Green Sea Turtle, *Chelonia mydas* (Linnaeus 1758) Conservation in Lundu, Sarawak: Historical Perspective, Framework for Headstart and Community-based Effort

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Green Sea Turtle, *Chelonia mydas* (Linnaeus 1758) Conservation in Lundu, Sarawak: Historical Perspective, Framework for Headstart and Community-based Effort

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A thesis submitted

In fulfilment of the requirements for the degree of Doctor of Philosophy

(Marine Science)

Faculty of Resource Science and Technology
UNIVERSITI MALAYSIA SARAWAK
2018

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I hereby declare that the work in this thesis is my own except for quotations and summaries which have been dully acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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9th August 2018

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ABSTRACT

Green turtle exists in Sarawak waters and its small scale conservation effort had already started since 1950s. The success of the effort is still debatable, as the data collected was not made readily available, while public participation in the conservation effort is still at infancy stage. The current study involved analysing nesting data of green turtles of Sarawak Turtle Islands, headstarting to obtain survival and growth of turtles in captivity while predicting the size at maturity for Sarawak's green turtle, disease profiling of turtle carcass from headstart program and conducting community based awareness program. Nesting, egg collection, incubation and hatching success data for 36 years has shown that Sarawak's green sea turtle population has stabilized (approximately 3000 nesters) after the drop in nesting trend in the 1950s. The number of eggs collected and incubated since 1990 until 2016 was 90 to 100 %, which helped to improve the number of nesters as more hatchlings were released into the sea. Estimation shows that Sarawak has an average of 3,088 mature nesters from 2010 until 2016 that corresponds to a calculated remigration interval of 3 to 4 years with internesting frequency of 3 times per season for matures nesters. Eighteen months of headstart program has been successful with survival rate of 22.5 % and 82 % for Batch 1 and 2, respectively. The growth rate of the turtles was 9.86 cm/year (Batch 1) and 15.92 cm/year (Batch 2). Batch 2 was found to be heavier and longer compared to Batch 1 with mean of 2.65 ± 0.64 g for weight and mean of 2.16 ± 0.02 cm for straight carapace length (SCL) compared to Batch 1's mean of 2.51 ± 0.63 g for weight and mean of 2.08 ± 0.19 cm for SCL. Based on both growth data from the headstart program and secondary data, a von Bertalanffy growth function was obtained for green turtles of Sarawak, where a first time female nester in 1982 with SCL of 101.03 cm was estimated to be between 12.5 to 13 years old. Commonly observed physical appearances of

dead hatchlings were eye infection, bite mark, red or blue marks, bloated plastron and emaciation. The types of diseases found were classified as infectious and non-infectious. The commonly found bacteria that are associated with infectious diseases are *Proteus* sp., *Pseudomonas* sp., *Klebsiella pneumonia*, *Morganella morganii* and *Citrobacter freundii* while 4 taxa of fungi namely *Cladosporium* spp., *Penicillium* sp., *Aspergillus* spp. and *Gibberella* sp. were found in the carcasses. Batch 1 showed a higher disease and mortality count when compared to Batch 2 as the handling and management technique was better for the latter. A Standard Operating Procedure comprising of human-turtle interaction manual, husbandry practice plus behavioural and disease management tactics to be used for small scale headstart program was produced. The awareness programs resulted in a positive community-based effort involving local communities of Lundu, the public, as well as private and government agencies. Development of an educational toolkit on green sea turtle at the end of the project is hoped to be of help in the conservation of sea turtle in the future. The survey conducted during the program has reflected a positive vibe as 96.5 % of the total participants were willing to attend another sea turtle awareness program.

Keywords: Green sea turtle, headstart, disease, awareness program, education toolkit.

Konservasi Penyu Agar,* Chelonia mydas *(Linnaeus 1758) di Lundu, Sarawak: Dari Perspektif Sejarah, Rangka Kerja untuk Program 'Headstart' dan Usaha Melibatkan Komuniti

ABSTRAK

Penyu agar wujud di perairan Sarawak dan usaha konservasi berskala kecil penyu agar telah bermula sejak tahun 1950an lagi. Namun begitu, kejayaan program konservasi penyu agar di Sarawak sering dipersoalkan kerana data yang dikumpul tidak tersedia untuk tatapan umum manakala usaha konservasi bersama orang tempatan adalah minimum. Kajian ini meliputi analisis data berkaitan penyu hijau yang bertelur di Pulau Penyu Sarawak, projek 'headstart' untuk mendapatkan data kelangsungan hidup dan tumbesaran untuk penyu yang diternak lantas menggunakan data itu untuk mengenalpasti saiz penyu agar yang matang, pengenalpastian penyakit dan agen pembawanya dari bangkai penyu yang dikumpul dari program 'headstart' dan mengendalikan program konservasi penyu berteraskan komuniti. Data berkaitan bilangan penyu bertelur, pengumpulan dan pengeraman telur penyu serta kadar penetasan selama 36 tahun telah menunjukkan populasi penyu agar di Sarawak dalam status stabil (lebih kurang 3000 sarang) setelah penurunan mendadak populasi sekitar 1950an. Jumlah telur yang dikutip dan dieramkan semenjak 1990 hingga 2016 adalah sekitar 90 hingga 100 peratus dan kemungkinan besar telah membantu menambahkan bilangan penyu bertelur kerana lebih banyak anak penyu telah dilepaskan ke laut. Dianggarkan Sarawak kini mempunyai purata 3,088 penyu matang yang bertelur dari tahun 2010 hingga 2016 dengan julat migrasi 3 ke 4 tahun dan frekuensi kekerapan bertelur sebanyak 3 kali semusim. Program 'headstart' penyu agar selama 18 bulan telah berjaya dilaksanakan dengan kadar kelangsungan hidup sebanyak 22.5 dan 82 % bagi kumpulan 1 dan 2 masing-masing. Kadar tumbesaran

penyu sekitar 9.86 cm/tahun (Kumpulan 1) dan 15.92 cm/tahun (Kumpulan 2). Berdasarkan data terkumpul 'headstart' dan data sekunder, fungsi tumbesaran von Bertalanffy bagi penyu agar Sarawak mendapati bahawa seekor penyu yang pertama kali bertelur pada tahun 1982, dengan 101.03 cm SCL dianggarkan berumur sekitar 12.5 hingga 13 tahun. Pemeriksaan fizikal bangkai anak-anak penyu telah menemukan kesan jangkitan mata, kesan gigitan, kesan lebam warna merah atau biru tua pada badan, 'plastron' membengkak dan sindrom 'emaciation'. Penyakit berjangkit dan bukan berjangkit yang terdapat pada bangkai penyu merekodkan kehadiran bakteria Proteus *sp.,* Pseudomonas *sp.,* Klebsiella pneumonia, Morganella morganii *dan* Citrobacter freundii. *Di samping itu, empat taksa fungi juga dijumpai iaitu* Cladosporium *spp.,* Penicillium *sp.,* Aspergillus *spp. dan* Gibberella *sp..Kumpulan 2 menunjukkan kadar kematian dan jumlah penyakit yang lebih sedikit berbanding Kumpulan 1 disebabkan oleh teknik pengurusan dan pengendalian yang lebih baik. Prosedur Operasi Standard yang mengandungi manual interaksi manusia-penyu, teknik penternakan dan juga taktik pengurusan perangai dan penyakit untuk digunakan oleh program 'headstart' berskala kecil telah dihasilkan. Program kesedaran berkenaan konservasi penyu agar Sarawak berteraskan komuniti telah memberi impak positif dengan penglibatan komuniti setempat sekitar Lundu, orang awam, pihak swasta dan pelbagai agensi kerajaan. Penghasilan kit pembelajaran berkenaan penyu agar pada akhir projek ini diharap dapat membantu program konservasi penyu yang berterusan pada masa hadapan. Survei yang dibuat selepas program kesedaran memberikan keputusan yang positif kerana sebanyak 96.5 % peserta mahu mengikuti program begini lagi.*

Kata kunci: *Penyu agar, program 'headstart', penyakit, program kesedaran, kit pembelajaran.*

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LIST OF ABBREVIATIONS

DNA	Deoxyribonucleic Acid
bp	Base pair
min	Minute
sec	Seconds
rRNA	Ribosomal Ribonucleic Acid
ppm	Parts per million
CTAB	Cetyltrimethyl ammonium bromide
NaCl	Sodium Chloride
$MgCl_2$	Magnesium Chloride
TAE	Tris-Acetate-ethylenediaminetetraacetic
ddH_2O	Deionized distilled water
g	Gram
mg	Milligram
mL	Mililiter
mM	Milimolar
M	Molar
L	Liter
µL	Microliter
µM	Micromolar
mm	Millimeter
rpm	Rotation per minute
UV	Ultra violet

V	Volt
SCL	Straight Carapace Length
×g	Gravity
dNTP	Deoxy-nucleotide triphosphates
SCW	Straight Carapace Width
CCL	Curved Carapace Length
CCW	Curved Carapace Width
SFC	Sarawak Forestry Corporation
IK	Information Kiosk
WCS	Wildlife Conservation Society
SFD	Sarawak Forest Department
SEATRU	Sea Turtle Research Unit
SOP	Standard Operating Procedure
UNEP	United Nations Environment Programme
STIs	Sarawak Turtle Islands
MU	Management Unit
TIHPA	Turtle Island Heritage Protected Area
UNIMAS	Universiti Malaysia Sarawak
CCC	Caribbean Conservation Corporation
CBC	Community Based Conservation
FACA	Faculty of Applied and Creative Arts
LCD	Liquid Crystal Display
cm	Centimeter
RH	Relative Humidity