



Long Term Turtle Management Plan

Annual Report 2016

Prepared for
QGC, APLNG and GLNG

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Abbreviations

Abbreviation	Description
APLNG	Australia Pacific LNG
DEHP	Queensland Department of Environment and Heritage Protection
DotE	Commonwealth Department of the Environment
ELA	Eco Logical Australia
ERMP	Ecosystem Research and Monitoring Program
FED	Fox Exclusion Device
GISERA	Gas Industry Social and Environmental Research Alliance
GLNG	Santos GLNG
GPC	Gladstone Ports Corporation
JCU	James Cook University
LNG	Liquefied Natural Gas
QGC	Queensland Gas Company
UQ	The University of Queensland

Executive summary

The LNG Proponents of Queensland Curtis LNG (QGC), Australia Pacific LNG (APLNG) and Santos GLNG (GLNG), are implementing a Long Term Turtle Management Plan (LTTMP) in accordance with approvals granted under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

This annual review report has been prepared for the Department of the Environment to provide an update on progress and report on the effectiveness of the management measures and operating controls directed at avoiding impacts on the marine turtle species. Submission of this annual report achieves compliance with Condition 56 of EPBC 2009/4977 (APLNG), Condition 38 of EPBC 2008/4402 (QGC) and Condition 38 of EPBC 2008/4057 (GLNG).

Across the three LNG projects, the construction workforce has reduced with the commissioning of new trains and commencement of export activities. Construction work at the QGC and GLNG facilities has been completed, with both facilities now having two trains in production. There is one train in production at the APLNG facility, with a second train currently under construction and due to commence production during the second half of 2016.

Eco Logical Australia Pty Ltd (ELA) has been contracted by the LNG Proponents to implement the monitoring tasks in the LTTMP. The LNG Proponents have also been progressing the completion of various monitoring tasks through various initiatives such as the Gladstone Ports Corporation (GPC) Ecosystem Research and Monitoring Program (ERMP) which is part of the Western Basin dredging project, and the Gas Industry Social and Environmental Research Alliance (GISERA). Some long term monitoring tasks have been progressed by other organisations such as GPC and the Department of Environment and Heritage Protection (DEHP).

A gap analysis identifying existing monitoring tasks and those scopes yet to be completed by the LNG Proponents has been prepared.

Findings of the initial monitoring are summarised as follows:

- Monitoring of nesting flatback turtles at Curtis Island and Avoid Island indicates nesting activity and incubation success is consistent with that recorded prior to the construction of the LNG facilities
- Incidental observations during the 2015-16 nesting census on Curtis Island identified that flatback hatchlings from some clutches displayed disrupted ocean-finding behaviour, heading towards the Gladstone-wide inland light horizon
- Flatback hatchlings emerging from nests within the swale section of the dune at Curtis Island (n=2) may be prone to disorientation or misorientation, due to the visual cues in this part of the system
- Foraging green turtles in Port Curtis have small and variable home ranges which have little overlap with the main shipping channel
- The inter-nesting habitat of flatback turtles has a high degree of overlap with sections of the main shipping channel located east of Barney Point
- Health surveillance of green turtles indicates that the Port Curtis population has made a partial but incomplete recovery from a major flood event in 2011

A work program for the 2016 and 2017 calendar years has been established. Contracts between ELA and various subconsultants including DEHP, the University of Queensland and Pendoley Environmental are currently being prepared for implementation.

The LTTMP risk assessment has been reviewed in light of the shift in project phases from construction to early operations. Most risks were assessed to have remained the same, with some risks related to vessel strike reduced due to the reduction in construction-related vessel movements.

Risks to inter-nesting flatback turtles were reaffirmed to be 'medium' on the basis of satellite tracking demonstrating a large degree of overlap with their inter-nesting habitats and the main shipping channel of Port Curtis. Risks of light impacts from increased Gladstone-wide sky glow were also reaffirmed to be 'medium' on the basis that reductions in construction lighting have been offset by increased light from flaring during the commissioning and operations phases.

1 Introduction

1.1 Background

Queensland Curtis LNG (QGC), Australia Pacific LNG (APLNG) and Santos GLNG (GLNG), hereafter referred to as the LNG Proponents, were granted approvals under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) to construct and operate new LNG facilities at Curtis Island, Queensland. The approvals followed the completion of extensive environmental studies and assessments as part of three separate environmental impact statement processes.

Conditions of approval for each LNG facility require the development and implementation of a Long Term Turtle Management Plan (LTTMP), to provide for appropriate management of marine turtles. The relevant EPBC Act approval conditions are Conditions 34-39 of EPBC 2008/4057 (GLNG), Conditions 34-39 of EPBC 2008/4402 (QGC) and Conditions 52-57 of EPBC 2009/4977 (APLNG). The approval conditions specify that the LTTMP must be submitted for the approval of the Commonwealth Minister for the Environment within three months of commissioning each LNG facility.

The EPBC Act approval conditions encouraged the LNG Proponents to take a collaborative approach in developing and implementing the LTTMP, rather than administering separate plans for their respective projects. A joint LTTMP was therefore developed by the LNG Proponents and was approved by the relevant Minister on 2 July 2014 (Revision 3). The LTTMP was subsequently amended, with the revised version (Revision 4) approved by the Minister on 3 August 2015.

Approval conditions state that within 60 days of each anniversary of the approval of the LTTMP, the LNG Proponents must provide a review report on the effectiveness of the management measures and operating controls directed at avoiding impacts on the marine turtle species. This annual report has been prepared to meet the requirements of these conditions.

Consultation with the Department of the Environment has clarified that the original LTTMP approval date (2 July 2014) is the date of relevance in relation to submission of the annual review report. The report must therefore be submitted to the Department each year on or before 31 August (60 days following 2 July).

1.2 Status of QGC, APLNG and GLNG Projects

Construction work at the QGC and GLNG facilities has been completed, with both facilities now having two trains in production. There is one train in production at the APLNG facility, with the second train currently under construction and due to commence production during the second half of 2016. During the current reporting year, GLNG commenced shipment of LNG from its facility in October 2015, with APLNG commencing shipments in January 2016.

Across the three LNG projects, the construction workforce has reduced with the commissioning of new trains and commencement of export activities. This has led to an associated reduction in vessel movements between Curtis Island and the mainland. The number of LNG carriers exporting LNG from the three facilities is gradually increasing. This trend will continue over the next one to two years, with each facility being visited by two to three LNG carriers per week.

2 Appointment of Consultant

2.1 Update on progress



In August 2015, the LNG Proponents sought proposals from suitably qualified consultants to implement the LTTMP, through a competitive tender process. In early 2016, Eco Logical Australia Pty Ltd (ELA) was chosen as the successful company, and a contract between ELA and the three LNG Proponents was executed in April 2016. A project inception meeting was held on 13 May 2016, and subconsultant agreements between ELA and other project team parties are currently being prepared for execution.

Prior to the appointment of ELA, the LNG Proponents have been progressing the completion of various monitoring tasks required under the LTTMP. These were funded by the LNG Proponents and delivered through various initiatives such as the Gladstone Ports Corporation (GPC) Ecosystem Research and Monitoring Program (ERMP) which is part of the Western Basin dredging project, and the Gas Industry Social and Environmental Research Alliance (GISERA). A summary of these projects and their initial findings is provided in Section 3.

The appointment of ELA will result in the direct commissioning of additional monitoring tasks from 2016 to meet the requirements of the LTTMP monitoring plan. ELA will also work closely with other organisations conducting monitoring of turtles and their habitat in the Gladstone region, including GPC and DEHP.

2.2 Experience and Qualifications of Team

ELA will lead a team of internal staff and external sub-consultants to continue the implementation of the LTTMP monitoring tasks and to provide reporting and reviews in accordance with EPBC Act approval conditions. The project team is highly familiar with the LTTMP and related turtle monitoring activities occurring under the GPC ERMP. A summary of the project team and their qualifications and experience is provided below.

Internal ELA Staff	
	<p>Miles Yeates (project manager and lead author) is a Principal Environmental Consultant with a career spanning 18 years across consulting and government roles. Miles was the lead author of the LTTMP and has an intimate knowledge of its content and links with other plans. Miles also recently assisted all three LNG Proponents in the development of their shipping management plans for Gladstone. In a previous government role as Regional Manager Moreton Bay, Miles led a program of turtle management for the Queensland Parks and Wildlife Service, overseeing marine stranding responses (300+ turtles per year), necropsies, planning and implementation of turtle and dugong 'go slow areas' and the assessment of development applications.</p>
	<p>Dr Ailsa Kerswell (project director and reviewer) has extensive experience with EPBC Act approvals, having worked at the Department of the Environment in their (then) Ports and Marine section. Ailsa has developed management and monitoring plans for sites throughout Australia and has undertaken several policy updates and reviews. She is regularly engaged to peer review environmental approvals documentation and biological monitoring reports and data, particularly for marine and coastal projects. Ailsa has also worked as field-based marine ecologist, undertaking both marine ecotoxicology studies and marine turtle surveys.</p>



Rebecca McCracken is an ecologist with considerable marine turtle experience, having previously planned, coordinated and implemented a range of marine turtle research and monitoring programs for resource clients. Rebecca is familiar with the statistical analysis of marine turtle field data and has written and reviewed high quality scientific reports to comply with environmental approval requirements. Rebecca has presented at international, national and state marine turtle conferences, and also has experience in other marine areas, including her involvement with the upgrade of Rio Tinto Iron Ore’s Dampier and Cape Lambert ports in Western Australia. Rebecca will provide technical marine turtle expertise for both field and reporting aspects of the project.



James Leonard, (junior ecologist), has led marine turtle field survey teams on beaches located within oil and gas projects and at remote field sites. He has experience in conducting research and monitoring programs relating to the tagging of nesting flatback turtles, the impacts of anthropogenic light on nesting turtles and emerging hatchlings, beach census of turtle tracks and turtle reproductive success (clutch marking and monitoring). James has undertaken the statistical and spatial analysis of marine turtle field data. James will provide field support for the project.








Phillipa Tompson is an ecologist who has worked at remote sites conducting marine turtle monitoring programs on behalf of oil and gas clients. Her field expertise is associated with monitoring of nesting flatback and green turtles (including tagging and DNA collection), beach track counts, in-water turtle observations and hatchling lighting research trials. Phillipa also has experience in coastal foreshore planning and management programs. Phillipa will provide field and reporting support for the project.



Mark Vile (principal environmental consultant) has 15 years of experience in the provision of environmental services to the resources sector. He is ELA’s Australian-wide Resource Sector Leader, and comes from both a consulting and an industry background, having previously held roles with Resource Strategies, Santos and BHP Billiton Iron Ore. He has worked on some of the most economically significant and challenging natural gas projects across Australia, including the GLNG Curtis Island Project and Narrabri Gas Project. Of specific relevance is his role with Santos’ EIS for the Curtis Island GLNG facility and marine pipeline crossing. Mark will provide expert advice on environmental impacts associated with the project.

Subconsultants / Research Team

	<p>Assoc. Prof. Col Limpus is Chief Scientist of the Threatened Species Unit at the Queensland DEHP and is an Adjunct Assoc. Prof. at the School of Veterinary Science, University of Queensland. Since 1976, Dr Limpus has conducted pioneering conservation and management research and education programs for marine turtles in Australia and overseas. Dr Limpus' current research activities involve nesting flatback turtles at Curtis Island, foraging turtles within Port Curtis and he is an independent expert on the GPC ERMP. Col will provide technical direction and implementation of selected turtle research tasks and expert advice as necessary. His team will be engaged through the DEHP as a subcontractor.</p>
	<p>Dr Helen Owen (veterinarian) is a lecturer in veterinary pathology in the School of Veterinary Sciences and a veterinary pathologist with 9 years' experience, both in Australia and the UK. Her current interests in this field include pathological investigation of dugong mortality and turtle histopathology. Helen will undertake turtle necropsies and boat strike examinations and provide strategic veterinarian advice. She will be engaged as a service provider through the University of Queensland.</p>
	<p>Dr Mark Flint (veterinarian) is the Director of the Veterinary Marine Animal Research, Teaching and Investigation program, and an Adjunct Senior Lecturer in the School of Veterinary Science at the University of Queensland. Mark is currently in Florida, where he holds a position as a Research Assistant Scientist in Coastal and Marine Sciences at the University of Florida. Mark's research areas focus on identifying prevalent and emerging diseases in marine and freshwater animal species as they relate to environmental and commercial stressors. Mark was a co-author of the LTTMP. He will lead the health assessment of green turtles in Gladstone Harbour and provide expert review services for the turtle necropsy and pathology reports. He will be engaged as a subcontractor through the University of Queensland.</p>
	<p>Assoc. Prof. Caroline Gaus leads a group of research scientists at the National Research Centre for Environmental Toxicology, Brisbane. She specialises in contaminant formation and transport processes of wildlife, involving state-of-the-art chemistry and modelling tools, combined with experimental and field-based scientific approaches. Caroline's team is currently undertaking extensive toxicology work on the blood of Green Turtles within Gladstone Harbour (a Turtle Plan monitoring task), and will be engaged as a service provider through the University of Queensland to continue this work in accordance with Turtle Plan objectives.</p>
	<p>Dr Kellie Pendoley has over 30 years' experience as an environmental practitioner within the oil and gas and mining industries in Western Australia. She has participated in the environmental management of multiple large-scale oil and gas developments in WA, providing advice on all aspects of development from seismic programs through to exploration drilling, production drilling, oil spill contingency planning, dredging, onshore and offshore construction and plant operations. Kellie's PhD studies were on marine turtles and the environmental management of industrial activities in the north-west of Western Australia, centred on the Barrow Island, Lowendal Island and Montebello Island groups. Pendoley Environmental will be engaged to conduct sky-glow assessments on Curtis and Facing Islands, and provide technical advice as required.</p>

2.3 Approach to Administration

The LNG Proponents have been engaging with key stakeholders relating to turtle conservation and management since early 2011. ELA's implementation of the LTTMP will be overseen by the LNG Proponents through a project steering committee. A project manager from QGC will liaise with the ELA project manager as part of the day to day administration of the project. The costs of implementing the LTTMP will be shared equally among the three LNG Proponents, with ELA to directly invoice each company on a monthly basis for the services provided.

In the event that it is necessary for an independent expert or panel to be established as described in Section 5.5 of the LTTMP, ELA will facilitate that process. ELA will also prepare a joint annual report on the LTTMP (of which this report is the first), which will be submitted to the Department by each LNG Proponent. ELA will also complete biannual (minor) and five yearly (major) reviews as outlined in Section 6 of the LTTMP. The first biannual review will be completed in 2017.

2.4 Consultation with Stakeholders

ELA and the LNG Proponents have been actively consulting with key stakeholders of the LTTMP. Consultation is important to maximise the conservation benefits of the scientific information collected during the project, enhance community knowledge of the monitoring activities, avoid duplication and provide synergies with existing research programs in Port Curtis. Recent consultation has involved the following key stakeholders:

- The ERMP Advisory Panel, which directs the scientific program of the ERMP
- GPC
- DEHP
- Queensland Parks and Wildlife Service
- South End Progress Association (Curtis Island local community)
- Quoin Island Turtle Rehabilitation Centre
- Gladstone Area Water Board Rehabilitation Centre
- Gidarjil Rangers

3 Completed Studies

3.1 Overview

The primary objectives of the LTTMP with respect to monitoring are to:

- Quantify the indicators of turtle population status at the start, throughout and at the conclusion of the 10 year life of the management plan through the development of independent monitoring programs and integrating with existing programs
- Have the adaptive ability to identify early and mitigate activities which may cause harm to marine turtle populations, based on the findings of monitoring
- Provide rigorous scientific information to assist in the sustainable management of marine turtle populations and their habitats within the Gladstone region.

In recent years, the LNG Proponents have been working with key stakeholders to progress and implement the monitoring tasks described in the LTTMP, by funding the completion of several studies on marine turtles and their habitats. This section provides a summary of these studies, how they have addressed the requirements of the LTTMP and discusses their findings in relation to the management of marine turtles in the Gladstone region. Further details of the monitoring results are available in technical reports provided in Appendix A. Where monitoring has identified any implications for the management of the LNG projects, such findings are discussed.

In future years, a more detailed analysis of the monitoring results will be provided once sufficient data are collected to allow the analysis of trends. The first biannual (minor) review of the LTTMP will be completed in 2017 and will involve an assessment of all baseline data available, and whether the objectives of the monitoring tasks are being met. Some refinements to the monitoring plan may be recommended at that time in consultation with turtle specialists, to maximise the benefits of the monitoring plan for marine turtle conservation and management.

3.2 Flatback Turtle nesting at Curtis Island and Avoid Island

Flatback turtle (*Natator depressus*) monitoring has been undertaken by DEHP at the rookery of Curtis Island for decades, with financial support from GPC since 1994. The GPC ERMP funded the most recent assessment at Curtis Island during the 2015-16 nesting season. Three years of monitoring has also been completed at the Avoid Island control site with funding support of the GPC ERMP, with two years of monitoring pre-dating this period, funded by the Queensland Trust for Nature and various research partners. Technical reports for Curtis Island and Avoid Island for the 2013-14, 2014-15 and 2015-16 nesting seasons are provided in Appendix A (Fitzsimmons and Limpus 2014, 2015, 2016; Limpus *et al.* 2014, 2015, 2016).

Monitoring has generally occurred over a period of four weeks each season, comprising two weeks during nesting (late November to mid-December) and two weeks during hatching (February-March). In some years, the formation of tropical cyclones has forced the evacuation of field teams from coastal regions and the suspension of monitoring activities (particularly during hatching). Results of the 2013-14, 2014-15 and 2015-16 mid-season monitoring at Curtis Island and Avoid Island are summarised in Table 1 and Table 2 respectively, in relation to baseline data available to ELA at the time of reporting.

South End Beach (Curtis Island) and South Beach, Middle Beach and North Beach (Avoid Island) were monitored nightly for at least six hours, beginning at least two hours before high tide. All turtles encountered were checked for tags, and tagged with titanium tags and Passive Integrated Transponder

(PIT) tags as necessary, and were measured. At Curtis Island, clutches at risk from flooding were relocated further up the dune within one hour of being laid and their eggs counted.

Fox exclusion devices (FEDs) made from standard plastic garden mesh were also laid horizontally at the beach surface over a number of nests to prevent feral predation (Limpus *et al.* 2014, 2015). As feral predators are absent from Avoid Island, predator exclusion work was not undertaken (Fitzsimmons and Limpus 2014).

Curtis Island was also examined twice daily (at dawn and late afternoon) to count nesting crawls, to locate hatchling emergence and identify daylight nesters (Limpus *et al.* 2014, 2015). The beaches were revisited during February/March to assess the incubation success of clutches (both rookeries) and the effectiveness of FEDs in protecting the clutches from feral predation (Curtis Island only). Standard Queensland Turtle Conservation Project methodologies (Limpus *et al.* 1983; Limpus 1992 as cited in Limpus *et al.* 2015) were followed.

The Curtis Island rookery has been monitored intermittently since 1969, with annual monitoring commencing in 1994 with support from GPC (Limpus *et al.* 2015). Monitoring at Curtis Island continues to indicate that the eastern Australian flatback turtle stock has had a stable breeding population over recent decades (Limpus *et al.* 2015). The number of flatback turtles utilising the nesting beach at South End Curtis Island has been relatively stable in recent years and consistent with those recorded in previous decades (Table 1; Figure 1). Full reports are provided in Appendix A.

Limpus *et al.* (2015) reported that nesting attempts during daylight hours were more common during the 2013-14 and 2014-15 breeding seasons than has previously been recorded at Curtis Island, with 26.9% of beachings occurring in daylight. However, this result was not replicated in 2015-16, when only 7% of beachings occurred during daylight hours.

Dogs destroyed at least nine clutches during the 2013-14 breeding season at Curtis Island (Limpus *et al.* 2014). There was no evidence of feral predation of clutches during the 2014-15 season. However signs of dog and fox presence were recorded. The Queensland Parks and Wildlife Service conducted dog trapping and fox baiting during this season. This action, together with the FEDs, appears to have been successful in reducing feral predation of clutches (Limpus *et al.* 2015).

Cyclone Dylan crossed the Queensland coast on 21 January 2014, and in conjunction with very high spring tides, resulted in severe beach erosion coinciding with the peak hatchling emergence period for clutches laid in late November - early December 2013. It is believed that approximately 38% of clutches laid during December 2013 and January 2014 were destroyed due to Cyclone Dylan (Limpus *et al.* 2014).

While monitoring incubation success of clutches at Curtis Island, flatback hatchling tracks were recorded leading away from some nests and heading inland away from the sea on some days (Limpus *et al.* 2016). The authors noted this was evidence of disrupted ocean-finding behaviour, caused by lights within the Gladstone and Port Curtis region and the associated sky glow. Such results warrant more detailed monitoring in 2016-17, as is proposed and described in Sections 4.3.2 and 4.3.3. There has been ongoing expansion in industrial and residential development within the Gladstone region in recent years, which may have contributed to increased sky glow.

Table 1 Summary of flatback turtle monitoring results (two-week census period) from Curtis Island (Limpus et al. 2014, 2015, 2016)

Monitoring variable	Baseline* (mean ± SD)	2013-14	2014-15	2015-16
Nesting females	62.0 ± 9.8 (n=5)	70	42	44
Nesting females - first time tagged	5.5 ± 1.9 (n=4)	17	12	7
Mean tracks per night ± S.D	5.5 ± 1.4 (n=5)	5.1 ± 2.8 (n=15)	4.6 ± 3.8 (n=14)	4.4 ± 2.0 (n=14)
Remigration interval (y) ± S.D	2.6 ± 0.6 (n=5)	3.2 ± 1.4 (n=50)	3.1 ± 1.7 (n=31)	2.8 ± 2.1 (n=35)
Inter-nesting interval (d) ± S.D	14.9 ± 2.0 (n=4)	14.1 ± 3.6 (n=18)	14.2 ± 2.2 (n=13)	13.8 ± 1.6 (n=15)
Average clutch size ± S.D	55.7 ± 0.9 (n=5)	55.1 ± 7.5 (n=48)	56.0 ± 11.7 (n=34)	56.8 ± 9.8 (n=44)
Hatching success (%) ± S.D	65.0 (n=1)**	77.4 ± 23.3 (n=47)	79.1 ± 24.2 (n=40)	87.7 ± 10.4 (n=47)
Emergence success (%) ± S.D	64.8 (n=1)**	77.4 ± 23.3 (n=47)	78.6 ± 24.3 (n=40)	86.4 ± 10.6 (n=47)

*Baseline: based on currently available survey reports (1999, 2000, 2002, 2005, 2006) from prior to construction which commenced in mid-2010 (1998/99, 1999/00, 2001/02, 2004/05 and 2005/06 breeding seasons). Data were from the approximate two-week peak census period only. Data were not available for all parameters or for all seasons. **Data available from 2005/06 season only.

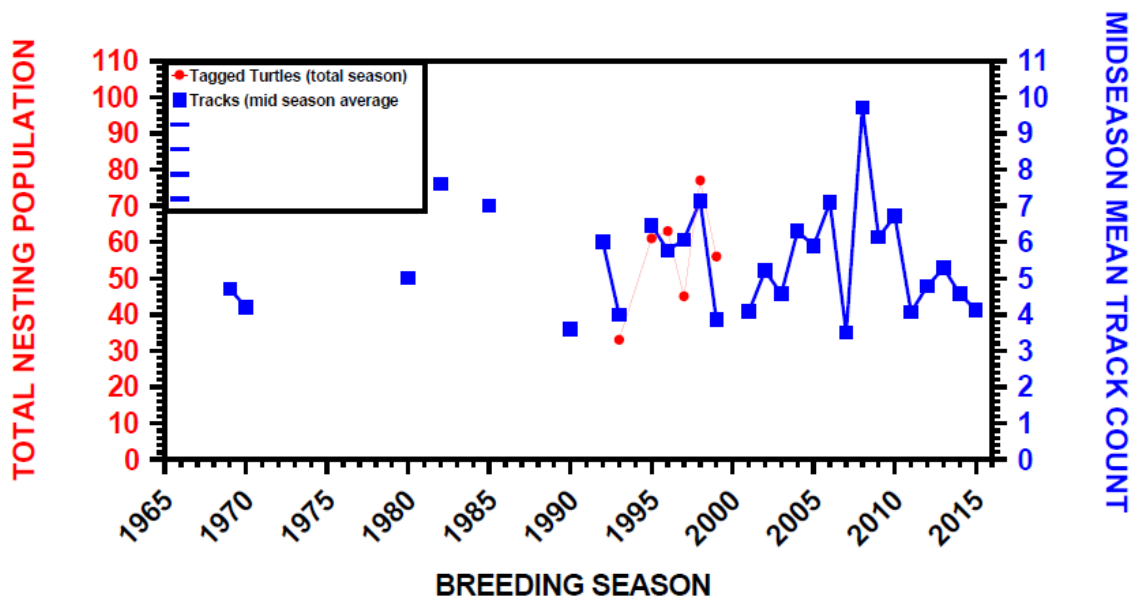


Figure 1 Comparison of annual flatback turtle, *Natator depressus*, census data using track counts during the standard mid-season census period at Curtis Island (Limpus et al. 2016)

Three years of monitoring has been completed at Avoid Island with the financial support of the GPC ERMP. Prior to this, an initial census was completed by other researchers during the 2007-8 breeding season, with regular monitoring commencing in 2012-13 with the support of the Queensland Trust for Nature (Fitzsimmons 2013, Fitzsimmons and Limpus 2014, 2015).

As observed at other nesting beaches, the eastern Australian nesting flatback turtles at Avoid Island display a high fidelity to the island with all remigrant turtles having been tagged previously at Avoid Island or Wild Duck Island. A summary of results of recent monitoring is provided in Table 2 and Figure 2. Full reports are provided in Appendix A.

Cyclone Dylan also caused severe erosion at Avoid Island in January 2014, with high losses of nests. Only six clutches (9%) marked during the two-week census period were not disturbed (Fitzsimmons and Limpus 2014). Cyclone Marcia on 19 February 2015 would have also caused the loss of several clutches laid below the dunes after the first week of December 2014; a post-cyclone survey was not conducted to determine the extent of damage (Fitzsimmons and Limpus 2015).

Table 2 Summary of flatback turtle monitoring results (two-week census period) from Avoid Island in 2013-14 and 2014-15 breeding seasons (Fitzsimmons and Limpus 2014, 2015, 2016)

Monitoring variable	2013-14	2014-15	2015-16
Nesting females	78	68	76
Nesting females - first time tagged	52	34	20
Mean tracks per night \pm S.D	8.4 \pm 7.5 (n=14)	6.8 \pm 3.8 (n=14)	10.2 \pm 7.0 (n=14)
Remigration interval (y) \pm S.D	2.4 \pm 2.3 (n=25)	1.9	2.1 \pm 0.6 (n=34)
Average clutch size \pm S.D	54.2 \pm 5.1 (n=6)	50.8 \pm 10.9 (n=44)	51.9 \pm 6.1 (n=29)
Hatching success (%) \pm S.D	78.1 \pm 21.3 (n=6)	86.4 \pm 22.6 (n=44)	80.7 \pm 21.9 (n=85)
Emergence success (%) \pm S.D	76.9 \pm 20.9 (n=6)	86.4 \pm 22.6 (n=44)	80.4 \pm 22.0 (n=85)

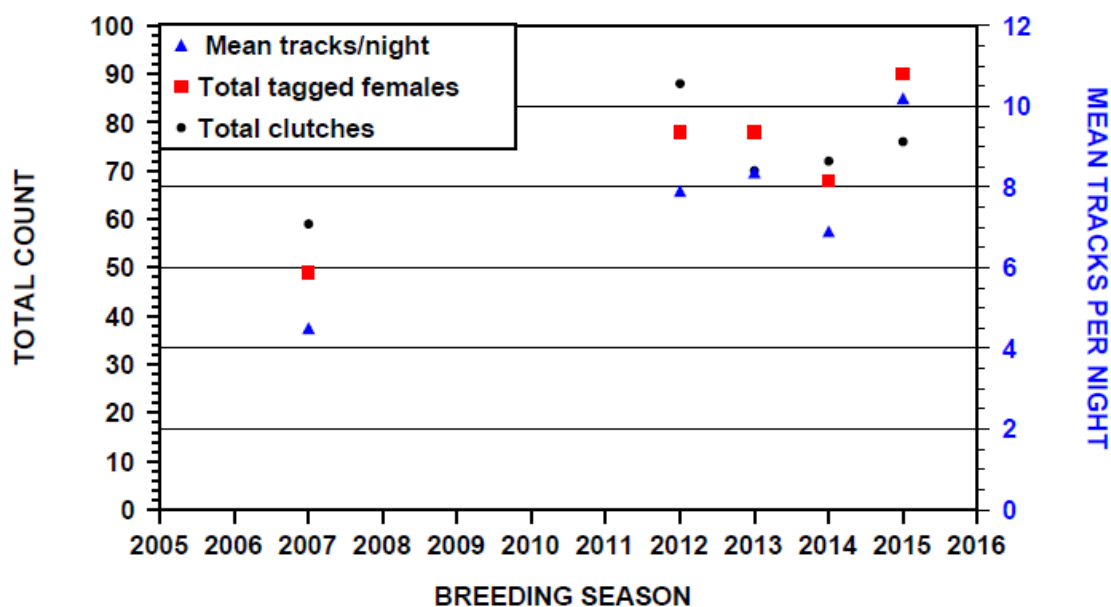


Figure 2 Comparison of annual flatback turtle, *Natator depressus*, census data using track counts, total tagged females and total clutches during the standard mid-season census period at Avoid Island (Fitzsimmons and Limpus 2016)

Both Avoid Island and Curtis Island experienced lower rates of nesting in the 2014-15 and 2015-16 seasons during the two-week census period, when compared with 2013-14 (Figure 1 and Figure 2). This is likely to be due to natural fluctuation of nesting females among years. The monitoring completed to date indicates that nesting activity and incubation success at Curtis Island is consistent with that recorded prior to the construction of the LNG facilities. However, further long-term monitoring is required before any definitive conclusions can be drawn.

3.3 Sky Glow Assessments

A baseline sky glow assessment was commissioned by GPC in 2011 at turtle nesting beaches on Curtis Island and Facing Island (Pendoley Environmental 2012). The aim of the assessment was to survey and quantify ambient night-time light levels at that time to assist in assessing changes to the night-time light horizon as perceived by marine turtles. The images collected provided baseline data prior to the construction of the LNG facilities within Port Curtis, with which the results of future sky glow assessments can be compared.

Data were collected during the new moon (to avoid lunar interference) at two locations on Curtis Island and two locations on Facing Island. The baseline assessment will be repeated at Curtis Island and Facing Island during the approaching nesting (December 2016) and hatching (February 2017) seasons, and biannually thereafter. The results of the sky glow assessments will provide additional data to evaluate the results of nesting and hatchling orientation studies in future years.

3.4 Hatchling Orientation Studies

Hatchling sea-finding behaviour upon emergence from the nest is primarily regulated by visual cues. Hatchlings have a primary tendency to orient towards the brightest horizon, typically the ocean in natural environments, as lit by astral light sources (the moon and/or stars), in contrast to the darker rear beach dune silhouette (Pendoley Environmental 2014). The presence of anthropogenic light can disrupt hatchling sea-finding behaviour, causing disorientation (moving in random directions) and misorientation (orientation in the wrong direction, i.e. towards point source of light), and can in turn affect hatchling survivorship (Pendoley Environmental 2014).

A study of hatchling orientation was commissioned by the GPC ERMP during the 2013-14 nesting season (Pendoley Environmental 2014; Appendix A). Curtis Island was the focus of the monitoring activities, with some sites at Facing Island also monitored. A total of 23 flatback turtle clutches were monitored for signs of disrupted sea finding behaviour at Curtis Island, with four flatback turtle clutches monitored at Facing Island. One green turtle clutch was also assessed on Curtis Island.

There was little difference observed in the results obtained at nesting sites from Curtis Island and Facing Island. Median spread angles of hatchling tracks ('fanning' out from the point of emergence) among the primary dune nesting locations were 35° (n=21) on Curtis Island and 34° (n=4) on Facing Island. Hatchlings emerging from clutches on the primary dune (located closest to the sea) at both Curtis Island and Facing Island oriented towards the ocean without detectable disruption. Mean offset angles (from a direct line to the ocean) were 8° (Curtis Island) and 9° (Facing Island).

The mean spread angle at Curtis Island from emerged nests located in the swale section of the dune (behind the primary dune) was 174°, and the mean offset angle was 35° (n=2). Hatchlings emerging from within the swale section of the Curtis Island dune system were found to spend greater periods of time on the beach immediately following emergence. The study authors thought that this result was due to a greater variation in topographical cues that confound sea-finding within the swale section of the dune system, resulting in hatchlings typically orientating parallel with the ocean along the valley of the swale. The higher spread angles and offset angles therefore may not be associated with altered night-

sky horizons due to anthropogenic light (Pendoley Environmental 2014). This observation warrants further investigation during future hatchling disorientation studies on Curtis Island, which will continue in the approaching 2016-17 season.

3.5 Tracking of foraging turtles in Port Curtis

Foraging green turtles (*Chelonia mydas*) living within Port Curtis are a key population of interest for the LTTMP. Such turtles are likely to be dependent on the ecosystem health of Port Curtis, and are potentially vulnerable to direct disturbance from the LNG facilities (e.g. from boat strikes from LNG carriers). An improved understanding of their home range, feeding patterns and interactions with shipping channels will therefore improve management of the population.

The GISERA green turtle tracking project involved the deployment of 46 acoustic receivers in Port Curtis to monitor the movement of tagged turtles around the Pelican Banks and Wiggins Island areas (Babcock *et al.* 2015; Appendix A). At the Pelican Banks, a total of 33 turtles were tagged with acoustic tags, with five of these turtles also tagged with satellite tags. At Wiggins Island, 16 turtles were tagged with acoustic tags, with five of these turtles also tagged with satellite tags. Between 1 May 2013 and 16 September 2014, the 49 tagged turtles were detected 1,385,100 times by the 46 acoustic receivers.

The GISERA tracking program found that turtles use varying components of Port Curtis' primary producer habitats, depending on the availability of these habitats in any given area. Turtles utilised seagrass as a primary food source in areas where seagrasses dominated. However, in other locations such as Wiggins Island, turtles utilised other food resources such as algae and mangroves. Turtles moved into shallower areas during high tides, and shifted to slightly deeper waters on the edge of channels at low tides.

Turtle home ranges were generally small and stable, although large variability was found according to location and season. Satellite tagged turtles had an average daily depth in the vicinity of 1 to 5 m. Modelling of turtle habitat use throughout Port Curtis and the mapping of shipping patterns from larger commercial vessels such as LNG carriers indicated a relatively low risk of boat strike for foraging green turtles (Figure 3).

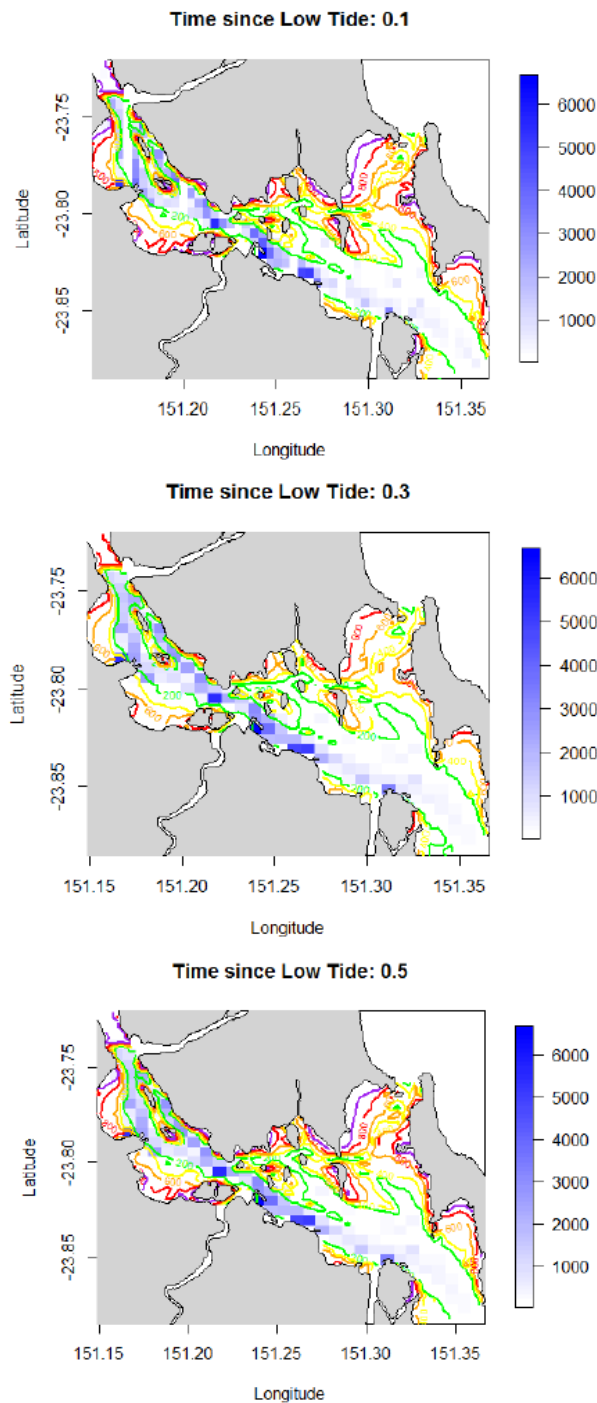


Figure 3 Maps of habitat preference of green turtles (coloured contours give the expected number of detections – green lowest’ purple highest). The blue shading gives average number of vessel positions per month (Babcock *et al.* 2015).

Satellite tracking of foraging green turtles within Port Curtis has also been completed by the GPC ERMP. This work is additional to the requirements of the LTTMP. An interim report is provided in Appendix A (Hamann and Limpus 2015), which will be supplemented with further results and reporting once the satellite tags cease transmitting.

3.6 Satellite tracking of inter-nesting flatback turtles

Inter-nesting female flatback turtles are a key cohort of interest to the LTTMP. While these turtles have foraging grounds in various locations well north of Port Curtis, they migrate to the region every 2-3 years to nest. There is little known of the habitat use of these turtles during the approximate two-week period between laying consecutive clutches of eggs (the inter-nesting period). Such information is important to inform assessments of the species' sensitivity to port-related activities in the region, such as those of the LNG facilities.

Three years of satellite tracking has been completed for the inter-nesting period of flatback turtles nesting on Curtis Island under the GPC ERMP. This has provided new information on the areas utilised by inter-nesting flatback turtles during this time. Information on the location of foraging grounds used by post-nesting Curtis Island flatback turtles was also obtained when the tagged turtles completed a northward migration at the completion of nesting activities.

Results of satellite tracking in 2013-14 and 2014-15 are provided in Appendix A (Hamann *et al.* 2015a, b). The results of the 2015/2016 monitoring will be reported once the satellite tags complete transmitting data. Eleven turtles were tagged each year, with tags providing information on water depth and location.

All tagged flatback turtles spent time within the waters of Port Curtis during the inter-nesting period. A majority of turtles spent 50% of their time in the area of the Port located west of Facing Island, adjacent to the main shipping channel. Most of the turtles' 50% and 95% inter-nesting habitats overlapped with sections of the main shipping channel located east of Barney Point.

The maximum water depth used by flatback turtles in 2014 was -22.3 m, with an average depth of -10.6 m. Turtles spent most of their time on the sea bed, with 14% of their time being in water depths of less than -2 m. Studies of inter-nesting flatback turtles in Western Australia have found that turtles have a tendency to spend some time inside recently dredged channels (Whitlock 2012).

Researchers implementing the LTTMP tasks suggest that the overlap of flatback turtle habitat with shipping channels warrants further investigation in Port Curtis. Unlike those foraging green turtles studied to date in Port Curtis, there does appear to be some overlap in habitat use between inter-nesting flatback turtles and shipping activities. The tendency for such turtles to utilise bottom habitats most commonly is also relevant to evaluating the risk of boat strike. Once completing their nesting activities in the Gladstone region, flatback turtles returned north to their foraging grounds in the Great Barrier Reef World Heritage Area.

3.7 Necropsies of boat strike and dead turtles

The LNG Proponents have continued their ongoing investment in the care and rehabilitation of marine turtles in the Gladstone region, through their support of the Quoin Island Rehabilitation Centre and the Gladstone Area Water Board Rehabilitation Centre. In circumstances where injured turtles have subsequently died while in care, veterinary necropsies have been completed to assist within identifying the cause of death. Two such necropsies were completed during the 2015-16 financial year on juvenile green turtles. The cause of death was attributed to shark bite/boat strike for the first turtle and parasitic load for the second turtle. This work will be expanded in 2016-17.

3.8 Seagrass health

Seagrass is a major habitat type supporting foraging green turtles in Port Curtis. Three years of seagrass monitoring was completed under the GISERA project titled 'An integrated study of the Gladstone marine system' (Babcock *et al.* 2015; Appendix A). The project was led by scientists from the CSIRO, who also developed a seagrass growth model for the Port.

Seagrass biomass was highest at the Pelican Banks with a mean overall above ground dry weight of 24.86 gDW/m². *Zostera muelleri* was the most abundant species, although mixed beds of *Halophila ovalis* were found in the southern parts of the banks. Seagrass depth range studies found a clear relationship between maximum depth of seagrass and Secchi depth (an indicator of water clarity). In waters offshore from Facing Island, *Halophila spinulosa* was recorded at depths of over 20 m.

A new model of seagrass growth and loss was developed, with detailed representations of the limiting processes of light and nutrient availability, and a simple representation of physiological processes. The model provides reasonable estimates of seagrass biomass in Port Curtis, based on predictions of the impact of environmental stressors on seagrass communities.

A study of the density of seagrass seeds (*Zostera muelleri*) and their viability in Port Curtis was completed by JCU through a study funded by the GPC ERMP (Jarvis *et al.* 2015; Appendix A). Seeds were found at all sites during all sampling events from March 2011 to March 2015. Seed density was relatively stable at the Pelican Banks, and variable at Rodds Bay and Wiggins Island. Viable seeds were found in the sediment seed bank at Pelican Banks, Wiggins Island and Rodds Bay. Seed bank viability reduced after four months of time spent in the sediment.

Other seagrass studies completed as part of the Western Basin Dredging and Disposal Project have shown that seagrass has recovered within Port Curtis following a major flood event in 2011 (e.g. Bryant and Rasheed 2013). Seagrass habitats remain sensitive to smaller flood events, as occurred in 2013, and respond to seasonal changes through periods of senescence and growth.

3.9 Health surveillance of live green turtles

Populations of foraging green turtles are reliant on the maintenance of indicators of ecosystem health, such as water quality and seagrass health. There are several instances in which events that have disrupted the ecosystem health of foraging habitat (e.g. floods or algal blooms) have resulted in reduced health outcomes and increased strandings (beaching of sick, injured or deceased turtles). Such an event occurred in Port Curtis in 2011 following a severe flood which reduced water quality and resulted in the temporary disturbance of seagrass habitats (Flint *et al.* 2015). The long term monitoring of the health status of live green turtles within Port Curtis is therefore important to understand how this species responds to environmental stressors, such as those that may be associated with the LNG facilities or other causes.

In 2015, the GPC ERMP commissioned a report on the health status of green turtles in Port Curtis (Flint 2015; Appendix A). A total of 99 green turtles were sampled in May 2014, with blood samples taken for biochemistry analysis and interpretation. Of the sampled animals, all except three were considered to be in good body condition, which is consistent with figures found in 'normal' wild populations.

Blood biochemistry performed on the 99 captured turtles indicated a high proportion of those sampled had chronic changes consistent with renal and hepatic insufficiencies. Haematology indicated 6% of turtles had minor white cell anomalies consistent with parasitism and infection. However, none of these findings were considered to be clinically significant.

Three of the turtles captured in May 2014 were 'recaptures', as they were first captured during a previous study of green turtles in 2011 (see Flint 2015). All three recaptured turtles were in good condition at the time of both assessments, and had increased in curved carapace length and weight over the three year period. The three recaptured turtles had lower blood lymphocytes, heterophils, eosinophils, creatinine kinase, urea, monocytes, albumin, total protein and globulins in 2014 when compared with the results obtained in 2011. Such results are indicative of a return to values similar to those expected of a 'healthy' population.

Findings from the study suggest that the green turtle population of Port Curtis has made a significant, but incomplete recovery since the major flood event in 2011 when elevated strandings and disease prevalence were documented. While only three turtles out of 99 samples had outward indicators of poor health, several prevalent biochemical anomalies were detected in blood analysis, as summarised below:

- Low creatinine was detected in 60% of turtles
- Low phosphorus was detected in 42% of turtles
- Low AST was detected in 19% of turtles
- Low total bilirubin was detected in 16% of turtles and
- Low creatinine kinase was detected in 15%

Possible causes for these anomalies include renal compromise, hepatic compromise and recovery from starvation. However, it should also be noted that renal and hepatic diseases result from a very wide range of causes and there may not necessarily be a single or common cause of disease in populations of wild animals. Such findings will continue to be monitored during the annual health assessments of green turtles in Port Curtis.

4 Monitoring Schedule

4.1 Overview

While there has been progress on several of the LTTMP monitoring tasks in recent years, the 2016/2017 breeding season is the first year that all monitoring tasks will be progressed as a coordinated program, following the appointment of ELA as a consultant to implement the program. The successful integration of planned monitoring tasks with those already commenced or completed under the ERMP and GISERA programs is important to avoid duplication. In addition, it is important to work with other agencies completing monitoring of turtles and their habitat in the region (e.g. DEHP and GPC) to avoid duplication and support the collection of data that is of relevance to the LTTMP.

A gap analysis has been completed which summarises the existing work in relation to LTTMP monitoring tasks (Table 3). The majority of monitoring work underway has been funded by the LNG Proponents, through their substantial financial contributions to the GPC ERMP. There are a small number of tasks that have been completed by others independently of the LNG Proponents and provide information relevant to the monitoring requirements of the LTTMP. These are:

- Monitoring of turtle nesting at Curtis Island in 2013-14 and 2014-15 (funded by DEHP and GPC)
- Seagrass monitoring (funded by GPC and JCU)

Both programs were in place at the time the LTTMP was developed, and were recognised as important existing sources of long-term data. The results of these studies have been published and are publicly available. The LNG Proponents have therefore referred to this information with appropriate referencing when reporting on the LTTMP, because:

- It provides relevant information that assists the assessment of environmental risk and mitigation measures
- A key objective of the LTTMP is to avoid duplication by working with or enhancing the work of existing research and monitoring organisations
- Approval conditions encouraged the LNG Proponents to work collaboratively with other industries and parties in the Port of Gladstone when developing and/or implementing a LTTMP.

The LNG Proponents do not seek to take credit for initiating or funding these particular studies, and will collaborate with the respective researchers during implementation of the LTTMP. The LNG Proponents also recognise the contribution made by GPC in coordinating and implementing the monitoring program being implemented under the ERMP.

Gap analysis studies of six marine turtle species in the Gladstone region (Limpus *et al.* 2013a, b, c, d, e, f) were also reviewed in preparing this annual report. The studies were commissioned by the GPC ERMP, and were not finalised at the time of the LTTMP's development. The review identified that the LTTMP Monitoring Plan is well aligned with addressing existing knowledge gaps while also building on existing data sets where a baseline (pre-LNG facilities) has been established.

4.2 Progress

A summary of the progress of monitoring tasks and the number of years remaining to meet the requirements of the LTTMP is displayed in Figure 4. There has been progress on the monitoring of the nesting success of flatback turtles and of their habitat use during the inter-nesting period. For clarity, the

2015-16 turtle nesting season at Curtis Island was the only season thus far to be supported by a financial contribution from the LNG Proponents (through the GPC ERMP). For some future monitoring tasks, there is some uncertainty whether they will be funded by the LNP Proponents directly or will be continued by extending the existing monitoring activities of the GPC ERMP.

The tracking of green turtles within Port Curtis has also been a focus of early work, with all such monitoring required by the LTTMP completed. Seagrass monitoring has also been extensively progressed, following the GISERA study and ongoing port-wide monitoring projects implemented by the GPC and JCU. The results of these studies have identified some interesting findings in relation to seagrass health and recovery from flood events which have links with other LTTMP monitoring tasks (strandings and green turtle health surveillance).

The 10 year annual health surveillance of green turtles has been initiated in 2016, with a review of previously collected data completed by the GPC ERMP (Section 3.9). The LNG proponents are also currently establishing arrangements to facilitate detailed necropsies of dead turtles and to forensically examine turtle carcasses where boat strikes have occurred within the Gladstone region. Work of this nature is not currently being undertaken on a regular basis and will contribute to an improved understanding of the cause of death of marine turtles in the region.

Table 3 Gap analysis summarising work completed to date for LTTMP tasks

Turtle Plan Monitoring Task	Summary of work completed to date	Additional work required to meet requirements of LTTMP
<p>Monitoring of nesting flatback turtles at Curtis Island and Avoid Island for at least 5 yrs. Full season monitoring every five years.</p>	<p>Decades of monitoring by DEHP with support from GPC at Curtis Island since 1994. The GPC ERMP has funded the standard nesting census on Curtis Island for the 2015-16 season with full season monitoring at Curtis Island planned for the 2016-17 season.</p> <p>3 years of monitoring completed at Avoid Island through GPC ERMP. GPC ERMP has one more year of monitoring at Avoid Island involving a full nesting census (2016-17 season).</p>	<p>Curtis Island – Work with DEHP and GPC to provide appropriate support to the ongoing monitoring program. May need to be continued if GPC and EHP do not continue with this work after the 2016-17 season.</p> <p>Avoid Island - May need to be continued for a fifth year if the ERMP does not continue with this work after 2016-17 season.</p>
<p>Ambient night time sky glow assessment to be completed biannually for 10 years during nesting and hatching.</p>	<p>Pendoley has completed a baseline assessment in 2011 through GPC. The GPC ERMP has indicated that there are no current plans to repeat this work.</p>	<p>Commission Pendoley to repeat the study every 2 years and coordinate timing with nesting and hatching.</p>
<p>Monitoring hatchling emergence tracks in the sand at Curtis Island for signs of disorientation for at least 5 years.</p>	<p>Pendoley has completed one round of monitoring at Curtis Island in 2013-14 through GPC ERMP. GPC ERMP currently has no plans to repeat this work.</p>	<p>Annual monitoring during hatching season, including at the same time as sky glow assessment (in those years). Investigate with DEHP the use of adult nesting disorientation as a more reliable surrogate for this method.</p>
<p>Turtle tracking – foraging green turtles in Port Curtis for 3 years.</p>	<p>GISERA funded work by CSIRO and DEHP has been completed.</p> <p>The GPC ERMP has also funded green turtle tracking and habitat utilisation work for three years in Port Curtis in 2014, 2015 and 2016.</p>	<p>No additional work required to address LTTMP requirements. However, additional work in the vicinity of navigation channels will fill current knowledge gaps and could be a higher priority than other LTTMP tasks. Requires further discussion with DEHP and DotE and consideration at biannual review.</p>
<p>Turtle tracking – 10 flatback inter-nesting females per year for at least 5 years, or as determined by results of initial monitoring (at both Curtis Island and Avoid Island).</p>	<p>Satellite tracking of 11 flatback turtles at Curtis Island completed for 3 years by JCU and DEHP through the GPC ERMP.</p> <p>Nothing completed at Avoid Island.</p>	<p>Continuation of this work at Curtis Island by GPC ERMP has not yet been decided (scheduled to be discussed at the ERMP Advisory Panel meeting August 2016). May need to be continued for 2 years pending the outcomes of the August meeting and review of the</p>

Turtle Plan Monitoring Task	Summary of work completed to date	Additional work required to meet requirements of LTTMP
		<p>results of the first three years collectively.</p> <p>Complete satellite tracking at Avoid Island for 5 years, or as determined by the results of initial monitoring.</p>
<p>Forensic examination of boat strikes</p> <p>Up to 10 years.</p>	<p>There is currently no systematic process for the forensic examination of boat strikes on turtle carcasses to determine the type of vessel involved.</p>	<p>Fund and coordinate forensic examination of boat strikes, utilising the University of Queensland (UQ) vet school and local vets.</p>
<p>Necropsies – cause of death general up to 10 years.</p>	<p>Ad hoc necropsies are being completed by the Turtle Rehabilitation Facilities. However, these are not always completed to the preferred standards and rarely make use of secondary studies of tissues.</p>	<p>Fund and coordinate vet necropsies, utilising UQ vet school and local vets.</p>
<p>Seagrass health 5 years.</p>	<p>Existing GPC project (in partnership with JCU) and GISERA project (completed). Long term seagrass monitoring projects in Port Curtis are ongoing.</p>	<p>There has been extensive seagrass monitoring in Port Curtis, and this continues regularly through GPC as part of the Western Basin Project. The LTTMP states that no new seagrass monitoring is required beyond the assessment of results in the existing programs.</p>
<p>Health surveillance of live turtles for 10 years (up to 200 turtles per year).</p>	<p>In 2015, the GPC ERMP published an assessment of blood biochemistry from 99 green turtles captured from Port Curtis in 2014.</p> <p>DEHP has started a 4 year project to capture and assess 400 turtles annually under the GPC ERMP. Objectives of this research differ slightly to those of the LTTMP, with existing funds not sufficient to do detailed toxicology and blood analysis required under the LTTMP.</p>	<p>Supplement the existing GPC ERMP project for 4 years by funding veterinary participation in some field trips for the collection and analysis of blood samples to meet the requirements of the LTTMP. This will add value to the existing monitoring, and results will provide a basis for more detailed health assessments.</p>

LTTMP Monitoring Activity	Years of Monitoring												2023	2024	2025
	2011	2012	1 2013	2 2014	3 2015	4 2016	5 2017	6 2018	7 2019	8 2020	9 2021	10 2022			
Nesting and hatching at Curtis Island	Green	Green	Green	Green	Green	Yellow	Blue (Minimum)				Blue	Stop			
Nesting and hatching at Avoid Island			Yellow	Yellow	Yellow	Yellow	Blue (Minimum)				Blue	Stop			
Sky glow assessment	Yellow					Blue		Blue		Blue		Stop			
Hatchling disorientation			Yellow	Blue		Blue	Blue	Blue (Minimum)							
Tracking – foraging green turtles			Grey	Yellow	Yellow	Yellow	Blue (Stop)								
Tracking – flatback inter-nesting at Curtis Island			Yellow	Yellow	Yellow	Blue	Blue (Stop)								
Tracking – flatback inter-nesting at Avoid Island						Blue	Blue	Blue	Blue	Blue (Stop)					
Boat strike examinations						Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Stop
Necropsy of dead turtles						Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Stop
Seagrass health	Green	Green	Green	Green	Green	Green	Green	Green							
Health surveillance of live turtles					Yellow	Orange	Orange	Orange	Orange	Blue	Blue	Blue	Blue	Blue	Stop

Key:

GPC project	Green
GPC ERMP project	Yellow
GISERA project	Grey
LTTMP new task (or continued ERMP project)	Blue
LTTMP enhancement of existing ERMP project	Orange
Completed	Vertical lines

Figure 4 Schematic summary of the progress of LTTMP monitoring tasks and future work program

4.3 Monitoring tasks and Program 2016-2017

This section provides an overview of the forward monitoring plan for the next 12 months. The information represents the best available at the time of reporting. It should be noted that contract agreements between ELA and sub-consultants were still being negotiated at the time of reporting.

4.3.1 Flatback nesting at Curtis Island and Avoid Island

There will be a full season nesting census completed at both Curtis Island and Avoid Island in the 2016-17 nesting season. This work will be funded through the GPC ERMP and implemented by DEHP and their partners including the Queensland Trust for Nature.

4.3.2 Sky glow assessments

A night time sky glow assessment will be completed at two sites at Curtis Island and two sites at Facing Island during both the approaching nesting season (December 2016) and hatching season (February 2017). The assessments will replicate the methodology applied during the baseline assessment in 2011 (Pendoley Environmental 2012). The surveys will be timed to coincide with the new moon (to reduce lunar interference) and studies of adult and hatchling orientation.

4.3.3 Hatchling Orientation Studies

Hatchling orientation studies will be completed by DEHP at Curtis Island during the full season nesting census. Data will be collected across the lunar cycle in January/February 2017, including on the same nights as the sky glow assessment.

4.3.4 Tracking of foraging Turtles in Port Curtis

All commitments for the LNG Proponents in the LTTMP have been met with respect to the tracking of foraging green turtles in Port Curtis. The GPC ERMP continues to invest in the satellite tracking of green turtles, and where such results are relevant to the LTTMP, they will be considered and reported.

4.3.5 Satellite tracking of inter-nesting flatback turtles Curtis Island and Avoid Island

The LNG Proponents are currently making arrangements to work with DEHP and their partners to conduct satellite tracking of inter-nesting flatback turtles at Avoid Island during the 2016-17 nesting season. Satellite tags will be deployed during the full season nesting census.

The ERMP Advisory Panel is meeting in August 2016 to decide whether to continue with satellite tagging of inter-nesting flatback turtles at Curtis Island. Three years of data have been collected to date. The LNG Proponents will consider what additional monitoring is required for this monitoring task after this ERMP Advisory Panel meeting, to meet LTTMP requirements.

4.3.6 Necropsies of boat strike and dead turtles

Logistical arrangements to facilitate the examination of dead turtle carcasses in relation to boat strike injuries and other potential causes of death are currently being established. It is anticipated that once in place, all turtle carcasses from the Gladstone region will be assessed for suitability of necropsy/examination, based on their location and condition.

Carcasses in good condition will be prioritised for transport and a detailed necropsy conducted at the University of Queensland Veterinary School at Gatton in Queensland. Carcasses in a reasonable condition, but not suitable for transport, will be prioritised for a local field or laboratory necropsy by a veterinarian in Gladstone. Carcasses that are in poor condition or are unable to be relocated will be prioritised for a field necropsy and examination (external examination, measurements taken and tags recorded).

Consultation is currently occurring with several local partners in the Gladstone region to facilitate the stranding response arrangements, including the Gladstone Area Water Board Turtle Rehabilitation Centre, Quoin Island Rehabilitation Centre, Gidarjil Rangers, Queensland Parks and Wildlife Service and DEHP. It is anticipated that the stranding response system will be operational in September 2016 (for a period of 10 years).

4.3.7 Seagrass health

There are no new seagrass monitoring tasks for the LNG Proponents in the LTTMP. The results of ongoing seagrass monitoring will be reviewed and reported as these are relevant to a range of other LTTMP studies, including the green turtle health surveillance and stranding response tasks.

4.3.8 Health surveillance of green turtles

The assessment of green turtle health has commenced, with four field trips to capture and record information on turtles in 2016 through the GPC ERMP. Sampling trips were successfully completed in May and June 2016 with a focus on tagging and morphometrics. Approximately 200 turtles were captured during these two trips. A further two field trips are planned for 2016 (September and October 2016). These trips will involve the collection and analysis of blood samples as a supplement to the existing ERMP project, funded by the LNG Proponents.

Turtle samples will be collected by qualified and trained personnel in accordance with DEHP protocols and the conditions of relevant scientific approvals (e.g. ethics approvals, Scientific Purposes Permits). Samples will be stored in accordance with laboratory protocols. The monitoring team includes specialists from DEHP, the UQ Vet School and the UQ National Research Centre for Environmental Toxicology, who are supported by dedicated laboratory and storage facilities for necropsy and tissue analysis tasks.

The LNG Proponents have also been offered access to up to 100 archived blood samples taken from green turtles captured in Port Curtis between 2011 and 2014. These samples were collected by the University of Queensland, and negotiations are currently in place to undertake analysis on these samples, to provide a continuous source of information on blood contaminants and biochemistry from 2011 onwards.

5 Effectiveness of Mitigation Measures

5.1 Introduction

One of the functions of the annual review report is to consider the effectiveness of the management measures and operating controls directed at avoiding impacts on the marine turtle species. This section addresses this requirement.

The following process was completed as part of the review process:

- Review of risk assessment and consideration of whether risks have been correctly evaluated
- Review of impacts and mitigation measures identified in the LTTMP, based on the most recent information available
- Assessment of the effectiveness of the mitigation measures, utilising available information including the initial results of the LTTMP Monitoring Plan.

5.2 Review of impacts, risks and mitigation measures

The residual risk to marine turtles as evaluated in the LTTMP has changed as the projects have moved from their construction phase to operations. Construction work at the QGC and GLNG facilities has been completed, with construction due to be completed at the APLNG facility during the second half of 2016. GLNG commenced shipment of LNG from its facility in October 2015, with APLNG commencing in January 2016.

During peak construction, APLNG estimated that there would be 140 additional ferry journeys and 70 additional barge journeys per month, with GLNG estimating that approximately 45 additional ferry and 45 to 90 barge journeys per month would be required. The conclusion of construction at QGC and GLNG has led to an associated reduction in vessel movements between Curtis Island and the mainland, with vessel movements also reducing from construction peaks at the APLNG facility.

The number of LNG carriers exporting LNG from the three facilities is gradually increasing and is expected to continue to increase over the next one to two years. Approximately two to three ships per week are expected to visit each LNG facility, once operational.

Dredging and piling activities from the projects were completed several years ago. However, maintenance dredging may be required in the future. Across the three LNG projects, the construction workforce has reduced with the commissioning of new trains and commencement of export activities.

In order to assess the changes in project risks to marine turtles and their habitat, the risk assessment in Tables 4 to 7 of the LTTMP was reviewed. Risks were reassessed for the current stage of the projects, utilising the risk assessment matrix in Table 3 of the LTTMP. The revised risks are presented in Table 4.

Table 4 Assessment of the potential for cumulative impacts for each marine turtle life cycle stage as outlined in the original LTTMP and based on the current stage of projects in 2016. The risk assessment is based upon the risk of boat strike, lighting, dredging and piling, and indirect project impacts

Life Cycle Stage	Boat Strike		Lighting		Dredging and Piling		Indirect Impacts		Potential for Cumulative Impacts	
	Original Assessment	2016	Original Assessment	2016	Original Assessment	2016	Original Assessment	2016	Original Assessment	2016
Egg	Low	Low	Low	Low	Low	Low	Medium	Medium	Low	Low
Hatchling	Low	Low	Medium	Medium	Low	Low	Low	Low	Low	Low
Juvenile (pelagic stage)	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Juvenile (coastal stage)	Medium	Low	Low	Low	Low	Low	Medium	Medium	Medium	Low
Foraging Sub-Adult or Adult	Medium	Low	Low	Low	Low	Low	Medium	Medium	Medium	Low
Nesting Female	Low	Low	Medium	Medium	Low	Low	Low	Low	Low	Low
Migratory Male (mating)	Medium	Medium	Low	Low	Low	Low	Low	Low	Low	Low
Inter-nesting Female	Medium	Medium	Low	Low	Low	Low	Low	Low	Low	Low

*Low – One risk assessed Medium or higher. Medium – Two risks assessed Medium or higher. High – Three or more risks assessed Medium or higher.

With the commencement of operations and the decrease in LNG facility-related vessel movements within Port Curtis, the risk of boat strike to juveniles (coastal stage), foraging sub-adults/adults has decreased, reducing the residual risk from Medium to Low. Consequently, this has reduced the potential for cumulative impacts from Medium to Low for juveniles (coastal stage), foraging sub-adults/adult life cycle stages.

The risk of boat strike to inter-nesting flatback turtles remains at Medium, as the results of monitoring tasks have found that the habitat utilised by inter-nesting females overlaps with the major shipping channels within Port Curtis. Monitoring undertaken in the 2014-15 breeding season found 48% of core habitat lay within the Port of Gladstone, within 64% of tracked turtles spending 50% of the time in the middle harbour region of the Port (Hamann *et al.* 2015).

The commencement of the operations phase of the projects has resulted in changes to the light emissions from the LNG projects. Lighting required to support operations is generally less than the lighting required during construction, which will contribute to a nominal decrease in sky glow visible from the turtle nesting beaches. Lighting impacts from vessels anchored offshore and lighting on jetties or navigational beacons are expected remain consistent with baseline scenarios.

Flaring has commenced for the commissioning and operations phases of all projects, which has the potential to increase light during certain times, reduce nesting success and disorientate/misorientate nesting females and hatchlings. Following full commissioning at all projects, flaring is expected to occur infrequently, and when possible, be timed to occur during the day or outside of the turtle breeding season. However, at this stage of the project the residual risk to hatchlings and nesting females from anthropogenic lighting is assessed to remain at Medium, with reductions in construction lighting being offset by increased light from flaring.

With the conclusion of capital dredging and pile installation for the construction of berth facilities several years ago, the risk of collisions with turtles (including with the dredge head) and the avoidance of the area by marine turtles due to increased noise and turbidity associated with these activities is low. The residual risk to hatchlings and nesting females from dredging and piling activities remains at Low. It should be noted that maintenance dredging may be undertaken in the future, and similar risks to marine turtles will apply during such activities.

Seagrass monitoring in Port Curtis has demonstrated recovery of seagrass habitats since 2011, with periodic flood events being the main factor causing a decline in the distribution and quality of habitat. Early results from turtle health assessments show that the green turtle population is in a good condition and has completed a partial recovery from the major flood event of 2011.

There is no evidence of significant impacts to marine turtles attributable to the LNG projects based on the data currently available. Such a result is to be expected given the short amount of time that has elapsed since monitoring commenced and the nature of the mitigation measures implemented. The potential for impacts will be assessed in greater detail as the monitoring projects progress and further data are available.

All existing baseline data will be available and analysed during the first biannual review scheduled for 2017. Control charts and other statistical analyses will be applied to determine whether significant levels of change have occurred at a power of 0.8.

The mitigation and management measures proposed in the LTTMP are considered to be appropriate to reduce risks to marine turtles and their habitats, and no revisions are necessary at this stage of the project. However, a proactive adaptive management approach will be applied to identify impacts early

and mitigate activities that may cause harm to marine turtle populations. Changes in the activities at the LNG facilities and their implications for the LTTMP objectives are summarised in Table 5.

Table 5 Assessment of the influence of changes in project status on LTTMP objectives

Activity	LTTMP Objective	Comments on project status
Increased vessel activity during construction of LNG Facilities on Curtis Island	Minimise the risk of boat strike on marine turtles during construction activities	Construction activities are mostly complete and will continue to decline over next 12 months. QGC and GLNG facilities are operational. There is one train in production at APLNG, with the second train due to commence production later in 2016
Boat strike from shipping activities in Port Curtis and ferries during operations	Minimise the risk of boat strike on turtles during LNG operations	LNG carrier movements are gradually increasing towards two to three LNG carriers per LNG facility per week. Ferry and barge movements will be low compared with construction phases
Boat strike from Shipping activities in the Great Barrier Reef Marine Park and lagoon	Minimise the risk of boat strike on turtles during LNG operations	LNG carrier movements are gradually increasing
Construction and operation of LNG facilities contributing to the sky glow of the Gladstone region	Reduce contribution to the existing sky glow of the Gladstone region when viewed from turtle nesting beaches	Construction lighting has reduced. Flaring is occurring as part of commissioning and operations phase
Light from navigation aids established to assist LNG ships navigate safely at night	Reduce the incidence of light disturbing nesting females and emerging marine turtle hatchlings	Nil change
Capital and maintenance dredging of berth areas and immediate approach channels using a cutter section or TSHD dredge	Minimise potential for interaction between dredge plant and marine turtles	Capital dredging completed. No maintenance dredging currently. Nil change.
Installation of piles into the seabed during construction of berth facilities	Minimise underwater noise and vibrations within the surrounding water that might affect marine turtles	Piling completed. Nil change.

Activity	LTTMP Objective	Comments on project status
Dredging and increased shipping activities	Minimise indirect impacts to marine turtles and their habitats arising from disturbance of marine environment	Dredging has been completed. Movements of LNG carriers are slowly increasing
Changes in underwater topography as a result of disturbance from dredging	Minimise and manage impacts arising from changes in the marine environment	Nil change
Increasing industrial activity	Minimise disturbance to marine turtles and their habitats from the LNG facilities' contribution to the industrialisation of the Gladstone region	The projects have contributed to increased industrialisation of the Gladstone region
Increased human presence in the region as a result of population increases from LNG facility workforce	Minimise disturbance to sensitive marine turtle habitats	The construction workforce population has reduced as projects have moved from the construction phase to operations
Increased presence of marine debris	No debris discarded to the marine environment	The risk of this occurring has reduced as the number of vessel movements reduces from construction to operations phase
Loss of habitat	Minimal loss of seagrass habitat, which is restricted to dredging footprint	Nil change

6 Conclusions

Monitoring tasks associated with implementation of the LTTMP have been underway for three years under various programs such as the GPC ERMP and GISERA. ELA has been appointed by the LNG Proponents to continue implementation of the LTTMP in a coordinated manner by implementing tasks that are yet to commence and working with researcher partners to supplement or continue existing monitoring programs.

Construction stages of the LNG projects are largely completed, with associated risks to marine turtles and their habitats reducing over the past few years. The QGC and GLNG projects are in their operations phase, while construction at the APLNG facility will be completed in 2016. Mitigation measures outlined in the LTTMP have been reviewed and are considered to be appropriate given the current information available and the reducing project risks to marine turtles and their habitats.

There is no evidence from the information available that the LNG facilities are having or have had a significant impact on marine turtles or their habitat. Monitoring results will continue to be reviewed and assessed for signs of potential impacts on marine turtles and their habitats. New scientific information collected through the monitoring program will enhance the future management of marine turtle populations.

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Appendix A Technical Reports

Technical reports referred to in this Annual Report are listed below. A link is provided for those reports that are available online. Other reports can be provided upon request.

1. Flatback turtle nesting report for Curtis Island 2013-14 (DEHP and GPC)
2. Flatback turtle nesting report for Curtis Island 2014-15 (DEHP and GPC)
3. Flatback turtle nesting report for Curtis Island 2015-16 (GPC ERMP) - [Link](#)
4. Flatback turtle nesting report for Avoid Island 2013-14 (GPC ERMP) - [Link](#)
5. Flatback turtle nesting report for Avoid Island 2014-15 (GPC ERMP) - [Link](#)
6. Flatback turtle nesting report for Avoid Island 2015-16 (GPC ERMP) - [Link](#)
7. Hatchling orientation report for Curtis Island and Facing Island 2013-14 (GPC ERMP) - [Link](#)
8. Acoustic and satellite tracking of foraging turtles, and seagrass health in Port Curtis (GISERA) - [Link](#)
9. Satellite tracking of green turtles in Port Curtis (GPC ERMP) - [Link](#)
10. Satellite tracking of inter-nesting flatback turtles at Curtis Island 2013-14 (GPC ERMP)
11. Satellite tracking of inter-nesting flatback turtles at Curtis Island 2014-15 (GPC ERMP) - [Link](#)
12. Seagrass seedbank density and viability studies (GPC ERMP) - [Link](#)
13. Health surveillance of foraging green turtles in Port Curtis (GPC ERMP) - [Link](#)

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