

North West Shelf Flatback Turtle Conservation Program Strategic Conservation Plan 2014–21



Department of Biodiversity,
Conservation and Attractions



Marine Turtles
Western Australia
North West Shelf Flatbacks

Department of Biodiversity, Conservation and Attractions (DBCA)
Locked Bag 104, Bentley Delivery Centre, WA, 6983

Phone (08) 9219 9000
Fax (08) 9334 0498
dbca.wa.gov.au

© Department of Biodiversity, Conservation and Attractions on behalf of the State of Western Australia, November 2017

This work is copyright. You may download, display, print and reproduce this material in unaltered form (retaining this notice) for your personal, non-commercial use or use within your organisation. Apart from any use as permitted under the *Copyright Act 1968*, all other rights are reserved.

This plan was developed with critical input from the North West Shelf Flatback Turtle Conservation Program Advisory Committee and associated Expert Panel.

This publication was prepared by Scott Whiting, Holly Raudino, Tony Tucker, Stuart Field, Chris Simpson, Alan Kendrick, Sabrina Fossette, Liz Grant and Hannah Hampson.

The purpose of this document is to outline conservation actions during the first seven years of the North West Shelf Flatback Turtle Conservation Program. These actions were developed using a decision process to objectively identify priorities for conservation. The details of specific management actions will be defined in internal planning documents. This document has been in operation since 2014, in draft format, and was finalised in 2016.

Questions regarding the use of this material should be directed to:
Principal Scientist, Marine Science Program, Science and Conservation Division
Department of Biodiversity, Conservation and Attractions
Locked Bag 104, Bentley Delivery Centre WA 6983
Phone (08) 9219 9752
Email scott.whiting@dbca.wa.gov.au

The recommended reference for this publication is:
Department of Biodiversity, Conservation and Attractions, 2017, *North West Shelf Flatback Turtle Conservation Program Strategic Conservation Plan 2014–21*, Department of Biodiversity, Conservation and Attractions, Perth.

This document is available in alternative formats on request.

North West Shelf Flatback Turtle Conservation Program

Strategic Conservation Plan 2014–21



Department of **Biodiversity,
Conservation and Attractions**



Marine Turtles
Western Australia
North West Shelf Flatbacks

Executive summary

The North West Shelf Flatback Turtle Conservation Program (NWSFTCP) is one of two additional conservation programs delivered from the Gorgon Gas Project via the *Variation Agreement* (2009) of the *Barrow Island Act* (2003). This plan is a road map for flatback conservation over a seven-year period and describes strategic management actions to be delivered under two objectives:

- 1) to increase the conservation and protection of the North West Shelf flatback turtle population; and
- 2) to provide sufficient data to allow the Advisory Committee (AC) to assess whether the Gorgon project is having a “significant” impact on the North West Shelf flatback turtle population. This should include advice to the Director General as to whether the State should make any request to begin the North West Shelf Flatback Turtle Intervention Program.

The plan was developed using a decision support system to prioritise activities in the most relevant and important areas. Management actions were focused around pressures to the North West Shelf flatback turtle management unit (MU) although many overarching actions including systems development, knowledge gaps, baseline information and ongoing monitoring were recognised as fundamental.

The management actions within the plan were developed with five implementation strategies: administrative frameworks, education (including communication and public participation), intervention, research and monitoring.

Overarching actions include: development of data management frameworks, operational systems, knowledge transfer, communication and education, designing comprehensive monitoring programs and filling knowledge gaps. Knowledge gaps include MU definition, identifying and ranking rookeries, identifying foraging habitats and understanding the connectivity between life stages and habitats. A major activity before the next plan will be to undertake a comprehensive vulnerability assessment including risk/exposure mapping to ensure all new knowledge is incorporated into future planning resulting in cost efficient conservation outcomes.

Major pressures to the MU include light impacts on adults and hatchlings at rookeries and predation by introduced animals at rookeries. Moderate pressures include global temperature increases, sea level rise, beach modification and impacts from marine debris. To address these pressures, studies will be conducted to understand and quantify impacts in conjunction with intervention actions to reduce or mitigate these pressures.

This plan has identified assessment criteria at multiple levels to assist in assessing the delivery of the NWSFTCP. At the end of this plan period it is expected that the monitoring program is fully established to help understand both the condition of the flatback turtle MU and the pressures upon it and that mitigation actions are in place to reduce current pressures.

Contents

Executive summary	1
Glossary	6
Acronyms	8
Scope	9
Vision	10
1 Introduction.....	11
1.1 Marine turtles	11
1.2 Flatback turtles.....	11
1.2.1 Conservation status.....	12
1.2.2 Management units.....	12
1.2.3 Nesting distribution.....	12
1.2.4 Foraging range.....	12
1.2.5 Major gaps in understanding	13
1.2.5.1 Identification of management units	13
1.2.5.2 Foraging habitat and diet	14
1.2.5.3 Post hatchling dispersal and habitat	14
1.2.5.4 Mating locations and inter-nesting habitats.....	14
1.2.5.5 Population demographics	14
1.2.5.6 Thermal biology	14
1.2.6 Key indicators.....	15
1.3 North West Shelf Flatback Turtle Conservation Program offset.....	15
1.3.1 Funding	15
WA Environmental Offsets	16
1.3.2 Definition	16
1.3.3 Geographic scope	18
1.3.4 Establishment of the NWSFTCP	18
1.3.5 Oversight and governance	19
1.3.6 Establishment of Advisory Committee and Scientific Panel of Experts	19
19	
1.3.7 Role of the Advisory Committee and Scientific Panel of Experts	19
1.3.8 North West Shelf Flatback Turtle Intervention Program	20
1.3.9 Annual reporting.....	20

1.3.10	Communication of program	20
1.3.11	Budget.....	20
2	NWSFTCP objectives	21
2.1	Objectives	21
3	Planning approach 2014–21	23
3.1	Overview.....	23
3.1.1	Conservation priorities – via prioritisation process	24
3.1.1.1	Decision process	24
3.1.1.2	Scoring the matrix.....	24
4	Results of the prioritisation matrix and decision framework.....	24
4.1	Conservation priorities for North West Shelf flatback turtles	24
4.1.1	Light impact on behaviour of nesting adults and hatchlings – onshore and offshore sources (See Appendix 1 for description of pressure)	25
	Specifically, for this MU, this pressure relates to the potential impacts in relation to industrial light around Barrow Island, Dampier Archipelago and Cape Lambert Port, industrial and urban light around Port Hedland and offshore light from anchored ships in the regions of Onslow/Ashburton River Area and Dampier Archipelago and Port Hedland.....	25
4.1.2	Introduced animals predating on eggs and hatchlings (See Appendix 1 for description of pressure).....	25
4.1.3	Global temperature increase - climate change (See Appendix 1 for description of pressure)	25
4.1.4	Modification of beaches - coastal development (See Appendix 1 for description of pressure)	26
	Specifically, for this MU, this refers to altered beaches through anthropogenic actions such as coastal developments and industrial or urban development. This refers to the loss or alteration of habitat with potential areas including Barrow Island, Dampier Archipelago and Port Hedland.	26
4.1.5	Sea level rise and altered storm frequency and severity - climate change (See Appendix 1 for description of pressure).....	26
4.1.6	Marine debris including entanglement and ingestion (See Appendix 1 for description of pressure).....	26
4.2	Research priorities	26
5	Conservation priorities, management strategies and management actions ..	29
5.1	Conservation priorities	29
5.2	Strategies and management actions.....	29
5.2.1	Management objectives and management targets.....	30

5.2.2	Management actions	31
5.3	Implementation of conservation priorities.....	31
5.3.1	Conservation priority – overarching actions (H)	32
5.3.1.1	Overarching actions– administrative frameworks (OA AF)	32
5.3.1.2	Overarching actions – education, communication and public participation (OA E).....	34
5.3.1.3	Overarching actions - intervention/mitigation (OA I)	36
5.3.1.4	Overarching actions - Research (OA R)	37
5.3.1.5	Overarching actions - monitoring (OA M).....	40
5.3.2	Conservation priority – Pressure 1 - Impacts of onshore and nearshore light (HIGH)	41
5.3.3	Conservation priority – Pressure 2- Introduced animals (HIGH).....	42
5.3.4	Conservation priority – Pressure 3 - Increasing temperatures – climate change (M)	43
5.3.5	Conservation priority – Pressure 4 - Modification to beaches (M)	44
5.3.6	Conservation priority – Pressure 5 - Sea level rise (M)	45
5.3.7	Conservation priority – Pressure 6 - Marine debris	46
6	Reporting and evidence based assessment.....	47
6.1	Reporting	47
6.2	Assessment	47
6.2.1	Efficiency.....	48
6.2.1.1	Administrative processes	48
6.2.1.2	Partnerships and value adding	48
6.2.1.3	Student projects and post-doctoral scholarships	48
6.2.1.4	Third party projects and data	48
7	Plan amendments and review	49
7.1	Plan amendments	49
7.2	Structured reviews of plan	49
7.2.1	2017 Review.....	49
7.2.2	2019 Review.....	49
7.2.3	6.1.3 Timing of reviews	49
8	Conclusion.....	50
9	Acknowledgements	50
	References.....	51

A i. Assets defined.....	57
A ii. Potential pressures listed.....	58
A iii. Asset – Pressure link described.....	58
Direct death or injury – dredging - coastal development.....	59
Disturbance of turtles on beaches - tourism/people.....	59
Global temperature increase - climate change.....	59
Fishing bycatch.....	59
Illegal or unregulated take outside Australia.....	59
Indigenous harvest.....	60
Introduced pests/feral animals.....	60
Light - onshore sources and offshore sources – coastal development.....	60
Marine debris (ghost nets and other debris).....	60
Marine habitat destruction – coastal development.....	60
Modification of beaches – coastal development.....	61
Noise - dredging/piling - port development.....	61
Noise – seismic.....	61
Sea level rise and altered storm frequency - climate change.....	61
Vessel strike and disturbance.....	61
Water pollution (acute).....	61
Water quality (chronic).....	61
Values of the asset (criteria for scoring).....	62
Pressures on the asset (criteria for scoring).....	64
9.1.1 Knowledge gaps (criteria for scoring).....	64

Glossary

Term	Description
General	
Nesting population	The turtles that nest at a rookery (see below). This term is included as it is commonly used to refer to turtles that use rookeries such as Barrow Island or Mundabullangana.
Management unit	Management units are usually defined by genetic stock identity but biological or other factors can also define a management unit. For the purpose of this plan the management unit (MU) is the flatback turtles of the summer breeding North West Shelf Management Unit in Western Australia, as described by the <i>Variation Agreement (2009)</i> until further redefined by genetic studies (see below).
Flatback turtles of the summer breeding North West Shelf management unit	Defined in the <i>Variation Agreement 2009</i> as “the flatback turtles of the summer breeding North West Shelf Management Unit that nest along the Pilbara and south west Kimberley coasts (including Barrow Island and Mundabullangana) which is distinct from the winter nesting rookeries of the Bonaparte Gulf (e.g. Cape Domett). This will remain the description until redefined by genetics.
North West Shelf flatback turtle population	Used in the <i>Variation Agreement (2009)</i> and used interchangeably with management unit in this plan. For the terms of this plan, the “North West Shelf flatback turtle population” or “management unit” will include all summer nesters until redefined by genetics or other evidence (See management unit).
Stock	<p>Stock refers to groups of animals with uniquely different genetic diversity indicating reduced gene flow between groups (<i>Moritz, 1994</i>). These groups have statistically different allele frequencies and if the group was lost it would take centuries to millennia to replace.</p> <p>The <i>Recovery plan for marine turtles in Australia (2003)</i> uses the term “stocks” for flatbacks in Western Australia, these stocks are currently being re-defined with additional genetic analysis, making management unit a more suitable term for this plan (See management unit).</p>
Rookery	A colony of breeding turtles. This is commonly a beach, group of beaches or island.
Plan Categories	
NWSFTCP objectives	The objectives for the NWSFTCP are directly derived from the objectives outlined by the <i>Variation Agreement (2009)</i> .
Conservation priorities	A conservation priority is developed from the prioritisation framework and calculated from the multiplication of Value scores and Pressure scores. High pressures were a primary driver for conservation priorities.
Management objectives	These objectives identify the primary aims of management. Management objectives were developed for each conservation priority obtained from the prioritisation framework and for each management strategy within the overarching actions.
Management actions	The specific actions to be completed during the NWSFTCP Plan period, measured by outputs and milestones
Management strategy	Five categories of actions: Administrative Frameworks, Education (includes communication and public participation) Intervention, Research and Monitoring. Several of these have been used by the department and the five listed are an extension of the categories stated in the <i>Variation Agreement (2009)</i> .

Assessment Terms	
Measure of success	Criteria used to assess the performance of the plan against the objectives.
Management targets	The desired end point of management in terms of this plan.
Outcomes	The short and medium term management result. These can include changes in behaviour, attitudes, major results, additional protection or major gains in understanding.
Outputs	The direct products or deliverables of the management actions. Outputs are tangible products such as data, reports, images, scientific papers, communication products, databases, systems, media, people trained and participants that show progress towards a target. Outputs and milestones will be used to assess if management actions are being achieved.
Milestones	Assessment points along the path to the management target to monitor progress and provide enough time to make corrections to ensure the program is on track. Milestones and outputs will be used to help assess if management actions are being achieved.

Acronyms

Acronym	Meaning
AC	Advisory Committee
AF	Administrative frameworks
C	Compliance
DCLM CEO	Referenced in the <i>Variation Agreement</i> (2009). It refers to the CEO of the former Department of Conservation and Land Management. Currently this refers to the Director General of the Department of Biodiversity, Conservation and Attractions.
DPIRD	Department of Primary Industries and Regional Development
E	Education
I	Intervention/mitigation
M	Monitoring
MU	Management unit
NdS	<i>Natator depressus</i> Summer Management Unit
NWS	North West Shelf
NWSFTCP	North West Shelf Flatback Turtle Conservation Program
OA	Overarching actions
EPA	Environmental Protection Authority, Department of Water and Environmental Regulation
DBCA	Department of Biodiversity, Conservation and Attractions (formerly the Department of Parks and Wildlife)
PP	Public participation
R	Research

Scope

The ***NWSFTCP Strategic Conservation Plan*** is nested within a planning framework that underpins the conservation of marine turtles in Western Australia (Figure 1). A parent plan, the *Western Australian marine turtle strategic conservation plan* (In Prep.), will include other species. The NWSFTCP is one of two additional conservation programs (similar to environmental offsets) delivered from the Gorgon Gas Project via the *Variation Agreement* (2009) to the *Barrow Island Act* (2003). This strategic plan sets out the direction of the NWSFTCP over seven years. Annual reports and annual rolling operational plans will provide further detail of projects and expenditure on an annual basis (Figure 1). Additional detailed documents, including science project plans, are required within the Department of Biodiversity, Conservation and Attractions (DBCA) to assist scientific planning.

This plan is intended to increase the conservation and protection of the North West Shelf flatback turtle population using the actions within the following areas stated in the *Variation Agreement*: a) by surveying, monitoring and research, b) reducing interference to key breeding and feeding locations and c) establishing information and education programs.

In addition, this program will provide sufficient information to allow the NWSFTCP AC to advise the Director General of DBCA whether the Gorgon project is having a “significant impact” on the North West Shelf flatback turtle population. Information presented to the AC should be sufficient to allow them to advise the Director General in relation to significant impact and whether the State should make any request to begin the North West Shelf Flatback Turtle Intervention Program.

The breadth of the NWSFTCP means that all available knowledge will be used to assess the conservation status of the North West Shelf flatback turtles, including seeking access to third-party data from existing programs to help understand key condition and pressure indicators. This includes seeking information and/or data from the Gorgon Gas Project turtle programs. The NWSFTCP Strategic Conservation Plan is approved by DBCA after advice is sought from the NWSFTCP AC and Scientific Panel of Experts.

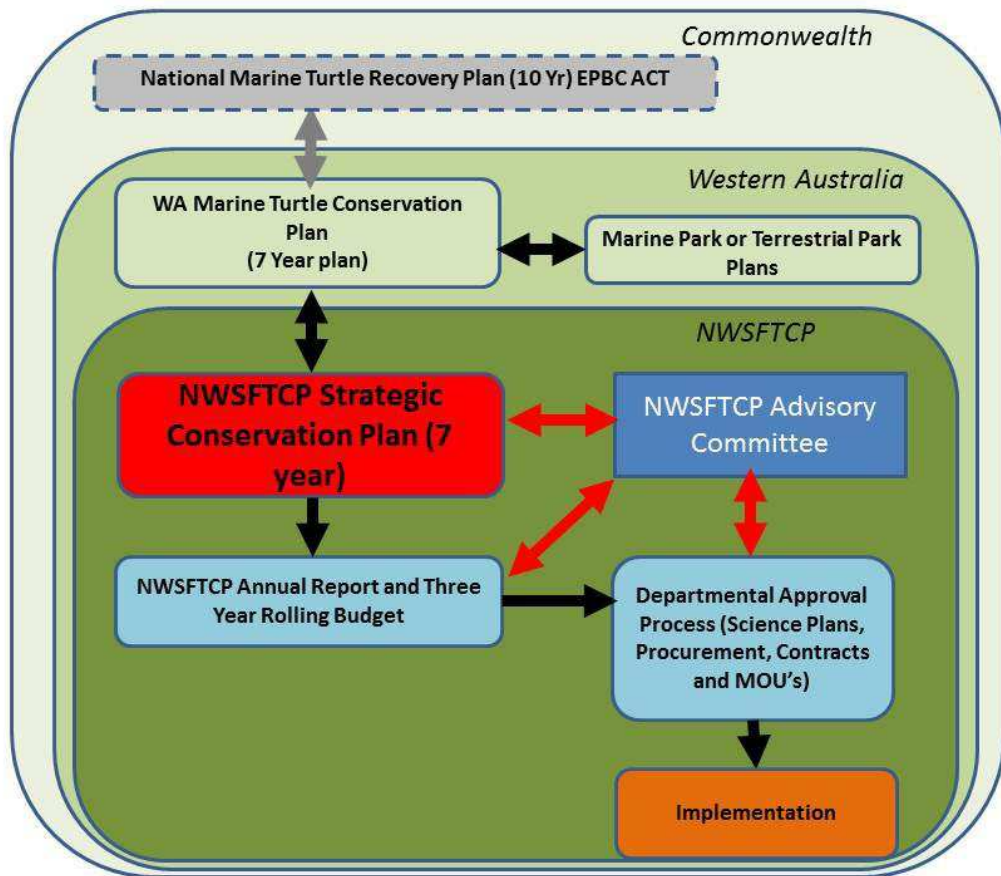


Figure 1. The planning framework for marine turtles in WA. Black arrows represent the process from the NWSFTCP through to implementation with the red arrows representing the steps where the NWSFTCP AC can comment and provide advice. The grey arrow indicates the connection with the Recovery Plan for Marine Turtles in Australia.

Vision

Ensure that the North West Shelf flatback turtle population is resilient, sustainable, no longer vulnerable and maintains its ecological, cultural and social values through the implementation of a world class conservation program.

1 Introduction

1.1 Marine turtles

Six of the world's seven species of sea turtles occur in Western Australian waters and include green (*Chelonia mydas*), flatback (*Natator depressus*), loggerhead (*Caretta caretta*), hawksbill (*Eretmochelys imbricata*), olive ridley (*Lepidochelys olivacea*) and the leatherback (*Dermochelys coriacea*). All species, except the leatherback turtles nest in WA. All nesting species, except olive ridley turtles, nest in nationally and internationally significant numbers in WA. Non-breeding phases of the lifecycle of all species also occur in WA.

1.2 Flatback turtles

Flatback turtles are endemic to Australia. All viable nesting occurs within Australia despite anecdotal infrequent nesting occurring in Papua New Guinea and eastern Indonesia and foraging ranges likely to extend into international waters. The flatback life history is classified as Type 1 by Bolten (2003) (Figure 2) and is characterised by the developmental period being contained within neritic continental shelf waters. This pattern may be split further, with some individuals commonly feeding in shallow waters (< 20m), while others are often found in 50-80 m (Pendoley et al 2014a).

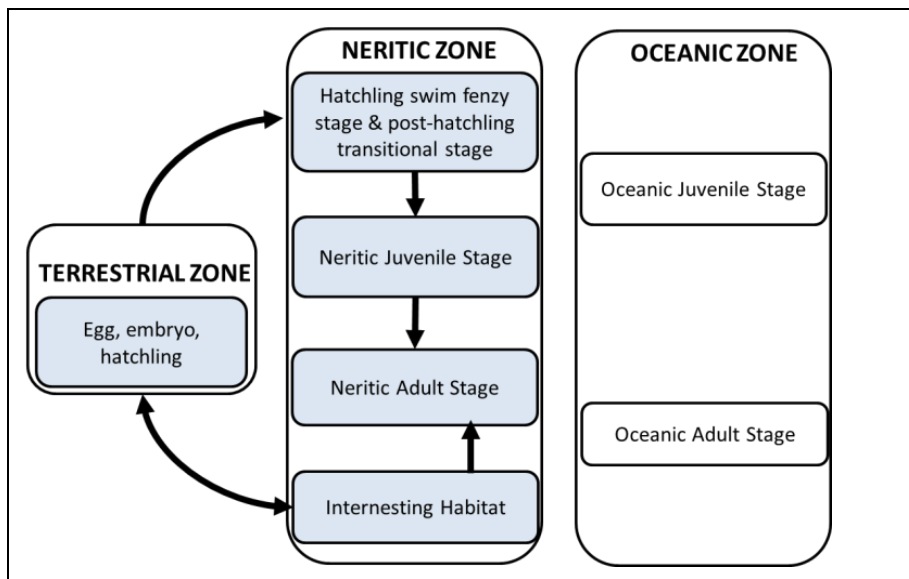


Figure 2. Diagrammatic life history of the flatback turtle life cycle described as Type 1 emphasising no oceanic phase (redrawn from Bolten 2003).

1.2.1 Conservation status

Flatback turtles are listed as Data Deficient under the IUCN Red List, in Appendix 1 under CITES and a Priority for Conservation under the Convention of Migratory Species. Nationally, flatbacks are listed as Vulnerable under the *Environment Protection and Biodiversity Conservation (EPBC) Act* (1999) and under the *Western Australian Wildlife Conservation Act* (1950) (set to change to Biodiversity Conservation Act) they are listed in Schedule 3 (rare or likely to become extinct).

1.2.2 Management units

The flatback turtles of the summer breeding North West Shelf management unit, defined by the *Variation Agreement* (2009), includes all summer flatback rookeries: rookeries south of Onslow through to the central Kimberley and Cape Londonderry at approximately 127 degrees longitude. Genetic analysis has not been completed so biologically relevant units are not defined. Preliminary genetic work from an honours thesis defined seven distinct flatback management units within Australia with up to three management units in Western Australia, noting incomplete sample coverage for WA (Pittard 2010). Flatback turtles nesting from Barrow Island and Mundabullangana Station were within one management unit defined as the Rowley Shelf (Pittard 2010). For the purposes of this plan the NWS flatback turtle population will be interchangeable with the term management unit (MU). Genetically, the northern boundary has not been defined.

1.2.3 Nesting distribution

In WA, flatback nesting ranges between the southern Pilbara to the Northern Territory border (Pendoley et al. 2014b). Flatback rookeries have been identified by DBCA through department records and the literature (Table 1). However, inventory data is sparse and this table will most certainly be expanded in the next plan. Quantitative surveys will further define the density as well as temporal and spatial scale of nesting at each rookery.

1.2.4 Foraging range

Foraging sites have been identified through various post-nesting migration satellite tracking studies over the past 10 years. Post-nesting migrations have shown that foraging areas can be highly dispersed from the nesting beach with 22% within 500 km, 45% between 500-1000 km, 24% between 1000-1500 km and 9% greater than 1500 km (Pendoley et al. 2014a). Foraging habitat includes nearshore areas and offshore areas to depths of 100 m (McFarlane and Mueller 2013; Pendoley et al. 2014a, DBCA unpublished data). The post-hatchlings and neonatal distribution is still largely unknown.

Table 1. Recognised flatback rookeries in WA as of 2015.

Rookery Significance	Region	Site	Source	
Very High > 1000 Nests	Pilbara	Barrow Island	Chevron 2014	
		Mundabullangana mainland coast	Chevron 2014	
		Delambre Island	Rio Tinto unpublished data	
	Kimberley	Cape Domett Lacepede Islands	Whiting et al. 2012.	
High 500-1000	Pilbara			
Medium 100-500	Pilbara	Thevenard Island	DBCA Island Database	
		Cape Lambert	Rowcliffe et al 2015	
		Bells Beach	Rowcliffe et al 2015	
		Varanus Island	DBCA Island Database	
		Cemetery Beach	Robbins 2015; Waayers and Stubbs 2016	
Low 10-100	Pilbara	Onslow mainland	No report available	
	Kimberley	Eco Beach	McFarlane 2015	
		Cable Beach	McFarlane 2013	
Unquantified	Pilbara	South Muiron Island		
		North Muiron Island		
		Airlie Island		
		Bridled Island		
		Angel Island		
		Dixon Island		
		Rosemary Island		
		Many other islands in Dampier Archipelago		
			Serrurier Island	
			Other Islands in Montebello Islands	
			Legendre Islands	DBCA Island Database
			Hauy Island	DBCA Island Database
			Montebello Islands – Hermite and Trimouile	Likely to be high from anecdotal evidence
			Islands between Exmouth Gulf and Cape Preston	Likely to be high from Anecdotal evidence
		Kimberley	Larmarck Island	
			Bigge Island	
			Helpman Island	
			Lacepede Islands	
			Maret Islands	
			Eighty Mile Beach	
	East Montalivet Island			
	Many islands across Kimberley			
		Beaches along the Ballanggara coast (north-east Kimberley)		

1.2.5 Major gaps in understanding

There are several major gaps in knowledge for flatback turtles.

1.2.5.1 Identification of management units

Limited genetic sampling in WA has resulted in ill-defined management unit boundaries. This should be resolved early in the life of the plan but remains a

knowledge gap required to refine the design of any monitoring program. Until these boundaries are re-defined, the MU will be described by the *Variation Agreement* (2009).

1.2.5.2 *Foraging habitat and diet*

Spatial data identifying the location of flatback foraging has been gained through a number of mechanisms including trawling by-catch prior to the introduction of turtle exclusion devices and satellite tracking of post-nesting females. Although many foraging locations are known, little is known about the habitat type and almost nothing is known about diet. Diet is only known through data from stranded animals from Queensland and includes sea pens and soft corals (Limpus 2009). Deep and often turbid water has limited the ability to collect in-water information on flatback turtles.

1.2.5.3 *Post hatchling dispersal and habitat*

Little is known about the dispersal behaviour of flatback hatchlings and their neonate ecology. There is a recognition that neonates and juveniles remain predominantly on the continental shelf but quantitative evidence is limited. Understanding this phase of the life cycle will help to identify key habitats and associated pressures.

1.2.5.4 *Mating locations and inter-nesting habitats*

No mating or courtship areas have been identified in Western Australian waters. Unlike other species where mating is often observed close to the nesting beach, no records of regular flatback mating locations exist. Recent studies on the inter-nesting habitats show displacement distances up to 62 km from the nesting beach (Whitlock et al. 2014).

1.2.5.5 *Population demographics*

Growth rates, age to maturity and survivorship parameters for non-nesting life stages are not available for flatback turtles. A difficulty with sampling flatback turtle's in-water has meant that the non-nesting life-stages have remained unstudied.

1.2.5.6 *Thermal biology*

Thermal biology of flatback turtles is not well known in WA. Previous studies on pivotal temperature in the Pilbara (Box 2010) and just recently through the NWSFTCP (Stubbs *et al.* 2014) has progressed this in WA. Further studies using climate change models (Stubbs *et al.* 2014) and resilience to increasing temperatures (Tedeschi unpublished data; Tedeschi et al 2015) are assisting in understanding the potential impact of climate change.

1.2.6 Key indicators

Key indicators are needed from strategic locations within the MU and at key life stages. At a minimum, the status of some key parameters will be required from Barrow Island and its reference site at Mundabullangana. An additional reference site is likely to be required for the NWSFTCP, in case the first is compromised, but also to add long term stability and representation. A selection process will be conducted to select the most biologically and logistically suitable location. Key demographic parameters will be essential to understand the functioning of the stock/MU (Chaloupka & Limpus 2001; National Research Council 2010; Pfaller et al. 2013). At a minimum, key indicators required at the nesting beaches will be: annual nesting abundance, survivorship, recruitment, nesting success, total annual clutches, hatching and emergence success (this would include measures of total clutch damage). In some cases, (years and locations) surrogates may need to be used. Pressure indicators will include those related to beach pressures and may include indices of: introduced animals, vehicles, light, shipping, sand temperature, sea level rise and habitat modification.

Other key condition and pressure indicators will be required as the program progresses. These may include habitat indices, diet, sex ratios, and pressures on non-breeding life stages.

1.3 North West Shelf Flatback Turtle Conservation Program offset

The NWSFTCP is one of two additional conservation programs delivered from the Gorgon Gas Project at Barrow Island. These are described in the *Variation Agreement* (2009) to the *Barrow Island Act* (2003). A summary of the key components of the NWSFTCP are detailed below.

1.3.1 Funding

The NWSFTCP additional undertaking is funded at \$1.5M pa for five years, \$1M pa for 25 years and \$1M pa for a further 30 years subject to paragraph (C) (*Variation Agreement* 2009) stating that “*The further amounts referred to in paragraph (a)(iv) shall only be payable if at the end of 30 years after the Relevant Date, the CALM Act Minister, after reviewing the objectives of the Northwest Shelf Flatback Turtle Conservation Program, its effectiveness to that date and planned ongoing program of activities, notifies the Joint Venturers that in the CALM Act Minister’s reasonable opinion there is a need for it to continue.*”

All amounts are indexed to 2007 values using the Consumer Price Index All Groups Perth published by the Australian Bureau of Statistics 3 months prior to 1 January each year (formal for index adjustment – *Variation Agreement* 2009).

1.3.2 Definition

The NWSFTCP is defined and described by the *Variation Agreement* (2009);

“means an ongoing program of activities (excluding any activities to be undertaken by the Joint Venturers in compliance with conditions of approval of the Project (including the Domgas Project) under this Agreement or State or Commonwealth legislation including the EP Act or the Environment Protection and Biodiversity Conservation Act 1999 (C’wlth)) to be developed by the DCLM CEO and implemented by the DCLM to increase the conservation and protection of the Northwest Shelf Flatback Turtle Population including:

- (a) surveying, monitoring and research;*
- (b) reducing interference to key breeding and feeding locations; and*
- (c) establishing information and education programs”*

WA Environmental Offsets

The NWSFTCP is technically not an environmental offset but mostly operates in a similar manner. In WA, environmental offsets are outlined in a position statement (Environmental Protection Authority 2006), guidance document (Environmental Protection Authority 2008) and policy (Anon. 2011). Similarly, in other jurisdictions, documentation related to the implementation of offsets has become available (for examples see, SEWPaC 2011).

The North West Shelf flatback turtle population as defined by the *Variation Agreement* means:

“flatback turtles of the summer breeding Northwest Shelf Management Unit that nest along the Pilbara and south west Kimberley coasts (including Barrow Island and Mundabullangana) which is distinct from the winter nesting rookeries of the Bonaparte Gulf (eg Cape Domett). It is unknown where the northern boundary of the Northwest Shelf Management Unit is located. Turtles of the Northwest Shelf Management Unit also use feeding grounds from at least Exmouth Gulf in the southern Pilbara to Melville Island in the Northern Territory” (Variation Agreement 2009).

In addition to the above definition the NWSFTCP is required to ensure that data is available to enable the AC and Scientific Panel of Experts (described below) to have enough information to determine if:

Clause 11A “the Project [Gorgon Project] is having a significant impact on the Northwest Shelf Flatback Turtle Population”; and if so, provide evidence that the State may demand payment under the North West Shelf Flatback Turtle Intervention Program (described below):

Clause (3) (b) "... if the Advisory Committee determines that monitoring clearly demonstrates that the Project is having a significant impact on the Northwest Shelf Flatback Turtle Population."

In summary, the NWSFTCP is designed to:

- 1) increase the conservation and protection of the North West Shelf flatback turtle population using the actions within the following areas:
 - a) surveying, monitoring and research;
 - b) reducing interference to key breeding and feeding locations; and
 - c) establishing information and education programs;
- 2) determine in the Gorgon Gas project is having a significant impact of the North West Shelf flatback turtle populations; and
- 3) provide through this project and other projects, evidence to allow the AC to advise the State regarding the implementation of the North West Shelf Flatback Turtle Intervention Program
- 4) after 30 years, enough information is available to allow the Minister to decide whether further funding is required for the NWSFTCP.

1.3.3 Geographic scope

Under the *Variation Agreement* (2009) the scope of this program includes all summer nesting flatback turtles and their distribution through their lifecycle. Currently this includes rookeries between south of Onslow through to and Cape Londonderry in the Kimberley (127 degrees longitude) and foraging distribution from Perth to Cape York including the coastal waters of WA, Northern Territory and Queensland and Commonwealth waters to the Exclusive Economic Zone. There is anecdotal evidence that flatbacks may venture beyond the Exclusive Economic Zone but this would represent a small proportion of the population.

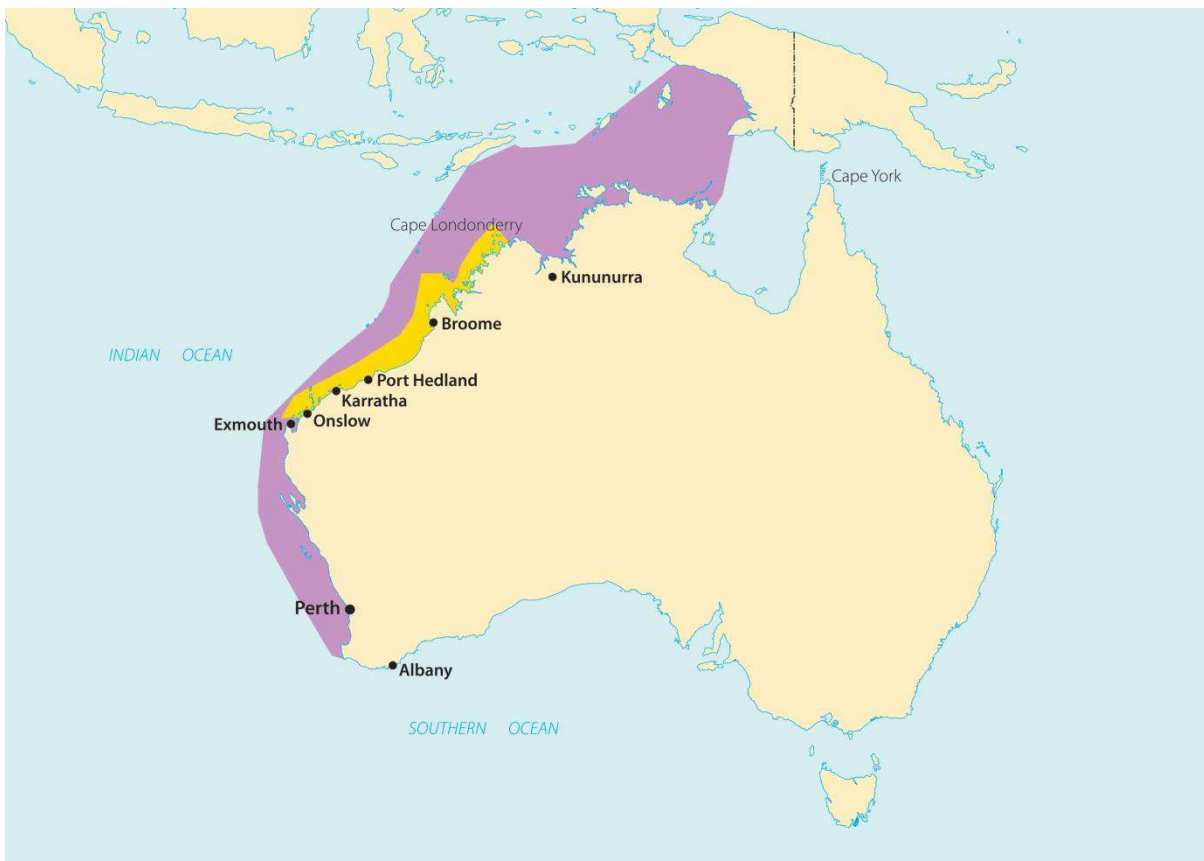


Figure 3. The potential scope of conservation actions within the NWSFTCP as determined by the range of the NWS summer breeding MU depicted by its nesting range (yellow) and foraging range (pink).

1.3.4 Establishment of the NWSFTCP

The Director General of DBCA (DCLM CEO- *Variation Agreement* 2009) is tasked with the establishment of the NWSFTCP –

“11A. (1) The State shall cause the DCLM CEO, in consultation with the Joint Venturers, to establish:

(a) the Northwest Shelf Flatback Turtle Conservation Program” (*Variation Agreement* 2009).

1.3.5 Oversight and governance

The NWSFTCP is administered by the DBCA through the Director General (previously referenced as DCLM CEO (*Variation Agreement* 2009)). The program is coordinated by the Marine Science Program, within the Science and Conservation service. The Director General receives advice from the NWSFTCP AC.

1.3.6 Establishment of Advisory Committee and Scientific Panel of Experts

The process of establishing the AC and Scientific Panel of experts was defined by the *Variation Agreement* (2009).

“For the purposes of the Northwest Shelf Flatback Turtle Conservation Program the State shall also cause the DCLM CEO, in consultation with the Joint Venturers, to establish to the Minister’s satisfaction:

(i) an advisory committee:

(A) to which each of the CALM Act Minister, the Joint Venturers and the Commonwealth Minister shall be entitled to appoint one representative (and to remove and replace their respective representative as seen fit);

(B) and in addition to which the CALM Act Minister and the Joint Venturers shall jointly appoint an independent chairperson (and to remove and replace that chairperson as seen fit); and

(ii) a scientific panel of experts”

1.3.7 Role of the Advisory Committee and Scientific Panel of Experts

The role of the AC and Scientific Panel of Experts is primarily to advise the Director General of DBCA, as defined in the *Variation Agreement* (2009):

“(c) The role of the Advisory Committee is to:

(i) provide advice and make recommendations to the DCLM CEO on the general objectives and timeframes for delivery of the ongoing activities to be undertaken as part of the Northwest Shelf Flatback Turtle Conservation Program and otherwise as to the establishment, development and implementation of that program as requested by the DCLM CEO;

(ii) to receive and consider on an annual basis a report from the DCLM CEO on the implementation of the Northwest Shelf Flatback Turtle Conservation Program and activities proposed to be undertaken as part of it during the following 3 years; and

(iii) at the request from time to time of the State, consider and advise the State whether or not in the Advisory Committee’s view (having regard to the advice of the scientific panel) the Project is having a significant impact on the Northwest Shelf Flatback Turtle Population

(d) The role of scientific panel is to provide expert scientific advice to the Advisory Committee to assist it in undertaking its abovementioned role.”

1.3.8 North West Shelf Flatback Turtle Intervention Program

The North West Shelf Flatback Turtle Intervention Program is defined in the *Variation Agreement* (2009):

(8) "Northwest Shelf Flatback Turtle Intervention Program" means a program of activities (in addition to the Northwest Shelf Flatback Turtle Conservation Program) to be developed by the DCLM CEO and implemented by the DCLM (except to the extent required to be undertaken by the Joint Venturers in compliance with conditions of approval of the Project (including the Domgas Project) under this Agreement or State or Commonwealth legislation including the EP Act or the Environment Protection and Biodiversity Conservation Act 1999 (C'wlth)) to improve recruitment to the Northwest Shelf Flatback Turtle Population.

“(3) (a) The State may only commence making demand under paragraph (a) if the Advisory Committee determines that monitoring clearly demonstrates that the Project is having a significant impact on the Northwest Shelf Flatback Turtle Population”

1.3.9 Annual reporting

A NWSFTCP annual report and three year rolling operational plan will be produced to outline key results, track progress of NWSFTCP and modify expenditure throughout the life of the plan through an adaptive management approach. A draft of the report will be available for comment by the NWSFTCP AC by September each year while a draft of the three year rolling plan will be available for viewing and comment by the NWSFTCP AC for finalisation by May each year.

1.3.10 Communication of program

The program will be communicated through the NWSFTCP annual report and three year rolling operational plan, the DBCA Science and Conservation service's annual report, and the department's annual report and year book. In addition, results will be available through media, internet, conference presentations and peer-reviewed journal articles.

1.3.11 Budget

The rolling operational plan for the NWSFTCP will be prepared by DBCA staff and submitted the NWSFTCP AC to enable advice to be given to the Director General on whether expenditure is appropriate. A summarised budget and detailed proposed annual expenditure will be included in this plan.

2 NWSFTCP objectives

The NWSFTCP objectives are directly derived from the *Variation Agreement* (2009). Measures of success were developed for this plan to assess performance against the objectives.

2.1 Objectives

The NWSFTCP objectives with this plan are to:

- 1) increase the conservation and protection of the North West Shelf flatback turtle population using the actions within the following areas:
 - a) surveying, monitoring and research;
 - b) reducing interference to key breeding and feeding locations; and
 - c) establishing information and education programs.

Measures of success

- A. There are no significant negative changes to adult nesting abundance, hatching and emergence success and other key demographic parameters at key rookeries within the MU (excluding Barrow Island) (short-term 0-7 years);
 - B. There are no significant increases in impacts from pressures upon the MU (Short-term 0-7 years);
 - C. There is a comprehensive understanding of the functioning of the MU in terms of biology, ecology and impacts to ensure that the best indicators are being monitored and there is capability of predictive modelling (0-14 years);
 - D. There are no significant negative changes in key parameters of the MU or associated habitat (nesting, foraging, migration) indices from quantified or estimated 2009 levels (long-term 0-50 years).
 - E. Based on assessment criteria, the NWSFTCP has made effective and efficient use of funds during the implementation this plan (0-30 years).
- 2) provide sufficient data to allow the AC to assess whether the Gorgon project is having a “significant” impact on the NWS flatback population. This should include advice to the Director General as to whether the State should make any request to begin the North West Shelf Flatback Turtle Intervention Program.

Measures of success

- A. The following has been completed: clarification of how significant impact will be assessed, including decision rules and processes of evaluation and communication (0-7 years).
- B. The monitoring program has been designed and is appropriate, given current understanding. It includes the following: biologically relevant unit defined, required data identified, the completeness and accuracy of the data is understood and data collection has commenced (0-7 years).
- C. A robust monitoring program is established, decision rules tested, and all relevant data required to make a decision on significance with high confidence is available (0-14 years).

3 Planning approach 2014–21

3.1 Overview

This plan emphasises a hierarchical approach to the delivery of the NWSFTCP and associated performance measures (Figure 4). The three NWSFTCP objectives from the *Variation Agreement* (see Section 2.1) were expanded and will be delivered through a framework of five management strategies (see Table 5, Section 5.2). Conservation priorities were determined through a prioritisation process (see section 3.1.1 below and Chapter 4). Management objectives were then developed for each conservation priority and were further broken down into groups of management actions, outlining the activities required to achieve these objectives.

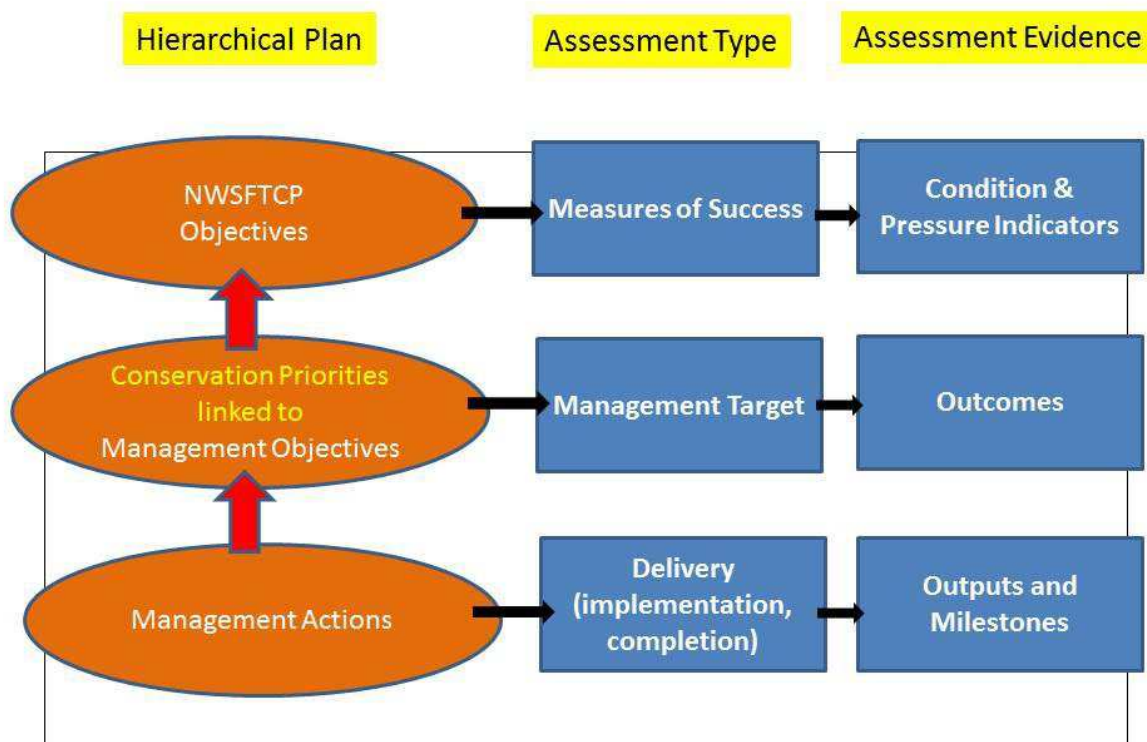


Figure 4. Simplified diagrammatic of planning, implementation and reporting. Evidence will include both quantitative and qualitative.

3.1.1 Conservation priorities – via prioritisation process

3.1.1.1 Decision process

To determine the conservation priorities for the plan we used a prioritisation process described below (details in Appendix 1) and modified from a framework used by DBCA (Simpson *et al.* 2015). The concept behind the framework is the assessment of each asset (in this case the MU) in terms of its value (V), the pressures (P) on this asset and the knowledge gaps (K) for this asset. The process used for the MU is nested within a plan for all turtle species within WA (*Draft Marine Turtle Strategic Conservation Plan* - in prep.) enabling conservation priorities to be compared across species.

The following equation was used to determine the conservation priorities:

- Value (V) * Pressure (P)

In terms of marine turtles in WA, those MUs (assets) of high *value* with the most *pressure* will take priority for conservation or management actions. A full list of pressures defined by stakeholders is listed in Appendix 1 with the main pressures listed in section 4.

3.1.1.2 Scoring the matrix

Scores in the matrix were combined from individual and group stakeholder sessions. Importantly, the final pressures produced from the matrix were reviewed by stakeholders and the NWSFTCP AC. The additional equation of $V*P*K$ guided the development of applied research priorities, identifying areas of high pressure with significant knowledge gaps.

4 Results of the prioritisation matrix and decision framework

4.1 Conservation priorities for North West Shelf flatback turtles

The results from the prioritisation framework (Table 3) produced two pressures listed as high priority and four listed as moderate priority (Table 2). Those pressures with a *low* score were not included in the list of Conservation Priorities but are included in Table 3. All scores were calculated using the same methods as all other Western Australian marine turtle management units (*Draft Marine Turtle Strategic Conservation Plan* – in prep).

In addition to the priorities developed it was recognised that there were many overarching actions that were related to multiple pressures, multiple species, or were knowledge gaps or foundation actions that were essential for a comprehensive NWSFTCP. This formed an additional conservation priority “overarching actions”.

Table 2. A list of the conservation priorities as determined by the prioritisation matrix. OA=overarching actions, P1=pressure 1 etc. H=high priority, M=moderate priority and L=low priority.

		Conservation Priorities	Priority
	OA	Overarching actions	H
Pressure	P1	Light impact on behaviour of nesting adults and hatchlings – onshore and offshore sources	H
	P2	Introduced animals predating on eggs and hatchlings	H
	P3	Global temperature increase - climate change	M
	P4	Modification of beaches - coastal development	M
	P5	Sea level rise - climate change	M
	P6	Marine debris – including entanglement and ingestion	M

4.1.1 Light impact on behaviour of nesting adults and hatchlings – onshore and offshore sources (See Appendix 1 for description of pressure)

Specifically, for this MU, this pressure relates to the potential impacts in relation to industrial light around Barrow Island, Dampier Archipelago and Cape Lambert Port, industrial and urban light around Port Hedland and offshore light from anchored ships in the regions of Onslow/Ashburton River Area and Dampier Archipelago and Port Hedland.

4.1.2 Introduced animals predating on eggs and hatchlings (See Appendix 1 for description of pressure)

Specifically, for this MU, this pressure refers to the predation on eggs and hatchlings at sites such as Mundabullangana Station, Cape Lambert and the Karratha, Port Hedland and Eighty Mile Beach regions. This pressure remains unquantified for all of these regions. In cases where impacts remain unquantified, expert opinion was used to estimate scores.

4.1.3 Global temperature increase - climate change (See Appendix 1 for description of pressure)

Specifically, for this MU, this refers to understanding the impacts of a warming planet on the population dynamics, how spatial and temporal distributions may change and how sex ratios may be altered. The pressure is likely to lead to reduced hatchling success, altered sex ratios and changes in spatial and temporal distribution of nesting and changes to foraging habitat.

4.1.4 Modification of beaches - coastal development (See Appendix 1 for description of pressure)

Specifically, for this MU, this refers to altered beaches through anthropogenic actions such as coastal developments and industrial or urban development. This refers to the loss or alteration of habitat with potential areas including Barrow Island, Dampier Archipelago and Port Hedland.

4.1.5 Sea level rise and altered storm frequency and severity - climate change (See Appendix 1 for description of pressure)

Specifically, for this MU, this refers to understanding the impacts of sea level rise on short and long-term habitat loss, the impacts of more intense and frequent storms. It refers to loss and change of nesting habitat and the impacts on hatching success, and to the loss or change in foraging habitat and its impact on population dynamics such as growth and fecundity. Spatial and temporal changes in nesting distribution are likely.

4.1.6 Marine debris including entanglement and ingestion (See Appendix 1 for description of pressure)

Specifically, for this MU, this pressure relates to the high level of marine debris in the northern waters of Australia between Broome and Cape York that entangle large numbers of marine turtles. There is uncertainty around the proportion of the NWS flatback turtles that are entangled, but preliminary data suggests up to 15 % of the captures are flatback turtles. In addition, ingestion of marine debris adds another level of uncertainty to the mortality or reduced level of health. Migration data indicate that this MU commonly uses these northern waters. Anecdotal information suggests that the level of marine debris for the waters south of Broome is less of a concern.

4.2 Research priorities

Research actions appear in each of the priority pressures and also in overarching actions. Priority Applied Research as determined by the matrix is shown in Table 4.

Table 3. Scores of the prioritisation matrix sorted by conservation priority V*P

Pressure	Value													Pressure Metrics					V*P		
	E1	E2	E3	E4	B1	B2	B3	B4	C1	C2	C3	C4	Sub Total	P1	P2	P3	P4	P5			Sub Total
	Func. Import	Areal extent	Population	Recovery	Local	Regional	National	Global	Cultural	Economic	Scientific	Recreational	Sub Total	Life stage	Spatial scale	Temporal	Consequence	Probability	Sub Total	V*P	
Light - onshore and offshore sources	2	3	1	2	3	3	3	3	1	1	3	1	26	1	3	3	3	3	30	780	H
Introduced pests/feral animals	Same scores as first row												26	1	2	3	2	3	24	624	H
Sea Level Rise - climate change	Same scores as first row												26	3	3	3	2	2	22	572	M
Global temperature increase - climate change	Same scores as first row												26	3	3	3	2	2	22	572	M
Modification of beaches - coastal development	Same scores as first row												26	1	1	3	2	3	21	546	M
Marine debris	Same scores as first row												26	2	2	3	3	2	20	520	M
Water pollution (chronic)	Same scores as first row												26	3	1	3	2	2	18	416	L
Direct death - dredging- port development	Same scores as first row												26	3	1	1	3	2	16	416	L
Disturbance of turtles on beaches - tourism/people	Same scores as first row												26	1	2	3	2	2	16	416	L
Vessel strike and disturbance	Same scores as first row												26	3	1	2	2	2	16	416	L
Marine habitat destruction - dredging - port development	Same scores as first row												26	3	1	2	1	2	14	364	L
Noise seismic	Same scores as first row												26	2	2	1	3	3	14	364	L?
Noise - dredging/piling - port development	Same scores as first row												26	3	2	1	1	2	14	364	L
Water pollution (acute)	Same scores as first row												26	2	1	1	3	2	14	364	L
Fishing bycatch	Same scores as first row												26	3	1	2	2	1	8	208	L
Illegal or unregulated take outside Australia	Same scores as first row												26	1	1	3	2	1	7	182	L
Indigenous harvest	Same scores as first row												26	1	1	3	1	1	6	156	L

Table 4. Scores of the prioritisation matrix sorted by Applied Research V*P*K

	Value													Pressure Metrics					Knowledge Gaps				Applied Research			
	E1	E2	E3	E4	B1	B2	B3	B4	C1	C2	C3	C4	Sub Total	P1	P2	P3	P4	P5	Sub Total	K1	K2	K3			K4	Sub Total
Pressure	Func. Import.	Areal extent of	Population	Recovery	Local	Regional	National	Global	Cultural	Economic	Scientific	Recreational	Sub Total	Life stage	Spatial scale	Temporal scale	Consequence	Probability	Sub Total	Inventory	Baseline data	Monitoring	Management	Sub Total	V*P*K	
Light - onshore sources	2	3	1	2	3	3	3	3	1	1	3	1	26	1	3	3	3	3	30	1	2	2	3	8	6240	H
Sea level rise - climate change	Same scores as first row												26	3	3	3	2	2	22	1	3	3	3	10	5720	H
Global temperature increase - climate change	Same scores as first row												26	3	3	3	2	2	22	1	3	3	3	10	5720	H
Marine debris	Same scores as first row												26	2	2	3	3	2	20	3	2	3	1	9	4680	H
Noise - seismic	Same scores as first row												26	2	2	1	2	2	14	3	3	3	3	12	4368	H
Water pollution (chronic)	Same scores as first row												26	3	1	3	2	2	18	2	2	2	3	9	4212	H
Direct death – dredging - port development	Same scores as first row												26	3	1	1	3	2	16	3	3	3	1	10	4160	H
Modification of beaches - industry	Same scores as first row												26	1	1	3	2	3	21	1	2	2	2	7	3822	M
Noise - dredging/piling - port development	Same scores as first row												26	3	2	1	1	2	14	1	2	3	3	9	3276	M
Water pollution (acute)	Same scores as first row												26	2	1	1	3	2	14	2	2	2	3	9	3276	M
Introduced pests/feral animals	Same scores as first row												26	1	2	3	2	3	24	1	1	1	2	5	3120	M
Disturbance of turtles on beaches - tourism/people	Same scores as first row												26	1	2	3	2	2	16	1	2	2	2	7	2912	M
Vessel strike and disturbance	Same scores as first row												26	3	1	2	2	2	16	1	1	1	2	5	2080	M
Marine habitat destruction - dredging - port development	Same scores as first row												26	3	1	2	1	2	14	1	2	1	1	5	1820	L
Fishing bycatch	Same scores as first row												26	3	1	2	2	1	8	1	1	2	1	5	1040	L
Illegal or unregulated take outside Australia	Same scores as first row												26	1	1	3	2	1	7	1	1	1	1	4	728	L
Indigenous harvest	Same scores as first row												26	1	1	3	1	1	6	1	1	1	1	4	624	L

5 Conservation priorities, management strategies and management actions

5.1 Conservation priorities

To summarise from the previous Chapter, the conservation priorities required to meet the NWSFTCP objectives include actions under the headings of:

- Overarching actions
- Light impacts
- Introduced animals
- Global temperature increase - climate change
- Modification of beaches - coastal development
- Sea level rise - climate change
- Marine debris – including entanglement and ingestion

5.2 Strategies and management actions

Management actions were developed under five strategies for the following reasons:

- to meet the requirements of the *Variation Agreement* (2009) (previous three categories expanded to five);
- ensure conservation is the focus of the program;
- provide transparency in expenditure;
- enable interrogation of actions; and
- enhance review capacities.

Five strategies were used to categorise management actions within each Conservation Priority (Table 5). These strategies meet the needs of the *Variation Agreement* (2009) which included (a) surveying, monitoring and research; (b) reducing interference to key breeding and feeding locations; and (c) establishing information and education programs”. In developing the five strategies “survey, monitoring and research” was split into two separate categories of “research” and “monitoring” and “administrative frameworks” was added to ensure that essential major foundation and integral components of the program could be included in planning and operation.

Table 5. Management strategies

Management Strategies	Description
Administrative Frameworks	This includes all frameworks needed to plan, organise, deliver and report on activities and outputs leading to targets. These include policy, regulations, codes of conduct and guidelines for financial structures, plans, training, communication and knowledge transfer.
Education (includes communication and public participation)	Education and interpretation increases public awareness on management and conservation issues related to sea turtles. Education may include a variety of formats and will help to develop a sense of stewardship. Communication is essential at multiple levels including within the NWSFTCP, the department and across stakeholders. Public participation helps to sustain stewardship and is an integral part of management. Public participation can assist all other strategies by including assistance in planning, on-ground action, research and monitoring.
Intervention/ mitigation	Management intervention includes direct management actions to achieve conservation outcomes for sea turtles and their habitats. These can be proactive (preventative) or reactive (restorative). Patrol and enforcement to monitor the level of compliance and actions to stop illegal behaviour are included in this category.
Research	Research is the science required to obtain necessary knowledge to establish inventory (i.e. spatial and temporal distribution) as well as baseline information, from which to detect changes of condition of pressures and identify key indicators to base monitoring on. Research is required to understand essential components of biology and ecology to develop effective and efficient population monitoring and to understand the impacts of pressures.
Monitoring	Monitoring is the key component of management that allows evaluation of effectiveness (i.e. meeting the management target) and efficiency (i.e. best value of both time and money). It includes monitoring key indicators of Pressure - State - Response (sometimes called Condition, Pressure, Response) (OECD 1993; OED 2004) through time to allow detection of trends and determine significance of any change. Indicators should be related to State (condition) of the asset, Pressure and Response. Monitoring will focus on key biological and ecological indicators and key pressure indicators to understand the whole MU.

5.2.1 Management objectives and management targets

Management objectives were developed within each conservation priority

The management target is the desired end point of management in terms of this plan. Where possible, targets are specific, measurable, achievable, repeatable and time-bound (SMART- Doran 1981). Targets will be assessed with quantitative and qualitative evidence.

5.2.2 Management actions

Management actions are the activities, or groups of activities, that are required to achieve the management objective. To allow for annual assessment of performance, outputs and milestones will be used to assess whether management actions are on track.

5.3 Implementation of conservation priorities

The following tables set out the road map for implementation of the plan over the seven years.

All actions are coded within each table. The first three letters relate to the MU (NdS = *Natator depressus* – summer breeding unit) allowing amalgamation with other MU plans. This MU coding allows MU tables to be combined so all species for WA can be viewed together, if necessary. The next group of letters relate to conservation priority. OA=overarching actions, P1=pressure 1, etc. The next group of letters identifies the management strategy: AF=administrative frameworks, E=education, I=intervention, R=research and M=monitoring. The following numeral represents the management action/s.

5.3.1 Conservation priority – overarching actions (H)

5.3.1.1 Overarching actions– administrative frameworks (OA AF)

Management Objective	Conservation frameworks, policy and legislation is used to maximise conservation with the support of efficient processes including databases, finance and the support of well-trained people, informed by active knowledge transfer			
Management Target	Key frameworks, systems and processes are aligned and functional to achieve efficient and effective management of turtles (evidence required)			
Code	Action	Priority	Complete Time	Output/ Milestone
NdS OA AF1	1. Establish and maintain administrative systems that simplify processes and increase efficiency and outputs			
	a. Align financial accounting with the strategic framework and reporting requirements	H	2017/18	a. Finance structures allow interrogation and audit
	b. Continue to develop clear and consistent decision processes for prioritising activities and dispensing funds to organisations outside of DBCA	H	2016/17	b. Dispersal of funds is consistent with strategic plan or amendments to the plan
	c. Develop standard operating procedures (SOPs) for regular activities	H	2015/16 ongoing	c. SOPs are developed
NdS OA AF2	2. Ensure that legislative roles in relation to marine turtles are met and that current legal and policy frameworks are used to enhance turtle conservation			
	a. Ensure that development proposals that impact on sea turtles have appropriate levels of internal assessment and advice	H	ongoing	a. All coastal development potentially impacting on flatback turtles has had the appropriate advice from DBCA
	b. Ensure that the legislative requirements of threatened and protected fauna are met through sound management, underpinned by robust science programs	H	2015/16	b. Management decisions are underpinned by science
	c. Review existing policy and legislation to ensure that opportunities are taken and bottlenecks eliminated to achieve the management target	L	2017/18	c. A review of current policy and legislation is undertaken to improve conservation outcomes
	d. Ensure that management strategies for marine turtles are included in marine and terrestrial park management plans, where appropriate	H	2018	d. The NWSFTCP is taken into account in any relevant new management plans
e. Provide secretariat and support for AC	H	ongoing	e. AC is operating as described in <i>Variation Agreement (2009)</i>	

NdS OA AF 3	<p>3. Establish efficient information management systems</p> <ul style="list-style-type: none"> a. Develop systems for the compilation, management and long-term storage of datasets and their metadata related to sea turtles and their habitats b. Develop a stranding information database c. Improve current marine turtle database to ensure functionality across user groups for tagged turtles, beach surveys and other information d. Develop project management systems (projects, scientific papers, reports, plans) that complement existing corporate systems 	<p>H</p> <p>H</p> <p>H</p> <p>H</p>	<p>2017/18</p> <p>2017/18</p> <p>2017/18</p> <p>2017/18</p>	<ul style="list-style-type: none"> a. Data management systems developed and operational b. Database developed and operational c. Database modified and operational d. Document management systems developed and integrated across categories
NdS OA AF4	<p>4. Maintain trained and informed people across the State to complete conservation actions. This will include:</p> <ul style="list-style-type: none"> a. Ensuring staff are trained and skilled to deliver the plan b. Promoting engagement, employment and training of Indigenous people to assist in delivery of the program c. Hosting training workshops as required 	<p>H</p> <p>H</p> <p>M</p>	<p>2015/16 ongoing</p>	<ul style="list-style-type: none"> a. Training provided to staff b. Indigenous people employed and engaged in the program c. Training workshops held on relevant topics
NdS OA AF5	<p>5. Knowledge transfer</p> <ul style="list-style-type: none"> a. Develop internal systems that ensure that knowledge is shared with relevant DBCA sections and other government departments to meet the management target b. Develop information sharing agreements between government agencies and stakeholders which could include informal agreements or MOUs regarding information or management activities 	<p>H</p> <p>M</p>	<p>2017/18 ongoing</p>	<ul style="list-style-type: none"> a. Knowledge sharing systems in place within DBCA and between DBCA, EPA and DPIRD b. Data sharing arrangements in place

5.3.1.2

Overarching actions – education, communication and public participation (OA E)

Overarching – Education, communication and public participation				
Management Objective	A wide cross section of the community understands flatback turtle conservation issues and opportunities exist for participation			
Management Target	Increased understanding of marine turtle conservation by all stakeholders through targeted education and participation programs			
Code	Action	Priority	Complete Time	Output/ Milestone
NdS OA E 1	1. Develop a communication and education plan to: <ol style="list-style-type: none"> a. Produce clear and consistent products that can be delivered at multiple levels (schools, public, volunteers, staff and in parks) b. Foster an environment that engages stakeholders and promotes communication between groups and organisations c. Promote knowledge transfer to management 	H	2015/16	Plan prepared with priorities and budget
NdS OA E 2	2. Deliver actions in communication and education plan to: <ol style="list-style-type: none"> a. Promote clear and consistent products that can be delivered at multiple levels (schools, public, volunteers, staff and in parks) b. Foster an environment that engages stakeholders and promotes communication between groups and organisations c. Promote knowledge transfer 	H	2016/17-2020/21	Communication and education plan achieved by 2021
NdS OA E 3	3. Host WA Marine Turtle Symposium or similar stakeholder communication activity biennially, or as appropriate	M	2014-2020	Events hosted and information published or distributed

NdS OA E4	4. Develop and maintain opportunities for the public to be involved in sea turtle conservation programs	H	2015/16 ongoing	Opportunities exist for the public and stakeholders to be involved in sea turtle conservation activities at a variety of levels
NdS OA E5	5. Develop measures of assessing educational impact (increase in knowledge, behavioural change)	H	2020/21	Measure of change developed and foundations for ongoing project
NdS OA E6	6. Ensure Indigenous engagement and activity are a focus of wider stakeholder engagement, ensure opportunities for education and participation	H	2020/21	Opportunities developed for Indigenous people. Numbers of people engaged
NdS OA E7	7. Assist Rehabilitation centres, as they provide educational and public participation value	H	2020/21	Funds distributed and centres engaged in program

5.3.1.3

Overarching actions - intervention/mitigation (OA I)

Overarching –Intervention/Mitigation				
Management Objective – To mitigate existing potential human impacts on the NWS management unit				
Management Target – All major pressures have relevant, effective and efficient intervention or mitigation				
Code	Action	Priority	Complete Time	Output/ Milestone
NdS OA I 1	1. Current and predicted flatback areas are included in marine and terrestrial protected area planning (e.g. specific conservation areas, acquisition of private land)	H	ongoing	Evidence of communication in relation to this issue across divisions within DBCA and Commonwealth Agencies
NdS OA I 2	2. Complete other intervention specific to relevant marine and terrestrial management plans as appropriate, including fisheries, oil spill response	H	ongoing	Complete intervention according to existing plans as is relevant to the NWSFTCP
NdS OA I3	3. Complete all intervention or mitigation on unplanned events – e.g. oil spill, algal blooms	H		Complete activities as appropriate and required and document
NdS OA I4	4. Ensure that advice from DBCA on development proposals related to the NWS flatback turtles is consistent and in line with the objectives of the draft <i>Western Australian Marine Turtle Strategic Plan, Recovery plan for marine turtles in Australia</i> and State and Commonwealth legislation	H	2014/15 ongoing	All subsequent large development proposals have had an adequate level of response by DBCA either through requests from the EPA or other channels such as public comment periods
NdS OA I5	5. Record and report non-compliance incidents to increase understanding	M	ongoing	Ability to detect trends in illegal activity

5.3.1.4

Overarching actions - Research (OA R)

Overarching - Research				
Management Objective - To implement collaborative and cost effective research programs to improve ecological and social knowledge directly related to the conservation of NWS flatback turtles and other species where there is direct benefit to the NWS flatback turtles or where other species can act as research surrogates.				
Management Target – Research produces knowledge for inventory, baseline, monitoring methodology and design, and predictive models to meet management and monitoring needs				
Code	Action	Priority	Complete Time	Output/ Milestone
Inventory (where, when, what)				
NdS OA R1	1. NWS flatbacks - Produce an inventory of nesting locations and seasonality (spatial and temporal distribution)	H	2017/18	Collation of existing information and surveys conducted to ensure that all major rookeries are mapped in the Pilbara
NdS OA R2	2. Neighbouring flatback MUs- Produce an inventory of nesting locations and seasonality (spatial and temporal distribution)	H	2016/17	Collation of existing information and surveys conducted to ensure that all major rookeries are mapped in the Kimberley
NdS OA R3	3. Define and map from existing data key spatial areas and habitats in the life cycle, including foraging areas, migration routes and mating areas	H	2017/18	Key foraging areas are identified and at least some mating areas are identified
NdS OA R4	4. Increase understanding of connectivity (both spatial and temporal) - a. Continue genetic analysis to define MUs b. Investigate innovative genetics methodology to establish local connectivity links between rookeries c. Collate or conduct relevant tracking studies of individuals between nesting and foraging grounds (Determining the level of connectivity between rookeries within MU and between rookeries and foraging habitat) d. Use techniques such as stable isotopes to link nesting beaches to foraging grounds	H	2016/17 to 2020/21	Connectivity between nesting and foraging grounds defined. Investigation of methodologies to investigate between rookery connectivity
NdS OA R5	5. Increase understanding of neonate biology a. Studies to understand the spatial needs and habitat use of neonate turtles b. Increase knowledge of neonate biology and genetics through access to stranded animals	M	2020/21	Increased knowledge on movement paths and habitat preference

NdS OA R6	6. Conduct a flatback risk assessment for all anthropogenic pressures and climate change scenarios ensuring to include cumulative pressures in space and time	H	2019/20	Spatial cumulative risk assessment completed
Baseline (Assessment and analysis to meet baseline requirements)				
NdS OA R7	7. Develop baseline and time-series data of nesting aggregations within the MU using available information. Use existing sites and historical information to estimate baseline condition levels (where available). Sites that are currently monitored include Barrow Island, Mundabullangana, Delambre Island and Cemetery Beach and to a lesser extent Eco-Beach. Where possible include measures of: <ul style="list-style-type: none"> a. Population dynamics parameters (annual nesting abundance, recruitment, survivorship etc.) b. Nesting success c. Hatching success d. Sand temperature e. Other condition or pressure metrics 	H	2020/21	Distribution and relative densities are collated and mapped All sites are summarised
NdS OA R8	8. Conduct site selection process to establish new monitoring sites for nesting turtles and conduct pilot program at sites to evaluate suitability for long-term monitoring	H	2020/21	Site selection completed and pilot study conducted.
NdS OA R9	9. Investigate options for sampling flatback turtles in-water in foraging grounds to enable demographic studies	M	2017/18	Scoping document produced that assesses the ability to sample flatback turtles within the NWSFTCP range
Process studies to enable the establishment of better monitoring parameters and developing appropriate methodology				
NdS OA R10	10. Design an efficient and effective research and monitoring program to fulfil the requirement in the <i>Variation Agreement</i> including: <ul style="list-style-type: none"> a. to enable monitoring of the MU; b. to enable the detection of “significant impact” of the Gorgon Gas Project on the MU. Includes establishing appropriate monitoring indicators. Ensuring monitoring parameters focus on key life stages to enable a comprehensive understanding of the functioning of the MU in terms of biology, ecology and impacts	H	2017/18	Completion of a robust monitoring design that would enable detection of impact based on empirical data or probability
NdS OA R11	11. Investigate in-water ecology of flatback turtles with the intent of identifying potential monitoring parameters (both turtle and habitat). Projects to include the following <ul style="list-style-type: none"> a. Characterising key foraging habitats b. Determining diet c. Scope studies on population dynamics such as size, sex and 	M	2020/21	Projects are established to understand flatback in-water ecology including habitat with the understanding that this will continue into the next plan

	<p>maturity structure in non-breeding areas</p> <p>d. Characterising mating and inter-nesting habitat</p> <p>e. Increase knowledge of male biology</p> <p>f. Scope studies to investigate energy budgets and reproductive output</p>			
NdS OA R 12	12. Climate change – Follows on from pressure 4. Determine pivotal temperatures within and between flatback turtle MUs in WA	M	2018/19	Studies conducted and results available
NdS OA R 13	13. Mortality - Use stranded animals to help understand the level and source of mortality and to determine trends and patterns (includes necropsies and pathology to increase the confidence in determining cause of death)	H	2020/21	Stranding network established (2016) and information used to categorise anthropogenic mortality and assess trends where possible
NdS OA R 14	14. Test new research methodologies that will improve monitoring efficiency - e.g. remote cameras, aerial survey, satellite technology	M	2020/21	Scoping document completed and projects initiated where applicable
NdS OA R 15	15. Investigate the potential extent and impact of suspected or potential pressures that were unable to be prioritised, e.g. radiation (Montebello Is.), seismic noise	M	2018/19	Scoping document completed and research projects initiated where applicable
NdS OA R 16	16. To support OA R 10, explore use of indicators within other life cycle stages and habitat to monitoring condition and pressure		2020/21	Assessment conducted for additional indicators
NdS OA R 17	17. Model future distributions of nesting and foraging flatback turtles to assess potential protected areas	M	2020/21	Research completed and results available
NdS OA R 18	18. In addition to connectivity in OA R4, investigate options for understanding whether flatbacks return to their natal beach	M	2020/21	Scoping document produced and research commenced
NdS OA R 19	19. Investigate the ecosystem role of flatback turtles and the effects of environmental factors on flatback demography (likely to roll over into next plan)	M	2020/21	Investigate options after reviewing results from pilot studies

5.3.1.5

Overarching actions - monitoring (OA M)

Overarching - Monitoring				
Management Objective: To implement a collaborative and cost effective monitoring program to provide the basis for adaptive management and to enable the assessment of management effectiveness and efficiency				
Management Target Indicators are showing a stable or increasing trend				
Code	Action	Priority	Complete Time	Output/ Milestone
NdS OA M 1	1. Following on from NdS OR R10 - Implement monitoring strategy for the NWS MU according to plan developed above. This should include at least two index nesting sites with the NWS MU (could include third party data) and some reference beaches outside the MU. It should ensure that monitoring includes appropriate key condition and pressure indicators (annual nesting abundance, nesting success, hatching success, emergence success).	H	In place 2016/17 ongoing	Established sites and monitoring implemented at index sites
NdS OA M 2	2. Investigation of key indicators (in addition to those at the breeding stage) will be investigated and monitored if possible. Surrogates obtained at the nesting beach may be used in some cases (such as clutches per season, intervals between breeding, and eggs per clutch)	H	2020/21	Indicators established and tested during life of plan

5.3.2 Conservation priority – Pressure 1 - Impacts of onshore and nearshore light (HIGH)

Pressure 1 – Impacts of onshore and nearshore light				
Management Objective – Light pollution does not impact on the viability of the MU				
Management Target - Quantify the impacts of light on flatback turtles and mitigate where feasible				
Code	Action	Priority	Complete Time	Output/ Milestone
NdS P1 AF	Administrative Frameworks Maintain appropriate conditions in development proposals to control the impacts of light, including ensuring light mitigation advice is consistent (as per EPA Guidelines). Support the development of regional and cross industry planning mechanisms for assessment of cumulative impacts of lights	H	ongoing	Improved mechanisms to achieve light management in relation to turtles (evidence)
NdS P1 E	Education a. Encourage industry to develop and maintain cultures of best practise light management b. Encourage best practise light management by all companies, councils and organisations where the impacts to sea turtles are high. Assist implementation of light reduction strategies with coastal urban communities	L H H	ongoing	a. Positive interactions with industry regarding light management practices b. Assistance provided by this NWSFTCP to initiatives where applicable
Nd S P1 I	Intervention Develop mechanisms to assist converting to turtle friendly lights which may include advice, new technologies, incentives and development of collaborations or partnerships	H	ongoing	Evidence of mechanisms developed
Nd S P1 R	Research a. Collate and/or conduct research to determine the quantitative impacts of lights on hatchlings and adults both on the land and at sea b. Encourage research on best practice light mitigation techniques using innovative technology	H M	2020/21 2020/21	a. Improved knowledge to understand the level of impact of light at key rookeries and on key life stages (adults and hatchlings) b. Better management of light
Nd S P1 M	Monitoring a. Conduct light monitoring at sites of potential impact b. Develop time series data at selected and/or impacted and non-impacted beaches to determine the level of impact of lights to the behaviour of adults and hatchlings c. All development projects with potential light pressures on flatback turtles have monitoring in place to quantify impacts	H	2020/21	Monitoring sites established at beaches with a continuum of no lights, residential lighting levels, and industrial light illumination levels

5.3.3 Conservation priority – Pressure 2- Introduced animals (HIGH)

Pressure 2 – Introduced animals				
Management Objective: Impact of predation by introduced animals on hatchling production is maintained at low levels				
Management Target: Quantify the impact of introduced animals on NWS MU and mitigate where feasible				
Code	Action	Priority	Complete Time	Output/ Milestone
NdS P2 AF	Administration/frameworks/planning Develop an integrated approach for managing leased land, private and government land in relation to introduced animal control	M	2020/21	Key sea turtle rookeries are included in strategic introduced animal control planning for the State
NdS P2 E	Education Encourage stakeholders and other land managers to begin or maintain fox control programs where appropriate	H	2016/17 ongoing	Stakeholders have latest knowledge and are engaged in the process
NdS P2 I	Intervention a. Introduced animal control programs in place at major nesting sites b. Work with relevant landholders and stakeholders to encourage control activities on non-DBCA lands	H H	2016/17 2016/17	a. Introduced animal control programs with associated measurement of success studies are in place across NWS b. Discussions commenced in regard to complimentary non-government control programs
NdS P2 R	Research a. There is a clear understanding of the predator/prey relationship and of the biology of both predator and prey b. Economic models are used in conjunction with biological models to produce the most effective and efficient control frameworks	M M	2020/21 2020/21 2020/21	a. Knowledge gaps are filled to understand the problem b. Economic models are integrated into long-term control programs
NdS P2 M	Monitoring a. Monitoring programs established on key marine turtle nesting beaches, where introduced animals occur (for example Mundabullangana and Eighty Mile Beach) b. Ensure research is sufficient to measure success of control programs (effectiveness and efficiency)	H H	2016/17	a. Adequate monitoring is in place to determine predator level and impact on eggs and hatchlings b. The level of impact is quantified and control programs have measures of effectiveness and efficiency

5.3.4 Conservation priority – Pressure 3 - Increasing temperatures – climate change (M)

Pressure 3 - Increasing temperatures – climate change				
Management Objective - The potential impact of increased temperatures on this MU is modelled and understood				
Management Target – Information is collected and future scenarios modelled with results transferred to planners				
Code	Action	Priority	Complete Time	Output/ Milestone
NdS P3 AR	Administration/frameworks/planning <ol style="list-style-type: none"> a. Ensure that marine turtles are included in climate change discussions at state, national and international levels b. Ensure that potential future nesting sites and critical habitat are included in planning for protected areas 	M	2020/21 ongoing	WA is engaged in wider discussions
NdS P3 E	Education Ensure that turtles are included in broad climate change awareness campaigns	L	2020/21 ongoing	
NdS P3 R	Research Conduct thermal studies to understand pivotal temperatures, produce hind cast and forecast estimates, model future scenarios	H	2020/21	Scientific studies can be used to model future scenarios and the impact on the MU
NdS P3 M	Monitoring <ol style="list-style-type: none"> a. Monitor sand temperatures on key beaches throughout MU b. Monitor hatchling survivorship/success 	H	2020/21	Monitoring is in place by 2018. Data produced and reported annually. For example, temperature loggers installed and reported on for important beaches

5.3.5 Conservation priority – Pressure 4 - Modification to beaches (M)

Pressure 4 – Modification to beaches				
Management Objective: Beach modification does not significantly impact on any major rookery				
Management Target: Understand the impacts of beach modification (including where possible natural events, and reduce impacts where feasible to the MU				
Code	Action	Priority	Complete Time	Output/ Milestone
NdS P4 AF	Administration/frameworks/planning a. Provide advice on appropriate conditions in development proposals to control the impacts of physical structures such as solid jetties and groins and of modifications to beaches through indirect pressures, such as dredging b. Provide advice and encourage light audits to ensure that development projects are compliant with conditions.	H M	From ongoing	a. All new developments have specific coastal management plans in place to manage impacts b. assessments and audits conducted
NdS P4 I	Management Intervention Encourage or enable management intervention (as required)	H	ongoing	Mitigation commenced (as required) and recorded
NdS P4 R	Research Identify beaches or areas of potential impact and investigate historical data sources to establish baselines and natural variability ranges Conduct detailed research on beaches, as appropriate (e.g. Port Hedland)	M	2020/21	Results incorporated into coastal vulnerability assessments and feed into potential mitigation
NdS P4 M	Monitoring Monitor all vulnerable sites for signs of potential impact	H	ongoing	All vulnerable sites have been assessed and monitoring is in place as required

5.3.6 Conservation priority – Pressure 5 - Sea level rise (M)

Pressure 5 – Sea level rise				
Management Objective: Assess and model the impacts of sea level rise on nesting beach productivity				
Management Target: Understand potential impacts, including developing predictive models of sea level rise and identify interim intervention measures, where appropriate				
NdS P5 AF	Administration/frameworks/planning Same as NdS P4 OA.	M	2020/21	WA is engaged in wider discussions
NdS P5 E	Education Same as NdS P4 E	M	2020/21	
NdS P5 R	Research <ul style="list-style-type: none"> a. Conduct predictive modelling of potential impacts and areas of vulnerability b. Conduct risk assessment 	H	2019/20	Scientific studies inform risk
Nd S P5 M	Monitoring <ul style="list-style-type: none"> a. Monitor shoreline position through integrated projects b. Monitor hatching success at index beaches 	H H	2020/21 2020/21	a. Monitoring is in place by 2018 b. Data produced is reported annually

5.3.7 Conservation priority – Pressure 6 - Marine debris

Pressure 6 – Marine Debris				
Management Objective: Understand the impact or potential of marine debris on NWS flatback turtles				
Management Target: Assess the real impact of marine debris on NWS flatback turtles				
Code	Action	Priority	Complete Time	Output/ Milestone
NdS P6 AF	Administration/frameworks/planning a. Establish a WA stranding network b. Investigate cross jurisdictional mechanisms for management in Arafura Timor seas	H M	2016/17 2020/21	a. Established and operational stranding network b. Discussions across jurisdictions
NdS P6 E	Education a. Promote marine debris (entanglement and ingestion) issue in general education	H	2014/15 ongoing	a. Awareness is raised throughout stakeholder groups b. Strandings are reported in standardised format
Nd P6 I	Intervention a. Encourage the removal of nets from water and beaches in affected areas by a variety of stakeholders where possible b. Support of community marine debris programs that provide scientific information relevant to this issue	M M	2014/15 ongoing	a. Nets removed from high impact areas b. Programs supported where applicable
NdS P6 R	Research Determine the number and proportion of MU killed and injured in nets (genetics)	H	2018/19	Research conducted to allow level of impact to be assessed
NdS P6 M	Monitoring a. Establish or support establishment of marine debris monitoring in WA b. State-wide stranding program is capable of interrogating for marine debris mortality	L H	2015/16 ongoing	a. Sites established where needed

6 Reporting and evidence based assessment

6.1 Reporting

An annual report and three year rolling plan will be produced each year.

The annual report will contain information on each of the activities for each year and provide cumulative evidence against assessment categories.

6.2 Assessment

Assessment will be evidence-based against the categories mentioned above and include measures of success, management targets and deliverables (output/milestones).

The NWSFTCP objectives will be assessed, based on measures of success, which will include relevant population and habitat metrics (condition and pressure indicators) and be presented in the form of time-series summarised data. In addition, other evidence and assessments by experts will be used.

Management objectives will be assessed through the management targets while each management action will be assessed through outputs and milestones. Both quantitative and qualitative evidence will be used to make assessments.

Evidence will be presented annually against each assessment criteria. Evidence against management actions will be recorded and categorised as being 1) not applicable; 2) not achieved; 3) partially achieved or 4) achieved.

This process will allow the AC to assess whether the NWSFTCP is on track to achieving its objectives as planned.

Key NWS flatback turtle condition and pressure indicators will be critical to monitoring the effectiveness of management actions. These indicators will be developed in the early stages of this plan and may include biological indicators such as: annual nesting abundance, hatching success, nesting success, survivorship, recruitment, habitat quality and temperatures. Pressure metrics such as light pollution, underwater noise, introduced animal predation of nests and climate change metrics such as sand temperature may be used.

6.2.1 Efficiency

Efficiency of the program is more difficult to measure and is sometimes less quantitative. Efficiency and value for money will be considered through a number of themes.

6.2.1.1 *Administrative processes*

The program will use the following mechanisms to ensure administration costs are kept low and value for money is achieved:

- use existing departmental processes for recruitment, procurement, finance, filing and auditing; and
- ensure administration costs are below 10% of annual expenditure.

6.2.1.2 *Partnerships and value adding*

This program will continue to be vigilant and seek and assess other projects, including existing environmental offsets, for overlap and shared goals to enable efficiencies to be gained. Efficiencies will be sought within the department providing many opportunities to value add or cost share.

The contribution by other parties to the project, either by cash or in-kind, increases the value of the project and produces a value ratio also called a leverage ratio. This can be presented as the ratio of:

NWSFTCP input: total value of activities

These contributions will be recorded and provide a metric showing where efficiencies have been achieved. Projects will be tabulated and viewed annually by the AC.

6.2.1.3 *Student projects and post-doctoral scholarships*

For specific research projects, post-graduate students and their institutions are excellent partners. Most students come with a scholarship to cover their salary and are highly productive in terms of outputs. Student projects will be used strategically for the NWSFTCP.

Similar to student projects, post-doctoral staff will be used strategically for specific projects.

6.2.1.4 *Third party projects and data*

Third party organisations have collected, and will continue to collect, information on NWS flatback turtles along with implementing management actions. It is important that the NWSFTCP does not duplicate effort. The NWSFTCP will keep a register of third party activities and seek use of data where applicable to ensure efficiencies. A table of data type, applicability to the NWSFTCP and availability will be kept and viewed annually by the AC to assess efficiency. Currently multi-year monitoring data exists for Barrow Island, Mundabullangana Station, Delambre Island, Cemetery Beach (Port Hedland) and Eco Beach.

7 Plan amendments and review

7.1 Plan amendments

The NWSFTCP strategic conservation plan was developed using the best available knowledge and with input from the NWSFTCP AC and from stakeholders and sea turtle experts.

Inevitably, information will become available during the life of the plan that may require management actions to be changed, be removed or added. Any changes within an adaptive management framework will be made in consultation with the NWSFTC AC.

7.2 Structured reviews of plan

7.2.1 2017 Review

This review is to ensure that the plan meets the needs of the NWSFTCP and the reporting format is appropriate. This review will be undertaken in October 2017, one year after finalisation of the plan.

7.2.2 2019 Review

This review will assess the plan to ensure that it continues to be both effective and efficient.

7.2.3 6.1.3 Timing of reviews

A timetable of review periods and the preparation of the subsequent plan is provided in Table 6.

Table 6. Timetable for review periods of the current plan and for the preparation of a new plan.

Date	Actions
2017	Sign-off of “ <i>North West Shelf Flatback Turtle Conservation Program - Strategic Conservation Plan 2014-2021</i> ”
Oct 2018	First review
Oct 2020	Review and preparation of new draft plan
Oct 2021	Finalisation: <i>North West Shelf Flatback Turtle Conservation Program - Strategic Conservation Plan 2022-2029</i> ”

8 Conclusion

The NWSFTCP strategic conservation plan is a road map for the conservation of NWS flatback turtles over seven years. During this time several major actions will be completed that will provide the basis of the next plan. These essential components will include:

- flatback MUs defined;
- risk and vulnerability assessment;
- inventory of flatback nesting within the MU;
- design and operation of sampling strategy to determine impact;
- research and mitigation of several pressures; and
- initial foraging/in-water studies underway.

At the end of this plan it is expected that there is a better understanding of the level of pressures, and suspected pressures and that there is a more quantifiable means of assessing pressure. Ideally, those pressures that are currently listed as *High* can be down listed based on management strategies implemented during this plan.

9 Acknowledgements

This plan was greatly improved by comments from the NWSFTCP AC and the Expert Panel.

References

- AGARDY, M. T. 1991. Conserving sea turtles while building an ecotourism industry in Guinea Bissau, West Africa. In: SALMON, M. & WYNEKEN, J. (eds.) Proceedings of the Eleventh Annual Workshop on Sea Turtle Biology and Conservation. 26 February - 2 March 1991, Jekyll Island, Georgia. National Oceanic and Atmospheric Administration, National Marine Fisheries Service.
- ANON. 2011. WA Environmental Offsets Policy. Western Australian Government, Perth. Pp. 4. <http://www.epa.wa.gov.au/EPADocLib/WAEnvOffsetsPolicy-270911.pdf>.
- BENHARDOUZE, W., AKSISSOU, M. & TIWARI, M. 2012. Incidental captures of sea turtles in the driftnet and longline fisheries in northwestern Morocco. Fisheries Research, 127/128, 125-132.
- BIRTLES, A., CURNOCK, M., DOBBS, K., SMYTH, D., ARNOLD, P., MARSH, H., VALENTINE, P., LIMPUS, C., HYAMS, W., DUNSTAN, A., CHARLES, D., GATLEY, C., MANGOTT, A., MILLER, D. L., HODGSON, E. S. & KENDRICK, A. 2005. Towards sustainable management of dugong and turtle tourism. Phase II Final Report to the Commonwealth Department of the Environment and Heritage. Townsville: James Cook University.
- BOLTEN, A. B. 2003. Variation in sea turtle life history patterns: neritic vs. oceanic developmental stages. In: LUTZ, P. L., MUSICK, J. A. & WYNEKEN, J. (eds.) The Biology of Sea Turtles. Boca Raton: CRC Press, Inc.
- BOX, T. 2010. A Mechanistic Approach To Predicting Hatchling Sex Ratios Of The Flatback Turtle (*Natator depressus*). In Honours thesis. Western Australia: The University of Western Australia, Animal Biology; 2010.
- CAMPBELL, C. L. & LAGUEUX, C. J. 2005. Survival probability estimates for large juvenile and adult green turtles (*Chelonia mydas*) exposed to an artisanal marine turtle fishery in the western Caribbean. Herpetologica, 61, 91-103.
- CASALE, P., FREGGI, D. & ROCCO, M. 2008. Mortality induced by drifting longline hooks and branchlines in loggerhead sea turtles, estimated through observation in captivity. Aquatic Conservation, 18, 945-954.
- CHALOUPKA M. Y. & LIMPUS, C. J. 2001. Trends in the abundance of sea turtles resident in southern Great Barrier Reef waters. Biological Conservation 102, 235-249. CHALOUPKA, M., KAMEZAKI, N. & LIMPUS, C. 2008. Is climate change affecting the population dynamics of the endangered Pacific loggerhead sea turtle? Journal of Experimental Marine Biology and Ecology, 356, 136-143.
- CHENG, I. J. & CHEN, T. H. 1997. Incidental capture of five species of sea turtle by coastal setnet fisheries in eastern waters of Taiwan. Biological Conservation, 82, 235-239.

- DORAN, G. T. 1981. "There's a S.M.A.R.T. way to write management's goals and objectives". *Management Review*. 70 (11): 35–36.
- DREDGE, M. C. L. & TRAINOR, N. 1994. The potential for interaction between trawling and turtles in the Queensland east coast trawl fishery. In: JAMES, R. (ed.) *Proceedings of the Australian Marine Turtle Conservation Workshop, Gold Coast 14-17 November 1990*. Queensland Department of Environment and Heritage and Australian Nature Conservation Agency. Canberra: Australian Nature Conservation Agency.
- ENVIRONMENT AUSTRALIA. 2003. *Recovery plan for marine turtles in Australia*. Approvals and Wildlife Division, Environment Australia. Canberra.
- ENVIRONMENTAL PROTECTION AUTHORITY. 2006. *Environmental Offsets. Position Statement No. 9*. Environmental Protection Agency, Western Australian Government, Perth. Pp. 31.
- ENVIRONMENTAL PROTECTION AUTHORITY 2008. *Guidance of the Assessment of Environmental Factors (in accordance with the Environmental Protection Act 1986). Environmental Offsets – Biodiversity*. Environmental Protection Agency, Western Australian Government, Perth. Pp. 31.
- FUENTES, M. M. P. B., LIMPUS, C. J. & HAMANN, M. 2011. Vulnerability of sea turtle nesting grounds to climate change. *Global Change Biology*, 17, 140-153.
- GUNN, R., HARDESTY, B. D. & BUTLER, J. 2010. Tackling 'ghost nets': Local solutions to a global issue in northern Australia *Ecological management and restoration*, 11.
- HAMANN, M., GODFREY, M., SEMINOFF, J., ARTHUR, K., BARATA, P., BJORN DAL, K., BOLTEN, A., BRODERICK, A., CAMPBELL, L., CARRERAS, C., CASALE, P., CHALOUPKA, M., CHAN, S., COYNE, M., CROWDER, L., DIEZ, C., DUTTON, P., EPPERLY, S., FITZSIMMONS, N., FORMIA, A., GIRONDOT, M., HAYS, G., CHENG, I., KASKA, Y., LEWISON, R., MORTIMER, J., NICHOLS, W., REINA, R., SHANKER, K., SPOTILA, J., TOMAS, J., WALLACE, B., WORK, T., ZBINDEN, J. & GODLEY, B. 2010. Global research priorities for sea turtles: informing management and conservation in the 21st century. *Endangered Species Research*, 11, 245-269.
- HAWKES, L. A., BRODERICK, A. C., GODFREY, M. H. & GODLEY, B. J. 2007. Investigating the potential impacts of climate change on a marine turtle population. *Global Change Biology*, 13, 1-10.
- HAWKES, L. A., BRODERICK, A. C., GODFREY, M. H. & GODLEY, B. J. 2009. Climate change and marine turtles. *Endangered Species Research*, 7, 137-154.
- HAYS, G. C. 2008. Sea turtles: A review of some key recent discoveries and remaining questions. *Journal of Experimental Marine Biology & Ecology*, 356, 1-7.

- HAYS, G. C., BRODERICK, A. C., GLEN, F. & GODLEY, B. J. 2003. Climate change and sea turtles: a 150-year reconstruction of incubation temperatures at a major marine turtle rookery. *Global Change Biology*, 9, 642-646.
- HAYS, G. C., FOSSETTE, S., KATSELIDIS, K. A., SCHOFIELD, G. & GRAVENOR, M. B. 2010. Breeding Periodicity for Male Sea Turtles, Operational Sex Ratios, and Implications in the Face of Climate Change. *Conservation Biology* 24.6 (2010): 1636-1643.
- HUMBER, F., GODLEY, B. J., RAMAHERY, V. & BRODERICK, A. C. 2011. Using community members to assess artisanal fisheries: the marine turtle fishery in Madagascar. *Animal Conservation*, 14, 175-185.
- IUCN 2012. The IUCN Red List of Threatened Species. , IUCN.
- JOHNSON, S. A., BJORN DAL, K. A. & BOL TEN, A. B. 1996. Effects of Organized Turtle Watches on Loggerhead (*Caretta caretta*) Nesting Behavior and Hatchling Production in Florida. *Conservation Biology*, 10, 570-577.
- KAMROWSKI, R. L., LIMPUS, C., MOLONEY, J., & HAMANN, M. 2012. Coastal light pollution and marine turtles: assessing the magnitude of the problem. *Endangered Species Research*, 19, 85-98.
- KAMROWSKI, R. L., LIMPUS, C., JONES, R., ANDERSON, S., & HAMANN, M. 2014. Temporal changes in artificial light exposure of marine turtle nesting areas. *Global Change Biology*, 20, 2437-2449
- KAMROWSKI, R. L., LIMPUS, C. J., PENDOLEY, C. J. AND HAMANN, M. 2015. Influence of industrial light pollution on the sea-finding behaviour of flatback turtle hatchlings. *Wildlife Research*. 41, 421-434.
- KIESSLING, I. 2003. Finding solutions Derelict Fishing Gear and Other Marine Debris in Northern Australia. National Oceans Office and Department of Environment and Heritage.
- LIMPUS, C., & KAMROWSKI, R. L. 2013. Ocean-finding in marine turtles: the importance of low horizon elevation as an orientation cue. *Behaviour*, 150, 863-893.
- LUTCAVAGE, M. E., PLOTKIN, P., WITHERINGTON, B. & LUTZ, P. L. 1997. Human impacts on sea turtle survival. In: LUTZ, P. & MUSICK, J. A. (eds.) *The Biology of Sea Turtles*. Boca Raton: CRC Press Inc.
- MCFARLANE, G. & MUELLER, A. 2013. Satellite tracking of West Kimberley Flatbacks: Eco Beach and Eighty Mile Beach. In: Prince, B, Whiting, S., Raudino, H, Vitenbergs, A. and Pendoley, K. *Proceedings of the first Western Australian Marine Turtle Symposium*. 28-29th August 2012, Perth. Department of Parks and Wildlife.
- MORITZ, C. 1994. Defining 'Evolutionarily Significant Units' for conservation. *Trends in Ecology & Evolution*, 9, 373-375.

- NATIONAL RESEARCH COUNCIL. 2010. Assessment of sea-turtle status and trends: integrating demography and abundance. Washington, D.C., USA: National Academies Press.
- OECD 1993. OECD Core set of Indicators for Environmental Performance Reviews. Environmental monographs, number 83 (A synthesis report by the Group on the State of the Environment). OCDE/GD(93)179. Organisation for Economic Co-operation and Development. Paris, France. 39p.
- OED 2004. Monitoring and Evaluation. Some tools, methods and approaches. The International Bank for Reconstruction and Development. The World Bank. 1818 H Street, N.W. Washington, D.C. 20433, U.S.A. 26p.
- PENDOLEY K, SCHOFIELD G., WHITTOCK, P.A., IERODIACONOU D., HAYS, G. C. 2014a. Multi-species use of a coastal migratory corridor connecting Marine Protected Areas. *Marine Biology* 161, 1455–1466.
- PENDOLEY, K., BELL, C., MCCRACKEN, R., BALL, K., SHERBORNE, J., OATES, J. & WHITTOCK, P. 2014b. Reproductive biology of the flatback turtle *Natator depressus* in Western Australia. *End Spec Res*, 23, 115-123.
- PFALLER, J., BJORN DAL, K., CHALOU PKA, M., WILLIAMS, K., FRICK, M. & BOL TEN, A. 2013 Accounting for imperfect detection is critical for inferring marine turtle nesting population trends. *PLoS ONE* 8(4): e62326. doi:10.1371/journal.pone.0062326.
- PENDOLEY, K., AND KAMROWSKI, R.L. 2015. Influence of horizon elevation on the sea-finding behaviour of hatchling flatback turtles exposed to artificial light glow. *Marine Ecology Progress Series* 529: 279-288.
- PIKE, D. A. 2013. Climate influences the global distribution of sea turtle nesting. *Global Ecology and Biogeography*.
- PITTARD, S. 2010. Genetic Population Structure of the Flatback Turtle (*Natator depressus*): A Nuclear and Mitochondrial DNA Analysis. Bachelor of Applied Science (Honours), University of Canberra.
- POINER, I. R., BUCKWORTH, R. C. & HARRIS, A. N. M. 1990. Incidental capture and mortality of sea turtles in Australia's northern prawn fishery. *Australian Journal of Marine and Freshwater Research*, 41, 97-110.
- POINER, I. R. & HARRIS, A. N. M. 1994. The incidental capture and mortality of sea turtles in Australia's Northern Prawn Fishery. In: JAMES, R. (ed.) Proceedings of the Australian Marine Turtle Conservation Workshop, Gold Coast 14-17 November 1990. Queensland Department of Environment and Heritage and Australian Nature Conservation Agency. Canberra: Australian Nature Conservation Agency.
- POLOCZANSKA, E. S., LIMPUS, C. J. & HAYS, G. C. 2009. Vulnerability of Sea Turtles to Climate Change. *Advances in Marine Biology*, 56, 151-211.
- POLOVINA, J. J., BALAZS, G. H., HOWELL, E. A., PARKER, D. M., SEKI, M. P. & DUTTON, P. H. 2004. Forage and migration habitat of loggerhead (*Caretta caretta*) and olive ridley (*Lepidochelys olivacea*) sea turtles in the central North Pacific Ocean. *Fisheries Oceanography*, 13, 36-51.

- PRINCE, R. I. T. 2007. The leatherback turtle (*Dermochelys coriacea*) in Western Australian waters: history to December 2001 and the connections with fisheries. Rock Lobster Industry Advisory Committee Workshop, 2007 Perth. Western Australian Fishing Industry Council.
- ROBINS, C. M., GOODSPEED, A. M., POINER, I. R. & HARCH, B. D. 2002. Monitoring the Catch of Turtles in the Northern Prawn Fishery. Fisheries Research and Development Corporation Final Report. Canberra.
- ROBINS, J. B. 1995. Estimated catch and mortality of sea turtles from the East Coast otter trawl fishery of Queensland, Australia. *Biological Conservation*, 74, 157-167.
- SENKO, J., SCHNELLER, A. J., SOLIS, J., OLLERVIDES, F. & NICHOLS, W. J. 2011. People helping turtles, turtles helping people: Understanding resident attitudes towards sea turtle conservation and opportunities for enhanced community participation in Bahia Magdalena, Mexico. *Ocean & Coastal Management*, 54, 148-157.
- SEWPaC. 2011. EPBC Act Environmental Offsets Policy: Consultation Draft. Sustainability, Environment, Water, Populations and Communities, Australian Government, Canberra. Pp 19.
- SIMPSON, C., COLEMAN, J. & HILL, A. 2002. A Strategic Framework for Marine Research and Monitoring in the Shark Bay World Heritage Property: A framework funded by the World Heritage Unit, Environment Australia. Fremantle: Department of Conservation and Land Management.
- SIMPSON, C., COLMAN, J., FRIEDMAN, K., HILL, A., KENDRICK, A., WAPLES, K., WHITING, S. AND WILSON, S 2015. Prioritisation of conservation research and monitoring for protected areas and threatened species. *Science and Conservation*. 9: 227–237.
- SMITH, L. M. 2006. Management of tourism based on viewing nesting marine turtles in the Jurabi Coastal Park, Western Australia: an evaluation of the effectiveness of the Jurabi Turtle Experience. Honours, Murdoch University.
- STUBBS, J.L., KEARNEY, M.R., WHITING, S.D., MITCHELL, N.J. 2014.: Models of primary sex ratios at a major flatback turtle rookery show an anomalous masculinising trend. *Climate Change Responses*. 1:20–30
- SURYAN, R. M., SABA, V. S., WALLACE, B. P., HATCH, S. A., FREDERIKSEN, M. & WANLESS, S. 2009. Environmental forcing on life history strategies: Evidence for multi-trophic level responses at ocean basin scales. *Progress in Oceanography*, 81, 214-222.
- TEDESCHI, J. N., KENNINGTON, W. J., BERRY, O., WHITING, S., MEEKAN, M. AND MITCHELL, N. J. 2015. Responses of heat shock genes in Loggerhead turtle embryos (*Caretta caretta*) exposed to thermal stress. *Journal of Thermal Biology*. 47:42-50. DOI: 10.1016/j.jtherbio.2014.11.006.
- VAN DE MERWE, J., WEST, E. & IBRAHIM, K. 2012. Effects of off-road vehicle tyre ruts on the beach dispersal of green sea turtle *Chelonia mydas* hatchlings. *Endangered Species Research*, 18 27-34.

- WAAYERS, D. 2010. A Holistic Approach to Planning for Wildlife Tourism: A Case Study of Marine Turtle Tourism and Conservation in the Ningaloo Region, Western Australia. PhD, Murdoch University.
- WALLACE, B. P., DIMATTEO, A. D., HURLEY, B. J., FINKBEINER, E. M., BOLTEN, A. B., CHALOUPKA, M. Y., HUTCHINSON, B. J., ABREU-GROBOIS, F. A., AMOROCHO, D., BJORNDAL, K. A., BOURJEA, J., BOWEN, B. W., BRISENO DUENˆ, R., CASALE, P., CHOUDHURY, B. C., COSTA, A., DUTTON, P. H., FALLABRINO, A., GIRARD, A., GIRONDOT, M., GODFREY, M. H., HAMANN, M., LOPEZ-MENDILAHARSU, M., MARCOVALDI, M. A., MORTIMER, J. A., MUSICK, J. A., NEL, R., PILCHER, N. J., SEMINOFF, J. A., TROENING, S., WITHERINGTON, B. & MAST, R. B. 2010. Regional Management Units for Marine Turtles: A Novel Framework for Prioritizing Conservation and Research across Multiple Scales. PLoS ONE, 5, e15465.
- WATSON, J. W., EPPERLY, S. P., SHAH, A. K. & FOSTER, D. G. 2005. Fishing methods to reduce sea turtle mortality associated with pelagic longlines. Canadian Journal of Fisheries and Aquatic Sciences, 62, 965-981.
- WHITE, D. 2006. Marine Debris in Northern Territory Waters 2004, WWF Report. Sydney: WWF Australia.
- WHITTOCK, P. A., PENDOLEY, KL., HAMANN, M. 2014. Inter-nesting distribution of flatback turtles *Natator depressus* and industrial development in Western Australia. Endangered Species Research. 26, 25-39.
- WILLIAMS, J., L. 2011 A comparison of the thermal influence of hatching and emergence success in two major flatback (*Natator depressus*) rookeries in North Western Australia. 31st Annual Symposium on Sea Turtle Biology and Conservation, 2011 San Diego, California, U.S.A.
- WILSON, C. & TISDELL, C. 2001. Sea turtles as a non-consumptive tourism resource especially in Australia. Tourism Management, 22, 279-288.
- WITT, M. J., HAWKES, L. A., GODFREY, M. H., GODLEY, B. J. & BRODERICK, A. C. 2010. Predicting the impacts of climate change on a globally distributed species: the case of the loggerhead turtle. Journal of Experimental Biology, 213, 901-911.

Appendix 1 – Prioritisation and decision process

Prioritisation framework and decision process

This plan uses the prioritisation framework from the draft *Western Australian Marine Turtle Strategic Plan* (DBCA in prep) which prioritised actions across all species and management units derived from a system used by DBCA (modified from Simpson et al. 2015). This framework provides a decision support tool to prioritise management actions. The steps in the planning process and framework are described below.

Prioritisation Process

- A. Pressure-State-Response model is defined (sometimes called a condition, pressure, response model)
 - i. Assets are defined
 - ii. Pressures are defined
 - iii. Asset-pressure link described

- B. Prioritisation framework is used to determine conservation priorities (modified from Simpson et al 2015).

- C. Management objectives are determined from conservation priorities
 - i. Management targets are developed for the management objectives
 - ii. Management actions are defined within a framework which addressed each conservation priority and each management objective using one of five implementation strategies
 - a. Implementation strategies are: administration frameworks, education, intervention, research and monitoring).
 - b. Research is prioritised around conservation priorities and foundational needs.

A i. Assets defined

The assets for this pressure-state-response model are based on MUs. For flatback turtles the MUs were defined as summer and winter breeding, until finalisation of current genetic stock studies.

A ii. Potential pressures listed

Pressures are those processes that affect the condition of the asset. These can be natural processes or anthropogenic activities including climate change that impact on the MU. However, this plan has defined pressures as those anthropogenic or human activities impacting the MU.

Anthropogenic pressures on Western Australian marine turtles were identified from existing literature as being a potential or actual pressure on turtles over the next 10 years. International pressures have been included even though little direct management intervention is possible. However, the inclusion of these pressures provides a more complete picture and helps to progress cooperative initiatives such as the *Indian Ocean and South East Asian Sea Turtle Memorandum of Understanding* or cooperative research indicatives. For flatback turtles, international pressures are less important. The following is a list of all pressures used for the prioritisation of all turtle species, with the list in section 4 only containing those pressures for flatbacks ranked at high, moderate or low:

- Direct death or injury – dredging - port development
- Disturbance of turtles on beaches - tourism/people
- Global temperature increase - climate change
- Fishing bycatch (domestic)
- Fishing bycatch (international)
- Illegal or unregulated take outside Australia
- Indigenous harvest
- Introduced pests/feral animals
- Light - onshore and offshore sources
- Marine debris
- Marine habitat destruction - dredging - port development
- Modification of beaches - development
- Noise - dredging/piling - port development
- Noise - seismic
- Sea level rise - climate change
- Vessel strike and disturbance
- Water pollution (acute)
- Water pollution (chronic)

A iii. Asset – Pressure link described

A list of pressures was developed in consultation with turtle experts and managers throughout WA for all turtle species and management units described in the draft *Western Australian marine turtle strategic conservation plan*. This means that some pressures do not relate directly to flatback turtles, but as the matrix was run for all species and all pressures they have been included here for completeness. The combined species in the matrix also allow comparison of relative pressures. The description of each pressure is generalised for all species.

Direct death or injury – dredging - coastal development

This relates to recognised pressures associated with direct entrainment of turtles in dredging operations resulting in death or injury.

Disturbance of turtles on beaches - tourism/people

This is disturbance of females and hatchlings through tourism activities on beaches. This includes people on beaches during the night, tyre ruts left by vehicles driving on beaches, sand compaction or camp fires (van de Merwe et al., 2012, Johnson et al., 1996, Agardy, 1991, Wilson and Tisdell, 2001, Waayers, 2010, Smith, 2006, Senko et al., 2011, Birtles et al., 2005).

Global temperature increase - climate change

This pressure specifically relates to the pressures of increased sand, water and air temperatures and the impacts on sea turtle biology and ecology. The most documented impacts include those related to the incubation period including feminisation for hatching ratios, higher egg embryo mortality (Hays et al., 2003, Hawkes et al., 2007, Williams, 2011, Fuentes et al., 2011, Poloczanska et al., 2009, Tomillo et al., 2012, Witt et al., 2010, Hawkes et al., 2009, Pike, 2013) but others including decreased food supplies and changes to breeding periodicity have been predicted (Chaloupka et al., 2008, Hawkes et al., 2007, Hays et al., 2010, Hays, 2008, Suryan et al., 2009, Witt et al., 2010, Pike, 2013, Hawkes et al., 2009)

Fishing bycatch

This pressure includes all turtle bycatch from active fisheries. It includes both domestic and international bycatch. This includes trawl gear, set nets, line fishing and trap fishing (Poiner et al., 1990, Robins, 1995, Guinea et al., 1997, Poiner and Harris, 1994, Dredge and Trainor, 1994, Cheng and Chen, 1997, Polovina et al., 2004, Campbell and Lagueux, 2005, Troëng and Chaloupka, 2007, Benhardouze et al., 2012, Casale et al., 2008, Humber et al., 2011, Watson et al., 2005, Prince, 2007). This relates to all fishing activities impacting on the MU, it is not limited to activities occurring inside state waters. It does not include impacts of turtles caught in ghost nets which is included in marine debris.

This category includes domestic and international bycatch.

Illegal or unregulated take outside Australia

This includes all active take of turtles outside of Australia. In most cases this is illegal, in some cases it may be legal and for subsistence purposes, but it is unregulated. This may be occurring within state boundaries (for example Browse Island) or occurring in neighbouring jurisdictions. This pressure has limited impact on NWS flatbacks but does impact other flatback MUs.

Indigenous harvest

Indigenous harvest refers to harvest of turtles by Indigenous Australians, permitted under the *Native Title Act* section 211 for customary purposes. For flatback turtles this is usually restricted to egg collection.

Introduced pests/feral animals

This relates to all impacts from introduced or feral pest species. Most commonly this refers to terrestrial species which predate on eggs and hatchlings and includes foxes, feral dogs, mixed bred dingoes, cats and pigs.

Light - onshore sources and offshore sources – coastal development

Onshore sources refers to the impacts of industrial and urban onshore light sources that may impact on hatchling or adult female turtles at the nesting beach. Impacts to positive photo taxis hatchlings will be on behaviour and potential survivorship by being attracted to lights while making their way from the nest to the water, or changes of behaviour once the hatchlings are in the water (Kamrowski et al 2012; Limpus 2013; Kamrowski et al 2014; Pendoley and Kamrowski 2015; Kamrowski et al 2015). Impacts to nesting females could occur during their negative photo taxis period prior to nesting or their photo positive period post-nesting while making their way to the water. The first could lead to aversion to a beach while the second could lead to risks to health through disorientation.

Offshore sources refers to the impacts of industrial and vessel light from offshore sources that may impact on hatchlings during their frenzy swimming phase when they leave a beach. These could include ports, jetties, and vessels. Impacts usually include behavioural changes of hatchlings causing disorientation or misorientation that may make them more vulnerable to predation in the nearshore environment or behavioural changes that may cause hatchlings to be detained in light pools.

Marine debris (ghost nets and other debris)

Marine debris is the discarded anthropogenic waste floating in the ocean. It ranges in size from microscopic to several kilometres of discarded fishing nets (ghost nets). Sea turtles are impacted through ingestion of particles that may block the digestive tract, poison the animal, entangle and drown or starve the animal. Entanglement is common in northern Australian waters (KieSSLing, 2003, White, 2006, Gunn et al., 2010).

Marine habitat destruction – coastal development

This refers to destruction or modification of habitat from dredging activities. This may include physical habitat removal or smothering of habitat by suspended material, groins or jetties (Lutcavage et al. 1997).

Modification of beaches – coastal development

Modification of beaches refers to significant changes in the physical structure of beaches or composition from sources such as coastal building, changes caused by solid jetties or groins, sediment composition from dredging actions and clearing of vegetation. (Lutcavage et al. 1997)

Noise - dredging/piling - port development

This pressure relates to noise associated with port construction primarily from dredging and piling sources. This includes physical injury to turtles as well as disturbance and exclusion from preferred habitat.

Noise – seismic

This relates to the unknown impact of seismic noise on marine turtles. This requires further evidence to understand the potential impacts including physical injury and disturbance.

Sea level rise and altered storm frequency - climate change

This pressure relates specifically to sea level rise and the impact of changes to nesting habitat such as shifts in nesting beaches or inundation of nesting beaches. It should consider the vulnerability of habitat specific to each MU.

Vessel strike and disturbance

This relates to all vessel movements that impact on turtles, either directly through mortality or injury, or indirectly through disturbance.

Water pollution (acute)

This category relates to acute events such as spills of toxic chemicals, hydrocarbons and fertilisers.

Water quality (chronic)

This pressure relates to the chronic pollution occurring continuously. This includes chemical pollution often observed in urban centres, modified catchments and ports. Common sources are sewage outfalls, storm water runoff from towns and agricultural lands as well as ports and ore loading facilities.

B. Prioritisation matrix

A prioritisation matrix was used to score Values and Pressures (modified from Simpson et al. 2015).

The following equation was used to determine the conservation and monitoring priorities:

- Value (V) * Pressure (P)

Those MUs of high value and high pressures scored high and were ranked high in conservation priority.

Values of the asset (criteria for scoring)

The values described here are adopted from Simpson et al (2002) with the exception “Trophic Status” which was replaced with Functional Importance (Table 7). The framework provides a score for each MU and value. Scores are based on 3= High, 2= Moderate and 1= Low.

Table 7. Value (V) criteria - definitions

Ecological Significance	Functional Importance	E1	This is the importance of turtles to habitats and ecosystems at a large scale. For example, green turtles are dominant drivers of nutrient cycling in seagrass and algae systems and would score a 3.
	Areal extent or biomass	E2	This refers to the extent of the asset. If the management unit is widespread in their distribution they would high.
	Vulnerability	E3	This refers to their susceptibility to degradation by natural events and or human pressures. MUs with degraded populations from historic pressures could score higher here.
	Recovery potential	E4	Recovery potential can be measured in terms of resilience (measured as the maximum stress from which a value can recover) and stability (measured as the rate of recovery from a stress). Attributes with a low recovery potential will score high for this criterion and vice versa. Slower breeding species could score lower in this criteria.
Biodiversity Significance	Locally	B1	Locally significant - nesting and/or foraging numbers
	Regionally	B2	Regionally significant - nesting and/or foraging numbers.
	Nationally	B3	MU is nationally significant – the size of nesting populations and/or foraging populations are significant nationally.
	Globally	B4	MU is globally significant – the size of whole nesting populations and/or foraging populations are significant globally.
Social Significance	Culturally	C1	Management units with existing or potential importance to the local, regional, national or international communities because of their heritage, historical, traditional, aesthetic and educational qualities will score high against this criterion. The species that are embedded within Aboriginal culture would score high.
	Economic	C2	Management units that have existing or potential economic importance will score high against this criterion. Examples of MUs that would score high would be those that support or contribute to important nature-based tourism.
	Scientific	C3	Management units that have particular significance for scientific study at local, regional, national and international scales. Most of the accessible MUs would score high based on access.
	Recreational/ Education	C4	MUs that have existing or potential importance as resources for recreational activities. For example, populations with nature based recreation such as watching nesting turtles or diving with turtles.

Pressures on the asset (criteria for scoring)

This section describes the criteria for scoring the impact of the pressures on the values of the MU (Table 8). These criteria follow Simpson 2002, with the exception that Biological Intensity (Simpson et al., 2002) was replaced with replaced with Life Stage.

Table 8. Pressures criteria – definitions

Pressure Category	Code	Description
Life Stage	P1	This criterion refers to life stage that is being impacted by the pressure. Eggs and hatchlings =1, immature turtles = 2, adult turtles =3. For example, a MU with predation on eggs would score 1 while predation of adults would score 3. For those pressures which include several life stages, a score based on the greatest impact would be used. This criterion acknowledges that impacts at early life stages potentially have less impact.
Spatial Scale or proportion of the population	P2	This criterion acknowledges that, in general, the greater the spatial extent of the pressure the greater the management concern (i.e. widespread impacts versus localised impacts) or the higher the proportion of the population impacted the higher the impact and score. For example marine debris may score high while a small number of illegally harvested adult turtles from the small Scott Reef MU may also score high because the pressure impacts the whole breeding component of the MU
Temporal Scale	P3	This criterion acknowledges that pressures that are on-going (i.e. chronic) are generally of greater management concern than pressures that are short-lived. Chronic or high frequency pressures will score high whereas low frequency pressures will score low for this criterion.
Consequence (social and political)	P4	This criterion acknowledges that different pressures have different social and political consequences. A high socio-economic/political consequence will score high and vice versa for this criterion.
Probability	P5	This criterion addresses the probability of a pressure occurring within the timeframe of the management plan. Existing pressures or a high probability of a pressure occurring will score high and a low probability of a pressure occurring will score low.

9.1.1 Knowledge gaps (criteria for scoring)

Knowledge gaps (Table 9) in the matrix are used later in the process to define research priorities (Simpson et al. 2002). We have modified the calculation used in Simpson et al (2002) slightly for simplicity. In Simpson et al. (2002), the adequacy of existing knowledge was positively correlated with the score (E.g. a lot of knowledge equalled 3). That meant the score needed to be subtracted from the total possible score to determine the relative inadequacy of existing knowledge. This plan modified

the terminology from “Knowledge” to “Knowledge gaps” to simplify the equation. Lack of knowledge or knowledge gaps now receives a high score. For example, areas where knowledge is needed scores a “3” and where it is less essential scores a “1”.

Table 9. Knowledge gaps criteria– definitions

Knowledge Category	Code	Description
Inventory	K1	This assesses the existing level of resource information required for this MU. Inadequate inventory data for a value-pressure will result in a high score.
Baseline Data	K2	This assesses whether adequate quantitative baselines exist to determine the spatial and temporal extent and cause/s of natural variation. These data are needed to distinguish between natural variation and human impacts. Adequacy of baseline is measured both in spatial and temporal terms. Lack of long term spatially representative baselines would score high.
Monitoring Parameters	K3	This criterion assesses whether adequate information exists to identify monitoring parameters. This information flows from process studies that provide an adequate understanding of key maintenance processes (e.g. growth and reproduction) of major structural components of the ecology and from studies that link natural or human ‘forcing factors’ with changes in the ecology or human use of an area; the ultimate aim being the identification of clear cause-effect links. Monitoring parameters may be direct measures of a value such as population estimates. If current knowledge is inadequate for appropriate monitoring parameters to be readily identified, a high score would be recorded.
Management Targets	K4	This criterion assesses whether the level of knowledge is adequate to formulate appropriate management ‘triggers’ and targets. Targets will be either the ‘natural’ state or some acceptable departure from the ‘natural’ state (i.e. Limits of Acceptable Change (LAC) approach). If the target is the ‘natural’ state or within the limits of natural variability this criterion would be scored low. The score will increase as the departure of target from the ‘natural’ state widens or as the level of understanding of the cause effect pathways decreases (i.e. declining level of confidence in being able to set an ‘acceptable’ level of change).

20170359 1117 100

