS). A batch of 51 beach sand samples were collected from turtle beaches across the Kimberley, Pilbara, and Gascoyne for sedimentology analysis and reported in Blair Bentley's UWA PhD and these can form the basis of some benchmarking that could be compared in future years. Currently, the sand at Cape Domett does not seem to impact on nesting success (the likelihood of a turtle laying a clutch of eggs) or hatchling and emergence success.

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Marine Turtles in the Kimberley: key biological indices required to understand and manage nesting turtles along the Kimberley coast

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PENDOLEY ENVIRONMENTAL
MARINE CONSERVATION ENVIRONMENTAL SERVICES

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