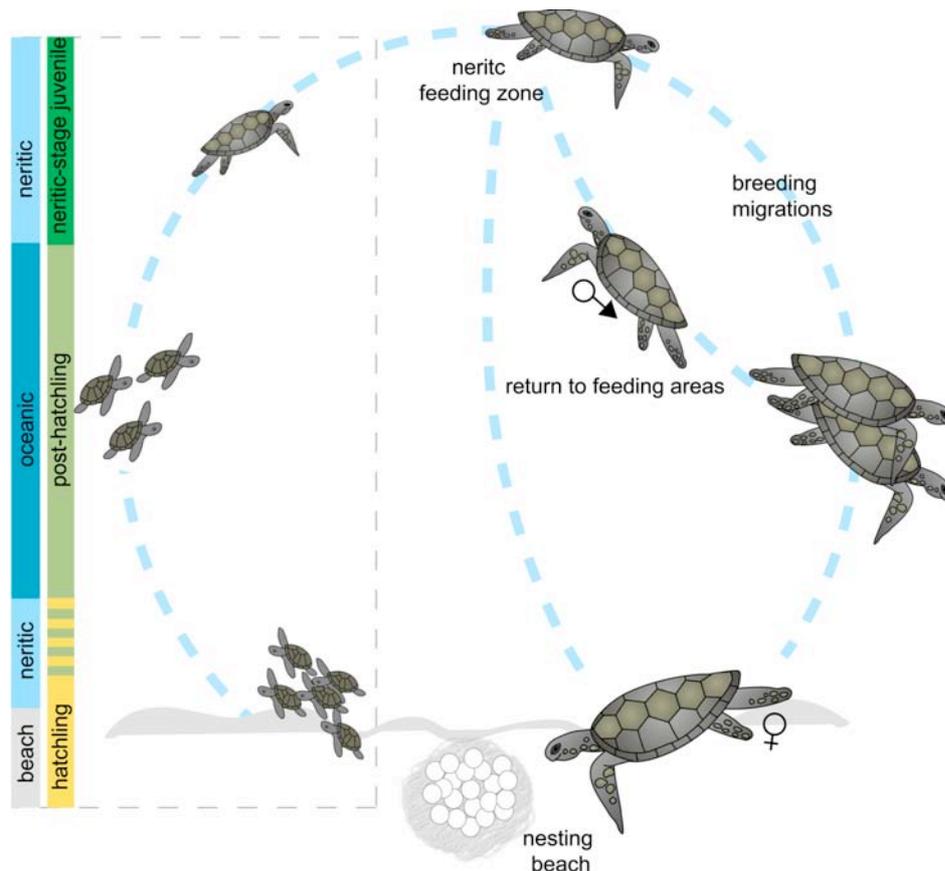


Post-hatchling sea turtle biology



This thesis is submitted for the degree of Doctor of Philosophy in the School of Marine and Tropical Biology at James Cook University, Townsville, Queensland, Australia by

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October 2006

Statement of sources

DECLARATION

I declare that this thesis is my own work and has not been submitted in any form for another degree or diploma at any university or other institution of tertiary education. Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references given.

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Statement of the contribution of others

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Glossary of terms

Many of these definitions are adapted from Lawrence, 1989 and Lincoln et al., 1998.

Anadromous	Referring to fishes that spend all or part of their adult life in salt water and return to freshwater streams and rivers to spawn.
Benthic	Organisms living in or on the bottom substrate of an aquatic environment.
Curved carapace length	A carapace length measurement for turtles. Measured from the anterior point at midline of nuchal scute to the posterior notch at midline between the supracaudal marginal scutes.
Clade	A monophyletic group of taxa sharing a closer common ancestry with one another than with members of any other group of taxa.
Colonisation	The invasion, and subsequent occupation of a new habitat by a species.
Colonisation bottleneck	A decrease in population density with resulting decrease in genetic variability through the process of colonisation.
Demersal	Organisms dwelling at or near the bottom of the sea or other body of water.
DNA	Deoxyribonucleic acid, the molecule of heredity that encodes genetic information.
DNA sequencing	The determination of the exact order of nucleotides in a segment of DNA.
Epipelagic	The upper part of the oceanic zone (normally photic) from the surface to about 200m depth.
Gene	A hereditary unit consisting of a sequence of DNA that occupies a specific location on a chromosome and determines a particular characteristic in an organism.
Genetic marker	A gene or segment of DNA with an identifiable physical location on a chromosome.
Haplotype	A unique DNA sequence usually referring to mtDNA.
Management Unit	Populations showing significant divergence in allele frequencies at nuclear or mitochondrial loci, regardless of phylogeny of alleles.
Microsatellite	A length of repetitive DNA composed of a variable number several to one hundred of more tandem repeats.
Monadrous	Referring to a mating system in which a female mates with only one male during a breeding season.
Natal origin	An individual's birth place.
Negative control	A PCR reagent to which no DNA has been added, used to indicate contamination of PCR reagents.
Neonate	With reference to marine turtles, a newly emerged hatchling, especially less than two days old.

Neritic		The inshore marine environment where bottom depths do not exceed 200m in depth.
Neuston		Minute organisms that float or swim on the surface of water.
Nucleotide		A subunit of DNA or RNA consisting of a nitrogenous base, a phosphate and a sugar molecule.
Oceanic		The open ocean environment where waters exceed 200m in depth.
Ontogenetic		The development history of an individual organism from its origin to its death.
Polymerase reaction (PCR)	chain	A technique for amplifying a region of DNA by separating the DNA into two strands and incubating it with flanking primers and DNA polymerase.
Pelagic		Organisms that occupy the water column in either the neritic or oceanic zone.
Philopatry		In animal behaviour, the tendency of a migrating animal to return to a specific location in order to breed or feed. Species that return to their birthplace in order to breed are said to exhibit natal philopatry.
Phylogeny		The evolutionary history of lineages or species.
Phylogenetic tree		A diagram showing the evolutionary relationships of a group of organisms that descended from a common ancestry. The distance of one group from the other groups indicates the degree of relationship.
Plankton		Tiny animals and plants floating in the sea or in lakes, usually near the surface.
Polyandrous		Referring to a mating system in which a female mates with several males during one breeding season.
Restriction length polymorphism (RFLP)	fragment polymorphism	Variations in the length of restriction fragments resulting from action by a specific endonuclease in a given genetic locus.
Stable Isotope		An isotope which does not spontaneously undergo radioactive decay.
Taq polymerase		A thermostable polymerase isolated from the thermophilic bacterium <i>Thermus aquaticus</i> . Often used in polymerase chain reaction.
Trophic shift		An organisms change of feeding habits.

Acronyms

BW	Beach washed (stranded)
CCL	Curved carapace length
CS	Coral Sea
DNA	Deoxyribonucleic acid
EAC	East Australian Current
MICRON	Micronesia
MR	Mon Repos, Queensland
MSA	Mixed stock analysis
mtDNA	Mitochondrial deoxyribonucleic acid
NC	New Caledonia
nDNA	Nuclear deoxyribonucleic acid
NEPNG	North-east Papua New Guinea
NGBR	Northern Great Barrier Reef
PF	Predatory fish
RFLP	Restriction fragment length polymorphism
SEC	Southern Equatorial Current
SGBR	Southern Great Barrier Reef
SIA	Stable isotope analysis
SR	Swains Reef, Queensland
WR	Wreck Rock, Queensland

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The post-hatchling stage of a sea turtle's life history has often been referred to as the 'lost years', reflecting the lack of understanding about this phase in their life. Obtaining information on where post-hatchlings go, or for how long, is significantly hindered by the elusiveness of a post-hatchling in its natural environment and the limitations of tagging technologies to track a hatchling as it leaves its nest. Consequently, much of what is understood of the post-hatchling life stage has been derived from indirect methods. As a result, our current understanding of post-hatchling biology is based on information gathered from stranded animals, opportunistic reports of sightings at sea, studies of hatchling behaviour, and more recently genetic based studies.

Although knowledge on the post-hatchling stage has progressed considerably in the last few years, studies have been limited primarily to loggerhead turtles in the northern Atlantic Ocean and northern Pacific Ocean. Thus there are substantial gaps in our knowledge of the life history of sea turtles for many regions of the world. The aim of this study is to increase the understanding of the ecology of loggerhead and green post-hatchling sea turtles in the southwest Pacific Ocean. The information acquired on the post-hatchling phase of sea turtle life history will help direct future regional management of these animals by providing region-specific information on the migratory routes and habitats occupied during the post-hatchling stage. This study also informs our global understanding of the sea turtle post-hatchling biology.

This study employed a multidisciplinary approach, incorporating ecological information from spatial and temporal distributions, diet and stable isotopes, and genetic methodologies. Post-hatchlings were sourced from strandings and from the stomachs of dolphin fish (*Coryphaena hippurus*). In addition, records were collated from the Queensland Environmental Protection Agency's database of marine wildlife strandings and deaths.

Data on the spatial and temporal distribution of post-hatchlings in relation to rookery location and oceanographic features compiled in this study provides evidence that loggerhead and green post-hatchlings from populations in the southwest Pacific region become entrained in oceanic currents and live a pelagic existence. Occupancy of an oceanic and pelagic habitat is supported by stable isotope signatures. In addition dietary investigations that show post-hatchlings in the southwest Pacific Ocean, from both of the investigated species, derive nutritional sustenance primarily from neustonic animal matter.

The spatial and temporal data on the two species of post-hatchlings however, indicates that the two species do not take the same migratory route after departing from the same coastal waters. The data provides strong evidence that loggerhead post-hatchling undergo trans-Pacific migrations within the southern Pacific sub-tropical gyre. This is suggested by; (i) incremental post-hatchling size increase in direction of this current away from nesting beaches, (ii) reports of loggerhead post-hatchlings are in New Zealand waters and on the eastern side of the southern Pacific, and (iii) loggerhead post-hatchlings larger than 13.7 cm CCL are not documented in the southwest Pacific Ocean. Although the current resolution of the genetic stocks in the southern Pacific does not allow differentiation between stocks on a regional scale, there is discrimination at the oceanic scale. Analysis of the haplotypes of the

loggerhead post-hatchlings shows that all specimens investigated in this study originated from southwest Pacific rookeries.

Whereas the data implies that loggerhead post-hatchlings embark on trans-Pacific migrations, it suggests that green post-hatchlings do not. Whilst this species also occupies offshore oceanic waters, it appears they remain in the southwest Pacific region. This is indicated by; (i) green post-hatchlings occupying waters around offshore seamounts (whereas loggerhead post-hatchlings appear absent), (ii) the absence of green post-hatchlings in New Zealand or southeast Pacific waters, and (iii) the occurrence of larger size classes of green post-hatchlings stranded on eastern Australian coast. Mixed stock analysis (using SPAM & TURTLE) performed with haplotypic information from post-hatchlings calculated that green post-hatchlings originate from the SGBR (60%), Coral Sea (27%) and New Caledonia (13%) rookeries.

This study is the first to describe the route that loggerhead and green post-hatchlings from the Australian region are taking. I demonstrate that these two species are undertaking significantly different migrations during this stage of their life. The principal findings of this study support the currently accepted view on the sea turtle's post-hatchling stage, for most species, is that of a pelagic oceanic existence.

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