

**A Constructive Review of the Status of Green Turtle Research,
Monitoring and Methodologies in Queensland, Australia with
Recommendations for Future Action**

A summary report prepared by

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In association with a workshop on green turtles held June 15-16 1999, Brisbane.

Prepared for Queensland Parks and Wildlife Service
and
Raine Island Corporation

June 1999

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1. Executive Summary

As a result of this review of the status of green turtles and the methodologies employed to answer management related questions, all aspects of the applied research and monitoring were found to be of superior quality as indicated in the findings on page 6 of this report.

The methodologies are of world standard as supported by the exhaustive list of publications in the accompanying file and the outline of methodologies in the findings on page 6

The significance of Raine Island as a special area of green turtle nesting density is acknowledged as providing a spectacular vista and of intrinsic biological significance to the stock of green turtles of the northern Great Barrier Reef stock as indicated on pages 6 and 7.

The recommendations are supportive of the excellence of the research and monitoring to date and will provide an expansion of these activities through a formal green turtle research project to address the missing parameters required for population modeling to address the management questions for each stock of green turtles in Queensland.

2. Acknowledgments

The authors express sincere appreciation to Queensland Parks and Wildlife Service and to Raine Island Corporation, Dr Colin Limpus, Dr Jeff Miller, Ms Ilze Brieze, Mr Duncan Limpus and Ms Lisa Ford for their considerable hospitality and assistance during all aspects of this review.

3. Background

The Queensland Parks and Wildlife Service has been conducting research and monitoring of green turtle (*Chelonia mydas*) populations of Queensland for over 20 years (Appendix 1). The last major, external review of these activities was undertaken in 1986. The last review of research and monitoring of the Raine Island component was undertaken in 1991. Queensland Parks and Wildlife Service and Raine Island Corporation have expressed their opinion that a review was in order at this time to establish the status of investigations and to ensure that optimum green turtle research and monitoring are being conducted by the most appropriate methods.

4. Review Process

To facilitate the reviewers task, a two day workshop was held in Brisbane June 15-16 1999. Participants included representatives from National and Queensland management agencies with an interest in green turtles. These agencies included Queensland Parks and Wildlife Service, Raine Island Corporation and Raine Island Corporation Scientific Advisory Committee, Environment Australia, CSIRO, Australian Fisheries Management Authority, Great Barrier Reef Marine Park Authority, Torres Strait Regional Authority, Queensland Department of Primary Industries, Queensland Museum, University of Queensland. The participants with their contact details and their affiliations are listed in the Appendix 2.

Mr Greg Wellard, Director Planning and Research, Queensland Parks and Wildlife Service, opened the meeting by extending his best wishes for a productive exchange of information and the successful accomplishment of the program review. The workshop included formal presentations by:

- Dr. Colin Limpus (biology, methods, management, nesting, distribution, migrations and feeding ground studies);
- Dr Craig Moritz (molecular genetics, stock identification);
- Dr Jeff Miller (northern Great Barrier Reef green turtle research);
- Mr Milani Chaloupka (modelling).

Comprehensive discussions, including questions and answers under the guidance of various chairpersons, were carried out by participants during all aspect of the workshop. Notes of the workshop were kept by Ilze Brieze and Lisa Ford. Ancillary written materials from the sessions have been placed in a Companion File (File Number XXXX). Following the workshop on June 17, additional discussions, feedback and informational exchange were carried out between Limpus, Miller, Brieze, Balazs, and Guinea. Using the information generated from these activities and sources, Balazs and Guinea produced the present report during the period June 18-20.

5. Terms of Reference

The terms of reference for the review were formulated by Queensland Parks and Wildlife Service and Raine Island Corporation.

5.1 Aims:

The principal aims of this review are to:

- assess the status of existing knowledge
- investigate the appropriateness of current methodologies; and
- determine the future requirements for research and monitoring to enable effective conservation and management of green turtle populations in Queensland.

5.2 Proposed outcomes:

The proposed outcomes of the workshop were to provide a succinct, prioritised summary of:

- parameters which need to be quantified for use in planning the management of:
- the northern Great Barrier Reef green turtle stock, including the nesting population of Raine Island and adjacent islands
- multiple stocks of green turtles in Queensland.
- appropriate methodologies available and need to be developed;
- a recommended research program to monitor green turtle stock and address the mechanisms underlying the trends and fluctuations in the population(s).

The terms of reference anticipated that a report to the preliminary stage was to be prepared by the working group during the workshop. However, the scope and the magnitude of information presented at the workshop exceeded the available time for this to be accomplished. Consequently this report was prepared post-workshop by Balazs and Guinea drawing on the verbal and written materials contributed and submitted by the participants during the course of the workshop. These responses from participants, to a key question posed by Guinea and Balazs, are presented in Appendix 3.

6. Findings

- The green turtles living in, and originating from Queensland, are listed locally as worthy of protection, nationally as vulnerable, and internationally as endangered. This resource is of substantial value for ecological, cultural, nutritional, aesthetic and tourism purposes. As such the resource requires high priority for research, monitoring and sound management to ensure sustainability.
- The applied research and monitoring activities conducted to date on green turtles in Queensland has significant and exemplary application to the development of sound management practices.
- The scientific publications that have resulted from research and monitoring of Queensland green turtles are numerous, timely and of the highest calibre and are a credit to the Queensland Parks and Wildlife Service and the Raine Island Corporation.
- The applied research, monitoring and methodologies used for green turtles in Queensland are appropriate, innovative, highly effective and equal to or exceed international standards for the study of sea turtles. These successful techniques and strategies include: capture and tagging of green turtles on nesting beaches and on foraging pastures as the foundation of critical data collection; creation of a computerised database; development of mathematical models to simulate turtle populations; molecular genetics for stock identification; use of external durable identification tags and selective use of internal PIT tags; gonad assessment (eg laparoscopy) for population research and modeling; disease assessments involving histopathologic analysis and PCR viral screening; aerial surveys of nesting beaches; relating climate change (ENSO Index) to green turtle reproductive dynamics; determination of green turtle food sources; national and international export of Queensland sea turtle technology and expertise; and the contribution to sea turtle awareness and conservation by training volunteer participants.
- At least three genetic stocks of green turtles have been identified in Queensland waters. These comprise the following gene pools: the southern Great Barrier Reef stock (sGBR), the northern Great Barrier Reef stock (nGBR), and, the Gulf of Carpentaria stock (GoC). The workshop focused on two of these stocks, nGBR and sGBR.
- The status of the nesting green turtle stocks in Queensland is unclear. A decrease in the size of first time nesting turtles at Raine Island, may signal a negative impact. There is considerable concern for conservation and sustainable management of stocks.
- The state of knowledge applicable to green turtle management is more advanced for the sGBR due mainly to historical emphasis on the core study sites in the Capricorn-Bunker Group (Heron Island) and relative ease of access.

- A provisional robust population model is very near completion for the sGBR green turtle stocks.
- Raine Island and the density and magnitude of green turtles nesting there, are a spectacular ecological wonder of acknowledged world acclaim, entrusted to Australia. The stewards of this resource are the Queensland Parks and Wildlife Service and the Raine Island Corporation. Their vital roles in applied research, monitoring and conduction of sound management are recognised.
- Early warning indicators of population change are urgently needed due to the slow growth, late maturation, long lived and migratory nature of green turtles. There is great potential for the development of these indicators through the modelling.

7. Recommendations

7.1 High Priority

- There is an urgent need to continue and expand the applied research and monitoring, including the tagging, of Queensland's green turtles, on nesting beaches and in feeding pastures in order to formulate sound management strategies.
- Queensland Parks and Wildlife Service should establish a formal green turtle project within its organisational structure.
- Population genetics research must be continued and intensified for the completion of a robust model of population simulation for each of the identified stocks.
- The Queensland Parks and Wildlife Service should commission (for an estimated six months period) a population modeller to bring the existing model to a level of completion for bench testing, for management purposes, with application to the sGBR green turtle stock.
- When the model has achieved fruition, population performance predictors and early warning indicators of population change should be tested for validity.
- For the nGBR stock, core feeding pasture study areas should be established for long term research and monitoring for the development of a management model concomitant to the sGBR stock.
- At Raine Island, it is absolutely essential that annual tagging and assessment of nesting females be continued during the established two week study window in December.
- The mass mortality of eggs due to catastrophic flooding from the Raine Island water table needs to be investigated and quantified. This will involve an additional visitation outside the previously identified December window.

- The magnitude of human induced mortality of green turtles needs to be better quantified from each of the stocks.

7.2 Other Recommended Actions of Priority

- Explore age estimates in green turtles using natural growth lines in bones (skeletochronology), for example, from dead turtles stranded at Raine Island and elsewhere.
- Deploy satellite transmitters on a sample of females at Raine Island during a low density nesting season to determine the locations of home feeding pastures of highest productivity.
- Assess primary productivity of foraging pastures utilised by each stock of green turtles.
- Expand the selective use of internal PIT tags to further evaluate the long term retention of external metal tags.
- Expand health screening of green turtles for the early identification of disease outbreaks (eg fibropapilloma tumours).
- Explore the use of remote sensing (eg satellite technology) to monitor and record/transmit in real time data and images of green turtles and their environment at Raine Island. Consider the use of a “webcam” to promote world wide conservation education about Raine Island and its wildlife.
- Continue building partnerships with other stakeholders in marine conservation, research, education and industry to accomplish critical tasks, such as set forth in the above recommendations.

8. Appendix 1

Additional background statement on green turtle research and monitoring conducted by the Queensland Parks and Wildlife Service.

The Queensland green turtle stocks are of significant national and international importance because of their shared habitats with neighbouring countries including Papua New Guinea, Indonesia and New Caledonia which have traditional, subsistence and commercial harvests of green turtles especially females of breeding size: and because of international treaties (Bonn Convention) which require monitoring of migratory species including green turtles which cross international boundaries.

In view of these factors, population performance indicators of hatching success of eggs, survivorship of hatchlings, recruitment of subadults to feeding grounds and their sex and age specific growth rates, recruitment of females into the breeding populations, age specific fecundity and reproductive longevity are required to produce life history and survivorship models from which acceptable levels of harvest may be produced to sustain the cultural requirements and food requirements for indigenous peoples and to maintain the economic endeavours of nationals of the countries affected by any proposed management plans.

Present knowledge of population genetics and analytical techniques have been able to identify three Queensland meta-populations with minimal genetic flow between each population within a larger genetic identity as indicated by preliminary work on microsatellite techniques, which comprise the above three meta populations. Of the three genetic stocks the southern Great Barrier Reef stock has received the greatest attention in terms of population performance indicators and life history analysis. The model developed for the Southern Great Barrier Reef stock holds great promise for being applicable to the remaining stocks. It is anticipated that the models developed for the stock based on core areas, ie Heron Island will assist in fast tracking the models based on core areas for the northern Great Barrier Reef Stock core areas, ie Raine Island. A core area for the Gulf of Carpentaria stock should be developed.

The Queensland National Parks and Wildlife Service and the personnel involved in green turtle research and monitoring are to be congratulated for developing methodologies to answer specific research and management questions. These methodologies include an assessment of existing external tagging techniques to produce a reliable long lived corrosion resistant self piercing reliable metal tag and assessing tag loss and correcting the sites of tag application on the animals. This methodology has enabled the documentation of life histories for a large number of individually identifiable sea turtles on feeding grounds and nesting beaches.

Saturation tagging of green turtles in the core areas of the southern Great Barrier Reef have reduced the problems inherent in having access to only a sample of

green turtles in the respective investigations of feeding ground and nesting beach studies.

Techniques of gonad assessment by either autopsy of dead turtles or laparoscopic examination to identify the sex of living individuals and their reproductive condition and their reproductive history, have been of international significance in fine tuning aspects of the model during its development.

9. Appendix 2

List of participants and their affiliations and addresses.

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10. Appendix 3

Transcripts of written submissions to Balazs and Guinea by the workshop participants in response to the question “What is the single most important research / management issue that needs to be addressed in the nGBR green turtle stock?”.

- Urgently address the lack of information regarding age structure of the population. Create a government funded position to provide this information in the short term.
- I don't feel qualified to comment, but from what I have seen today and yesterday, it would have to be the “black hole” of the Indonesian/PNG harvest. What proportion of the nGBR stock migrate to these regions and what proportion are harvested? Is it sustainable and, if not, how can it be reduced?
- Obtain the data necessary to facilitate the development of a biologically based model in support of the conservation management of the stock.
- Develop and sustain data capture strategies / sites that will allow the use of robust, multifactorial population modeling suite (*a la* Chaloupka's presentation). management use of these models to then aim to sustain pre-European population levels.
- Key management issue: “What is the impact of harvesting (indigenous, New Caledonian etc) on the long-term viability of the nGBR metapopulation?”

Management objective could be: “What is the probability of nGBR stock abundance declining to effective extinction (eg < 100 individuals) within 100 years of the impact?”

Inadequate data exists for nGBR stock available to address this issue. Research agenda needs to focus on this. In the interim the sGBR model could be used.

- Must address competing risks including: What is the impact of the collective harvest of green turtles in Torres Strait, Gulf of Carpentaria, Arnhemland, Eastern Indonesia and Southern PNG on the nGBR Stock? Is the current egg mortality at Raine Island and Moulter Cay leading to the decline of the population of the population? Where is the principal productivity of hatchlings for the nGBR stock?
- Research: Develop and implement (at an appropriate number of sites eg. Raine Island and Millman Island) recruitment indices (eg pelagic to benthic; proportion of first time breeders at nesting beach) that can be used as an “early warning” indicator of the status of the nGBR metapopulation.

Management: Collate review and integrate the existing nGBR metapopulation turtle and harvest data into a population model (with the assumptions and the treatments in the model explicitly documented). The objective of the model would

be to undertake a risk assessment and to clarify research, monitoring and management priorities.

- Hatchling production at Raine Island and Moulter Cay - geomorphological features that decrease hatchling production (flooding of nests/ shallow sand layer preventing digging) - high unsuccessful nesting attempts and its potential to decrease hatchling production - high rates of atresia warrants investigation.

- Density dependent nesting turtle destruction of incubating clutches.

Microbial contamination of such non-viable eggs and subsequent fungal invasion of adjacent healthy clutches, further decreasing hatch success.

Incubation problems associated with water table fluctuations.

The influence of the above factors on hatchling production and the availability of future reproductive stock.

- Where are the turtles nesting at Raine Island / nGBR coming from? Are they residing / foraging within Queensland? Australia? or neighbouring countries (Indonesia Papua New Guinea, East Malaysia)? What are the proportions for each site? And what are the impacts at these resident/foraging areas?
- Indonesian take - is it significant in context of nGBR stock sustainability?
- How important is the nesting ground at Raine Island to the distribution of turtles in other regions - Gulf of Carpentaria, Indonesia, Malaysia, Southern Great Barrier Reef?
- Obtain the data necessary to facilitate development of a biologically based model in support of the conservation management of the nGBR stock.
- Within other model requirements determine:

Survivorship

Settlement pelagic / benthic

Recruitment at puberty

Recruitment into adult population on an annual basis at more than two sites.

Determine interisland breeding exchange rates at two or more sites.

Determine annual breeding rates for each site

Determine annual growth rates of different size classes for each sex at several sites

- Determine hatching success and emergence success at several sites including Raine Island. Determine mortality risk for identifiable threats.

Background - I recognise nGBR data has not been worked up as for the south, but in any event, I am only able to comment in relation to Raine Island.

Response - Raine Island is famous for (through media coverage) its unimaginable number of green turtles at nesting time. It is constantly described as the largest nesting site in the world and as the last such frontier. The management protection and associated research must keep it that way. Should there be failure then my subsequent question would be: Did it fail because of the management instituted and kept in place? Because of the failure to institute adequate appropriate measures?

- There is a need for identification of the population of turtle in the Torres Strait area.

What part of the Torres Strait do turtle come from and belong to?

Impact of the catch rate from PNG, Indonesia and neighbouring countries and other Australian areas (hunting communities)?

Traditional inhabitants need further education and understanding of the green turtle - its stock nationally and internationally - its biology (This is important to the Torres Strait traditional inhabitants) - an understanding of their impact not only within the Torres Strait but overall (nationally / internationally).

- Determine if the stock is in decline.

Identify critical monitoring indicators

Develop population models with robust prediction or interpretive powers

provide management with decision making tools

Resource these activities.

(The attached flow diagram accompanied this response.)

