Marine Ecology Enhancement Fund (MEEF)
Declaration

To: The Secretariat of the MEEF

Reference No.: MEEF2019010

Project Title: Three-dimensional forensic scene investigation of marine vessel interaction in Indo-Pacific humpbacked dolphins and Indo-Pacific finless porpoises in the Hong Kong waters

Name of Project Leader: Brian Chin Wing Kot

I hereby irrevocably declare to the MEEF Management Committee and the Steering Committee of the relevant Funds including the Top-up Fund, that all the dataset and information included in the completion report has been properly referenced, and necessary authorisation has been obtained in respect of information owned by third parties.

Signature: _____
Project Leader, Brian Chin Wing Kot

Date: 21.1.2021

For Use by the Secretariat:
MEEF2019010
(Reference Number)

MARINE ECOLOGY ENHANCEMENT FUND (MEEF)

Completion Report for Year 2019-2020

Report for the period ending 30 June 2020

Any opinions, findings, conclusions or recommendations expressed in this report do not necessarily reflect the views of the Marine Ecology Enhancement Fund or the Trustee

Part A: Executive Summary

1. Executive Summary

Throughout 12 months, from 1 July 2019 to 30 June 2020, project entitled "Three-dimensional forensic scene investigation of marine vessel interaction in Indo-Pacific humpbacked dolphins and Indo-Pacific finless porpoises in the Hong Kong (HK) waters", has been ongoing progressively and its objectives have been 20-30% accomplished. Despite the social unrest and COVID-19 pandemic, all supporting staffs had been recruited to assist the workflow of this project. The realization of the 5 project objectives are illustrated as below:

a) To describe and compare the spatiotemporal patterns of vessel traffic between night and day and within the day in Indo-Pacific humpbacked dolphins and Indo-Pacific finless porpoises habitats in the HK waters;
b) To identify and document the vessel type and speed that pose interaction risk with cetaceans and reveal the unsuspected vessel interaction 'hot spots' by analyzing the AIS-cetacean population density data in the HK waters;

Two sources of retrospective dolphin sighting data collected by line transect surveys from Agriculture, Fisheries and Conservation Department (AFCD: Monitoring of marine mammals in Hong Kong waters) and Hong Kong Airport Authority (3RS: Expansion of Hong Kong International Airport into a Three-Runway System Construction Phase Annual EM&A Report) were consolidated by our team for the contractor to generate the map illustrating the distribution of dolphin sightings in HK as the first step of analysis. Three more sources of data from Hong Kong-Zhuhai-Macao Bridge Hong Kong Boundary Crossing Facilities, Hong Kong Link Road and Tun Mun-Chek Lap Kok Link will also be added into the preparing grid layer.

c) To document and describe the types of suspected trauma-inflicting instrument using 3-D surface scanning technique, leading to injury induced by vessel interaction in stranded cetaceans;

In May 2020, our team conducted 3-D surface scanning (3DSS) on 2 marine vessels by Artec Ray as the trial scan. These 2 trial scans allowed us to familiarise with the practical technique in using the Artec Ray on scanning the marine vessel and related accessories. Site visit and planning on the 3DSS were required prior to the actual scan. Each scan should have at least 4 personnel to operate the Artec Ray, and ensure that the scanning quality is up to standard. In view of the COVID-19 pandemic and prohibition on group gathering, more 3DSS on vessel will be conducted once the situation allows.

d) To combine the 3-D models obtained from virtopsy (internal) and 3-D surface scanning data (external) and perform matching analysis of the injury induced by vessel interaction and suspected injury-inflicting instrument using 3DSS, virtopsy and conventional necropsy findings;

As of 30 June 2020, 42 out of 51 HK stranded cetaceans (82%) were performed virtopsy, including 10 Indo-Pacific humpbacked dolphins (SC), 26 Indo-Pacific finless porpoises (NP), 6 other species. All the virtopsy findings were verified by subsequent necropsy, with supplemented information given for the analysis of human interaction related injury and death of stranded cetaceans. The remaining 9 stranded cetaceans (18%) were recognized to be non-transportable and inappropriate for virtopsy by cetacean stranding response team of the Ocean Park Conservation Foundation Hong Kong (OPCFHK). Onsite necropsy and sample collection were directly performed on these cetacean carcasses by the team of OPCFHK.

In these 42 cases, findings of 11 stranded cetaceans (3 SCs and 8 NPs) were sufficient to assign the cause of death with confirmed, probable or suspect category associated with human interactions (33%), which included evidence of fishery (e.g. fishing gear entanglement/digestion), and vessel interactions (e.g. sharp chopped wound). The rest 31 stranded cetaceans (7 SCs, 18 NPs, and 6 other species) were likely associated with different causes of death, e.g. respiratory diseases, drowning and natural death. Most virtospy findings were consolidated and published bilingually on the project team stranded cetacean blog, allowing general public and international experts to obtain first-hand information and share their opinion on local stranding events.

For 3-D surface scanning, 10 cetacean carcasses and skeleton specimens (4 SCs, 5 NPs and 1 OT) were scanned by the 2 handheld scanners. 3-D models were reconstructed for matching analysis of the injury induced by vessel interaction and suspected injury-inflicting instrument using 3DSS, virtopsy and conventional necropsy findings.

e) To compile postmortem findings collected by original field notes, 3-D surface scanning, virtopsy and conventional necropsy, as well as the overlaid AIS-cetacean population density data, and transcribe into cetacean postmortem multimedia analysis platform for first time all-in-one real-databased models of the stranded cetacean for geometric comparison of patterned injuries with the presumed types of vessel interaction

A web-based database named "Cetacean Postmortem Multimedia Analysis Platform" was used to store all the data for post-processing and data analysis. Data compilation of 197 virtopsy cases (from March 2014 to 30 June 2020, included 46 SCs, 131 NPs and 20 other cetacean species) and respective links between the web server and DICOM viewer were completed. Inclusion of the corresponding stranding information and other multimedia of retrospective cases are in progress.

Three presentations were giving regarding a review of the currently available stranding and mortality database and virtopsy findings in this present project in 2 international conferences. Three manuscripts were submitted to peer-reviewed journals and under final review for publication. Findings from this present project had attracted extensive media attention, with a number of local and international print media voiced rising concern on unusual surge of stranding numbers during the project period, with supplemented virtopsy findings reported from P.I. and his team on cetacean stranding blog.

The highest number of stranding cases (55 cases) was recorded in 2019 for the past 10 years. From 1 July 2019 to 30 June 2020, 51 stranded cetaceans (12 SCs, 33 NPs, 6 other species) were recovered in HK waters, which was recognizably higher than the same periods of previous years' records (e.g. 45 cases in 2018). Eleven out of 42 stranded cetaceans underwent virtopsy were likely suspected to be associated with human interaction related injury and death. Although the project happened during the social unrest and COVID-19 pandemic with the unexpected surge of cetacean stranding, the project team had paid immediate efforts to convey precise conservative messages via outreach activities, such as maintaining social media engagement, conducting interviews with different print media and radio programs, holding talks and workshops, which jointly organised with the Hong Kong Science Museum and universities, to

elevate the public awareness on cetacean stranding response program, immediate threats the local cetaceans facing, injury and death of local cetaceans caused by human interactions, and the greater scope: marine conservation and interest in science and technology.

Part B: The Project and Investigator(s)

2. Project Title

Three-dimensional forensic scene investigation of marine vessel interaction in Indo-Pacific humpbacked dolphins and Indo-Pacific finless porpoises in the Hong Kong waters

法證重組: 船隻撞擊對香港水域的中華白海豚及江豚造成的威脅

3. Project Period

From 1 July 2019 to 30 June 2020 (both dates inclusive)

4. Nature of the Project

- ☐ Marine Habitat & Resource Conservation & Enhancement
- ☑ Scientific Research & Studies
- ☐ Environmental Education & Eco-tourism

5. Brief description of the Purpose of the Project

The reported number of local cetacean stranding and mortality cases have increased dramatically in recent years in the HK waters, with marine vessel interaction believed as the most commonly identified threat. Accurate documentation and visualization of injury patterns are crucial to determine the mortality as a result of vessel interaction. This project will pay specific focus on three-dimensional (3-D) forensic scene investigation of marine vessel interaction, by conducting matching analysis on injury on all cetaceans stranded in the HK waters, using 3-D models obtained from virtopsy (internal) and 3DSS datasets (external) of the carcasses and suspected injury-inflicting instrument. Spatiotemporal models of vessel interaction risk based on the overlap between cetacean population density/habitat use and marine traffic will also be established, which can complement information provided by postmortem investigations and eye-witness reports. This project will achieve useful outcomes to facilitate related government officials from Agriculture, Fisheries and Conservation Department, Environmental Protection Department, and HK Marine Department to formulate conservation plan, marine vessel route diversion and speed control, and fellow stakeholders including relevant ferry service/shipping companies, academics, green groups and cetacean experts to implement effective management plan for injury prevention for vulnerable local resident cetaceans in our waters.

近年，鯨豚在香港水域擱淺及死亡的數字有顯著的上升，當中最常見的威脅相信便是船隻撞擊，判斷船隻撞擊為鯨豚死亡原因的關鍵則是準確地紀錄與重現其損傷的模式。

本項目會集中研究船隻撞擊鯨豚的法證重組。透過影像解剖及立體掃瞄，本項目可取得所有在香港擱淺鯨豚身上的傷口及有機會造成其損傷的船隻的立體模型，再加以配對及分析資料，從而重組船隻撞擊鯨豚的情況。其次，透過重疊鯨豚族群分佈及海上交通航道，本項目亦可建立鯨豚受到船隻撞擊風險的模型，藉此互補鯨豚的死後調查與生前目擊報告。

本項目的結果將會協助漁農自然護理署、環境保護署及香港海事處制定保育計劃、海上交通航道分流及速度管制。其他持份者包括船務公司、學者、環保團體及鯨豚專家亦可以藉此推行有效的管理計劃，防止在香港水域居住的易危鯨豚受到傷害。

6. Investigator(s) and Academic Department/Units Involved

Research Team	Name / Post	Unit / Department / Institution
Principal Investigator	Dr. Brian Chin Wing KOT, Research Fellow/Visiting Assistant Professor	State Key Laboratory of Marine Pollution/Department of Infectious Diseases and Public Health, Jockey Club College of Veterinary Medicine and Life Sciences, City University of Hong Kong
Co-investigator	Prof. Sophie DENNISON, Adjunct Professor	Diagnostic Imaging, University of Wisconsin, Madison, Wisconsin, USA
Co-investigator	Dr. Paolo MARTELLI, Chief Veterinarian	Department of Zoological Operations and Conservation, Ocean Park Corporation
Co-investigator	Prof. Michael J. THALI, Director	Institute of Forensic Medicine, University of Zurich
Supporting body	Dr. Wai Chuen NG, Marine Conservation Officer	Agriculture, Fisheries and Conservation Department, The Government of the Hong Kong SAR
Supporting body	Dr. Lindsay Porter	SMRU (Hong Kong) Limited
Supporting body	Dr. Jonathan P. SPEELMAN	Peace Avenue Veterinary Clinic, City University of Hong Kong
Supporting body	Dr. Andreas SRTRUCK	NAVAMA

7. Timetable of Completed Activities against the Proposed Work Schedule

Activities	Original Period	Progress
Recruitment of support staff	July 2019	Completed
Training of support staff	July – September 2019	Completed
Compilation of retrospective cases and prospective data collection	July 2019 – June 2022	In progress
Stranded cetacean blog	July 2019 – June 2022	In progress
Press release/media tea reception	Winter 2019	Completed
HK SciFest 2020	Spring 2020	Cancelled due to the COVID-19 pandemic
Public seminar/Symposium I	Autumn 2020	Preparation in progress
HK SciFest 2021	Spring 2021	On schedule
Public seminar/Symposium II	Autumn 2021	On schedule
HK SciFest 2022	Spring 2022	On schedule
Data consolidation and write up publications	April – June 2022	In progress
Handbook of three-dimensional forensic scene investigation of marine vessel interaction in stranded cetaceans	April – June 2022	In progress

8. Project Expenditure

Project expenditure details are not disclosed due to confidentiality reason.

Part C: Completion Report on Year 2019-2020 Project Progress

9. Project Objectives

9.1 Objectives as per Original Application

a) To describe and compare the spatiotemporal patterns of vessel traffic between night and day and within the day in Indo-Pacific humpbacked dolphins and Indo-Pacific finless porpoises habitats in the HK waters;
b) To identify and document the vessel type and speed that pose interaction risk with cetaceans and reveal the unsuspected vessel interaction 'hot spots' by analyzing the AIS-cetacean population density data in the HK waters;
c) To document and describe the types of suspected trauma-inflicting instrument using 3-D surface scanning technique, leading to injury induced by vessel interaction in stranded cetaceans;
d) To combine the 3-D models obtained from virtopsy (internal) and 3-D surface scanning data (external) and perform matching analysis of the injury induced by vessel interaction and suspected injury-inflicting instrument using 3-D surface scanning technique, virtopsy and conventional necropsy findings;
e) To compile postmortem findings collected by original field notes, 3-D surface scanning, virtopsy and conventional necropsy, as well as the overlaid AIS-cetacean population density data, and transcribe into cetacean postmortem multimedia analysis platform for first time all-in-one real-databased models of the stranded cetacean for geometric comparison of patterned injuries with the presumed types of vessel interaction.

9.2 Revised Objectives

N/A

10. Research Activities

(Results / descriptions on the completed activities with appropriate analysis, with the support of photos, videos, social media platform, etc.)

10.1 Areas addressed in relation to the project objectives that were carried out during this reporting period

A. Recruitment of the supporting staff

Due to the unexpected social unrest in HK, only one Senior Research Assistant was able to recruit by November 2019 for a period of around 8 months. In order to catch up the project progress, 3 more staff were recruited subsequently. One Senior Research Assistant was recruited by February 2020 for a period of 5 months. One Research Assistant was recruited by January 2020 for a period of 5 months and 1 Research Assistant was recruited by the same month for a period of 3 months. All staff have quickly taken up the role as project manager or assistants to assist P.I. to oversee project logistics arrangement, liaison and coordination among other team members, departments and collaborators, data collection and management (i.e. and data gathering and archiving) and publication preparation.

B. Training of the supporting staff

The supporting staff underwent training by the P.I. in the first month of employment for PMCT/PMMRI imaging techniques, 3-D surface documentation techniques, and 3-D volume reconstruction and rendering processes, familiarization of highly specific cetacean anatomy and pathology, as well as the basic knowledge on vessel traffic and the cetacean habitats in HK waters. The staff was also advised that the project should be executed according to timelines, with proper documentation maintained throughout the project. Following the initial training period, the supporting staff accustomed to the stranding procedures, assisted all postmortem imaging procedures, stranded cetacean carcass logistics and liaison, and data gathering and archiving.

C. Stranded cetacean blog and media coverage

Two social media accounts regarding this project have been developed, including Facebook and Instagram, as a continuation of the good practice in the previous MEEF project (reference number: MEEF2017014 and MEEF2017014A). These social media acted as a world-first stranded cetacean social platform 1) to document stranding incidents (highlight injury and death caused by marine vessel interaction) with virtopsy-driven stranding response effort in HK waters; 2) to allow clinicians, scientists, researchers, governmental officials and general public to archive first-hand information and share their views on HK local cetacean stranding cases; 3) to promote regional seminar and workshop to facilitate knowledge exchange on stranded cetacean postmortem investigation with injury and death caused by marine vessel interaction; and 4) to deepen engagement with social networks around marine ecology, conservation and related research interests. Up to 30 June 2020, the blog has reached over 290,000 users with 2,127 followers and 123 posts were published.

On 29 November 2019, due to the expansion in role and nature of our team, the team was renamed as Aquatic Animal Virtopsy Lab (Facebook: https://www.facebook.com/aquanimallab/ ;Instagram: https://www.instagram.com/aquanimallab/) (Fig. 1). The team will persist the focus on cetacean postmortem research, and at the same time, expand and extend our established virtopsy techniques and knowledge to other aquatic animals as well, such as sea turtles in HK waters.

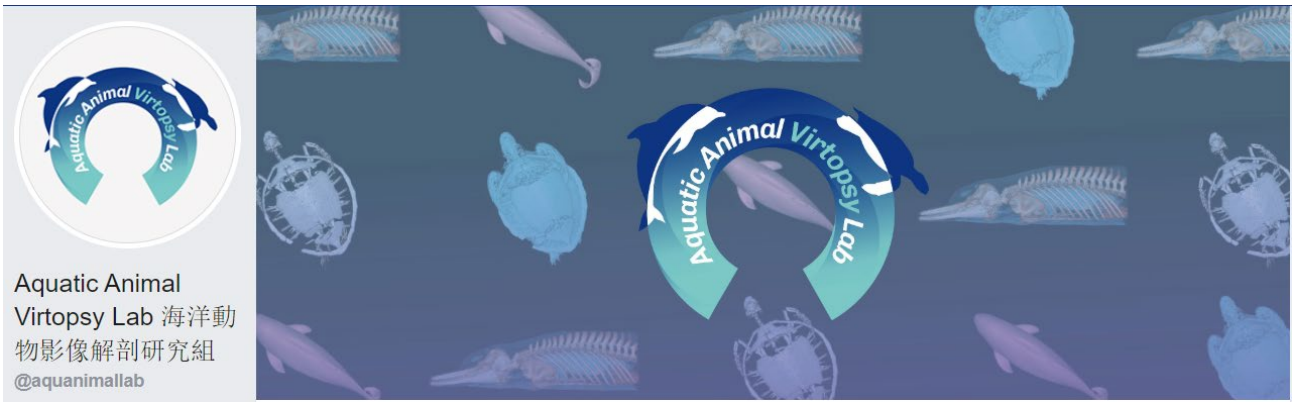


Fig 1. Expansion and rename of our team - the Aquatic Animal Virtopsy Lab.

Apart from the promotion of cetacean stranding blog, *CityU today*: an university official magazine published by the Communications and Public Relations Office of City University of Hong Kong, with the mission to inform the University's stakeholders around the world of University activities, issues, people and achievements, published a cover story of this project in October 2019. This cover story entitled "Virtopsy – new ways of looking at marine mammals", featured in-depth interviews with P.I. and his team regarding the virtopsy and postmortem investigation on local stranded cetaceans. This article also highlighted the outreach events P.I. and his team organized in 2019 and acknowledged the funding support from the Marine Ecology Enhancement Fund.

Six interviews on P.I. and his team's works and virtopsy findings were also conducted by the various media and published from December 2019 to June 2020, as listed below:

Newspaper	Title	Date	URL Link
Apple Daily 蘋果日報	【隨着魚們下沉】合力推上水面協助呼吸 終不果 7條中華白海豚伴幼豚屍	15th June 2020	https://bit.ly/3fA7jcR
	100條偽虎鯨維港暢泳 目擊市民：成群跳上海面、好生猛	17th January 2020	http://bit.ly/37Zxbvz http://bit.ly/2RWTOLt
CityU NewsCentre	Virtopsy – new ways of looking at marine mammals/影像解剖：研究海洋哺乳動物的新方法	October 2019	http://bit.ly/39BF8YL
Headline Daily 頭條日報	7條中華白海豚伴屍 用嘴將幼豚推上水面協助呼吸	15th June 2020	https://bit.ly/3fBwyM1

HK01	鯨豚擱淺歷年最多　「鬼網」塞滿胃部　垃圾致營養不足、骨質疏鬆	21st December 2019	http://bit.ly/37YOVa9
Petsmao 寵毛網	幼豚不幸死亡　7海豚頻推不止躍海面：孩子快醒醒！	22nd June 2020	https://bit.ly/3gbLyk6
Sing Tao Daily 星島日報	7條中華白海豚伴屍 用嘴將幼豚推上水面協助呼吸	15th June 2020	https://bit.ly/2YJqNFm

D. Public seminar, talk, workshop and exhibition

Six biodiversity workshops jointly organised with the Hong Kong Science Museum, entitled, "Virtopsy: Threats to Hong Kong's Cetaceans" were held on 3 July, 24 July, 21 August, 28 September, 16 November, 28 December 2019, at the Nature Lab of the Biodiversity Gallery in the HK Science Museum (https://hk.science.museum/en_US/web/scm/pe/bdg/biodiversity_workshops.html). Each workshop day consisted of 2 biodiversity workshop sessions, which aimed to provide the general public an overview of cetacean stranding in HK waters and implementation of virtopsy into local stranding response program (Fig. 2). Throughout 12 workshops in 6 days, over 360 participants were recorded. Five more identical workshops were scheduled in the first and second quarter of 2020 to continue our outreach effort on this current MEEF-funded project. Two CityU undergraduate students were also trained to assist delivering talks and interact with the public audience. These students could act as the seeds to transfer the concept of virtopsy, implementation of virtopsy into local stranding response program, implications of stranding investigation and corresponding threats local cetacean facing (such as marine vessel interaction), and pass on conservation knowledge to the next generation.

Fig. 2. A biodiversity workshop organized in the Hong Kong Science Museum, with 2 CityU undergraduate students trained by our team to assist the delivery of workshops.

However, due to the social unrest and COVID-19 pandemic, the 5 scheduled biodiversity workshop sessions and the HK SciFest 2020 were cancelled, for the concerns for the safety and health of our

participants, partners and staff. To extend our outreach goals in such difficult era of social distancing, our team had accepted invitation on interviews by the Radio Television Hong Kong (RTHK) Putonghua Channel AM621 programme, Huan Ting Shi Jie, on the topic of local cetaceans in HK waters and the threats they are facing (Fig. 3). Two sessions of the interview were broadcasted in June 2020, and recorded in RTHK online programme archive for revisit, as listed below.

Media	Title	Date	URL Link
Radio Television Hong Kong 香港電台	《寰聽世界》: 寰宇百科 - 認識海豚	16th June 2020	https://bit.ly/2YJt2IM
	《寰聽世界》: 寰宇百科 - 香港海豚知多少	23rd June 2020	https://bit.ly/3hVX4l5

Fig. 3. A radio program interview by Radio Television Hong Kong on 1 June 2020.

E. MEEF Project Visit

A project visit by the MEEF Director and Steering Committee was organized in CityU on 12 May 2020. The concept of utilizing virtopsy on the cetacean stranding investigation and 3-D forensic scene investigation of marine vessel interaction were presented by P.I. and his team, in conjunction with a demonstration of 3DSS (Fig. 4). The project was featured in the Hong Kong Airport News Issue 144 (https://www.hongkongairport.com/iwov-resources/html/hkairportnews/2020issue144/hkairportnews2020issue144.pdf). Promotional footage of the project was filmed on 13 May 2020 and featured on the MEEF website (http://env.threerunwaysystem.com/en/meef/meef_projects_media.html).

Fig. 4. Demonstration of 3DSS on a dolphin skeleton with a handheld 3-D scanner to the MEEF Director and Steering Committee during the project visit on 12 May 2020.

10.2 Research activities in relation to the project objectives that were carried out during this reporting period

A. Development of a web-based database

A web-based database named "Cetacean Postmortem Multimedia Analysis Platform" was used to store all the data for post-processing and data analysis. Data compilation of 197 virtopsy cases (from March 2014 to 30 June 2020, included 46 SCs, 131 NPs and 20 other cetacean species, and respective links between the web server and DICOM viewer were completed. Inclusion of the corresponding stranding information and other multimedia of retrospective cases are in progress.

B. . Virtopsy cases performed

From 1 July 2019 to June 2020, 42 out of 51 stranded cetaceans (82%) in HK waters, included 10 SCs, 26 NPs and 6 other species, were performed virtopsy (Fig. 5). All the virtopsy findings were verified by subsequent necropsy, with supplemented information given for the analysis of human interaction related injury and death of stranded cetaceans. The remaining 9 stranded cetaceans (18%) were recognised to be non-transportable and inappropriate for virtopsy by OPCFHK delegates. Onsite sample collection was directly performed on these cetacean carcasses by the stranding response team of OPCFHK.

Fig. 5. Stranded cetaceans underwent virtopsy in the imaging center and later in transit for the next procedures.

In the aforesaid 42 cases, findings of 11 stranded cetaceans (3 SCs and 8 NPs) were sufficient to assign the cause of death with confirmed, probable or suspect category associated with human interactions (33%), which included fishery and vessel interactions (Fig. 6). The rest 31 stranded cetaceans (7 SCs, 18 NPs and 6 other species) were likely associated with different causes of death, with various biological health concerns recognized, e.g. parasitic infection and pneumonia. Most virtopsy findings were shared bilingually on our stranded cetacean blog (Facebook page: https://www.facebook.com/aquanimallab)

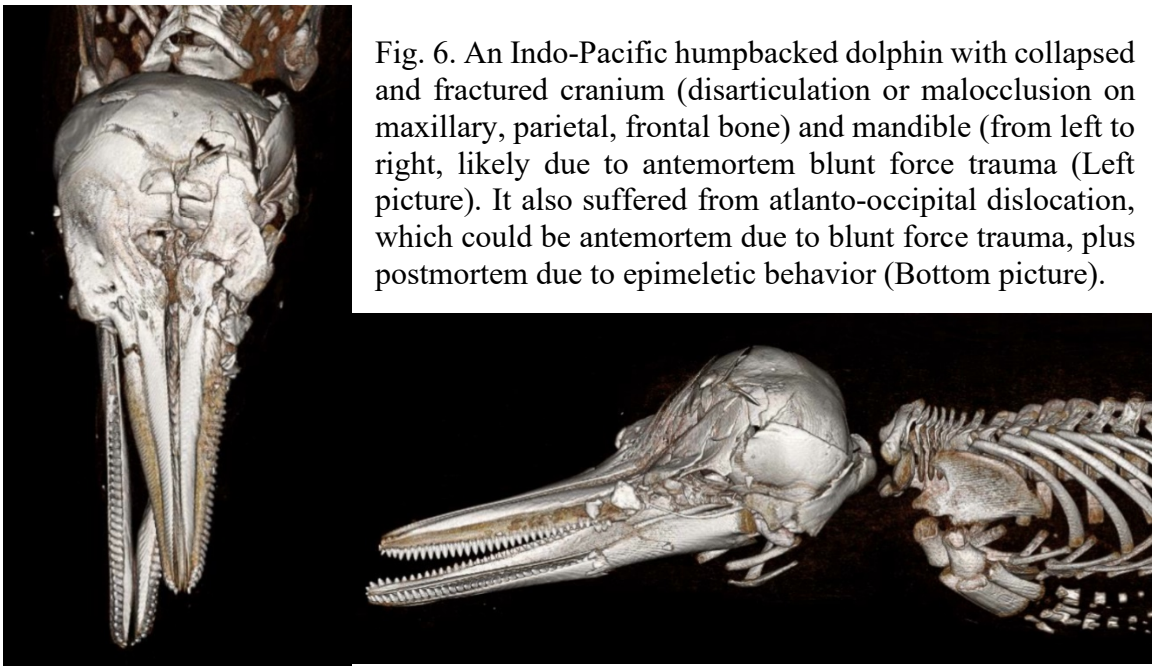


Fig. 6. An Indo-Pacific humpbacked dolphin with collapsed and fractured cranium (disarticulation or malocclusion on maxillary, parietal, frontal bone) and mandible (from left to right, likely due to antemortem blunt force trauma (Left picture). It also suffered from atlanto-occipital dislocation, which could be antemortem due to blunt force trauma, plus postmortem due to epimeletic behavior (Bottom picture).

C. 3-D surface scanning (3DSS)

Two handheld 3-D scanners purchased in the course of previously funded projects (MEEF2017014 & MEEF2017014A), namely Artec Eva and Artec Spider, were continuously used in the current project for the documentation of external injuries of the carcass (Fig. 7), with reference to the 3DSS standardised techniques established by our team. These 2 scanners were used for the production of geometry of the carcass external surface in 3-D, true to scale and with a high-resolution. Exact geometrical reconstructions of the carcass external surface were created, which allowed further measurement, modelling and subsequent 3-D simulations. By 30 June 2020, 10 cetacean carcasses and skeleton specimens (5 SCs, 4 NPs and 1 OT) in HK were scanned and reconstructed by the 2 handheld scanners, in conjunction with the built-in software Artec Studio.

Fig. 7. An Indo-Pacific humpbacked dolphin (upper picture) and the corresponding reconstructed 3DSS model (bottom picture) created by our team.

A long-range 3-D scanner, namely Artec Ray, which was purchased in the current project, has been expected to document structures include hulls, keels, blunt and sharp skegs, propellers, boat strakes, antiventilation plates, trim tables and fins, with reference to the standardised techniques established by our team, when the vessel is lifted out of the water at the shipyards and ship repairers, with the base of the vessel exposed.

Due to the social unrest in the summer/autumn 2019, the procurement process of the long-range 3-D scanner was interrupted and delayed. Successful purchase was done in December 2019, and the corresponding delivery was made in January 2020. Our research team quickly underwent intensive training on the operation of this new unit, with trials conducted on large complex structures, such as car and buildings (Fig. 8). The scan data were used as practice models for the team to create dimensionally accurate 3-D models, which served as reliable and simple means of acquiring the later accident scene measurement data (documentation of marine vessel structures) for subsequent forensic investigations. In this present project, results acquired by all three 3-D scanners have indispensably facilitated the later matching analysis of the injury induced by vessel interaction and suspected injury-inflicting instrument using 3DSS techniques, virtopsy and conventional necropsy findings.

The project team is the first worldwide to use long-range 3-D scanner on cetacean postmortem investigation. With the clear discrepancy on corresponding usages and data acquisition theories between close-range 3D scanner (Artec Eva and Artec Spider) and the long-range 3D scanner (Artec Ray), specific techniques for surface documentation using long-range 3-D scanner were needed to develop timely, with reference to the standardised techniques on using close-range 3D scanner established by our team.

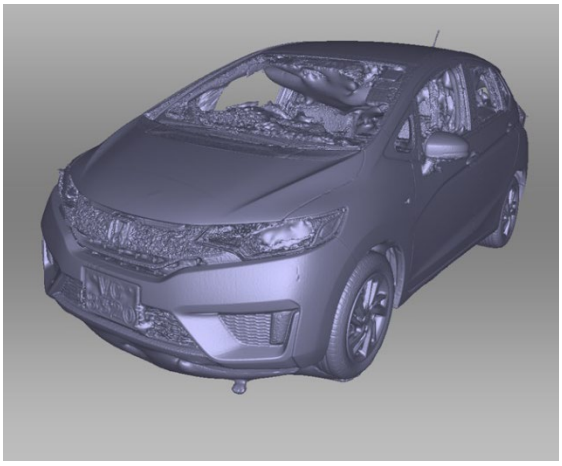


Fig. 8. A trial application of 3DSS on a car scanned by our team in City University of Hong Kong using Artec Ray. This equipment and scanning technique will be used to document and describe the types of suspected trauma-inflicting instrument using 3DSS technique, leading to injury induced by vessel interaction in stranded cetaceans.

In May 2020, our team conducted 3DSS on 2 marine vessels using Artec Ray as trials (Fig 9 and 10). These 2 trial scans allowed the project team to familiarise with the technique in using the long-range 3-D scanner on scanning marine vessels, and progressively allowed standardised techniques to be established. Site visit and prior planning on 3DSS procedures are essential. 3DSS with Artec Ray requires at least 4 personnel for site setting, scanner operation and scan quality assurance. In view of the COVID-19 pandemic and prohibition on group gathering, more 3DSS on marine vessel will be conducted once the situation allows.

Fig. 9. A demonstration of the 3DSS reconstructed model (upper) and the original marine vessel (bottom) scanned by our team using Artec Ray in May 2020.

Fig. 10. A demonstration of the 3DSS reconstructed model (upper) and the original marine vessel (bottom) scanned by our team using Artec Ray in May 2020.

D. Spatiotemporal patterns of vessel traffic and cetacean habitats in HK

Since April 2020, we have been working with the contractor on the description and comparison of the spatiotemporal patterns of vessel traffic between night and day and within the day in Indo-Pacific humpbacked dolphins and Indo-Pacific finless porpoises habitats in the HK waters. Two sources of retrospective dolphin sighting data collected by line transect surveys from Agriculture, Fisheries and Conservation Department (AFCD: Monitoring of marine mammals in Hong Kong waters) (2014-2018) and Hong Kong Airport Authority (3RS: Expansion of Hong Kong International Airport into a Three-Runway System Construction Phase Annual EM&A Report) (2014-2018) were consolidated by our team for the contractor to generate different grid layers illustrating the distribution of dolphin sightings in HK (Fig. 11) as the first step of analysis. More data sources from Hong Kong-Zhuhai-Macao Bridge Hong Kong Boundary Crossing Facilities (HKBCF), Hong Kong Link Road (HKLR) and Tun Mun-Chek Lap Kok Link (TMCLKL), will also be added into the listed grid layer.

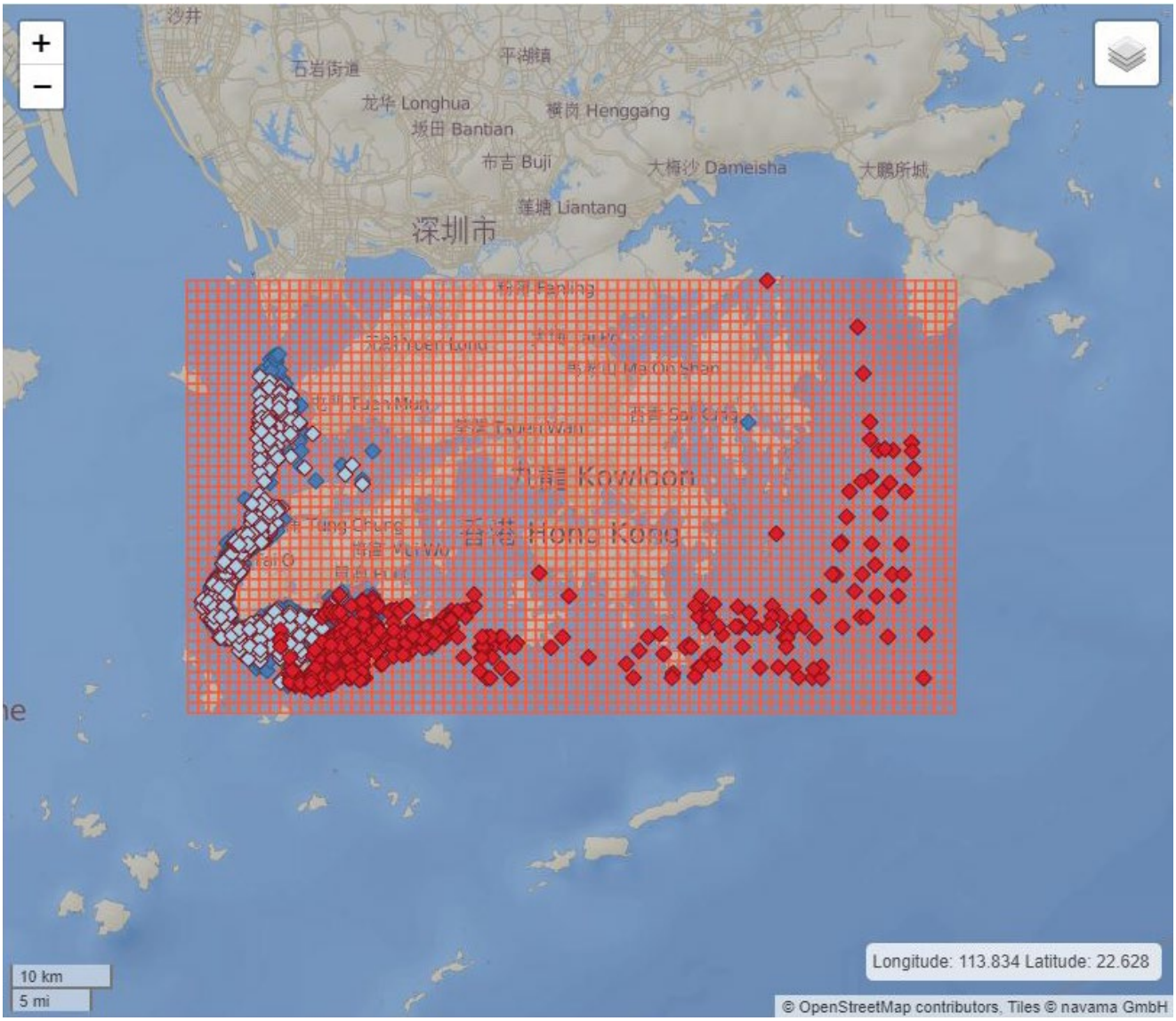


Fig. 11. A grid layer map plotted by our team, illustrating the distribution of cetaceans in HK waters using line transact data collected from 2 main projects between 2014 and 2018. Blue and red dots represent sightings of Indo-Pacific humpbacked dolphins and Indo-Pacific finless porpoises respectively.

E. Publications

P.I. had received an invitation from Dr. Wei Cheng Yang, President of Taiwan Cetacean Society and Associate Professor of National Taiwan University, to attend "The 3rd Asian Marine Mammal Stranding Network Symposium and Workshops" in Taiwan from 1 to 6 September 2019. P.I. demonstrated the technique of 3DSS on stranded cetacean carcass in the workshop and orally presented 2 talks on findings from MEEF-funded related projects in the symposium, entitled "The Effect of Marine Debris – Analysis of Current Situation in Asian Countries (Hong Kong, from the virtopsy prospects)" (Appenix 1) and "Diagnostic Imaging in Stranded Marine Mammals" (Appendix 2) respectively (Fig. 12). Relevant disclosure and acknowledgement of MEEF's support were listed in the presentation slides.

Fig. 12. P.I. demonstrated the 3DSS with the help of a CityU undergraduate student in the workshop and gave talks in the symposium sessions.

P.I. had received another invitation from Dr. Wei Cheng Yang to attend a 6-day symposium and post-symposium workshop in Taiwan, entitled "Advanced Imaging Technique for the Evaluation of Biological Health and Profile in Marine Mammals", as an invited speaker and coach from 15 to 20 November 2019. P.I. orally presented findings from MEEF-funded related projects entitled, "Three-dimensional Surface Scanning in Postmortem Investigation of Stranded Cetaceans: A Step-by-step Guide for Carcass Surface Documentation" (Appendix 3). Relevant disclosure and acknowledgement of MEEF's support were listed in the presentation slides.

Three manuscripts related to the current MEEF-funded project were submitted to peer-reviewed journals and under final review for publication. The first manuscript entitled "Image Rendering Techniques in Postmortem Computed Tomography: Evaluation of Biological Health and Profile in Stranded Cetaceans" (Appendix 4) aimed to assess different image rendering techniques in virtopsy for the evaluation of biological health and profile in stranded cetaceans in the HK waters. The second manuscript entitled "Postmortem Neuroimaging of Cetacean Brains Using Computed Tomography and Magnetic Resonance Imaging" (Appendix 5) focused on the documentation and categorization on the brain condition and postmortem change of stranded cetaceans by postmortem computed tomography and magnetic resonance imaging. The third manuscript entitled "Virtopsy as a Revolutionary Tool for Cetacean Stranding Programs: Implementation and Management" (Appendix 6) illustrated the first routine cetacean virtopsy stranding response programme ever in the world, explaining the overall procedure and highlighting the pitfalls in execution. The first manuscript was submitted to Journal of Visualized Experiments, the second and third manuscripts were submitted to Frontiers in Marine Science. Acknowledgements of MEEF's support were listed in all 3 manuscripts.

11. Evaluation of the project effectiveness in achieving the proposed objectives addressed to date

Objectives *(as per 9.1/9.2 above)*	**Addressed** *(please tick)*	**Percentage achieved** *(please estimate)*
1. To describe and compare the spatiotemporal patterns of vessel traffic between night and day and within the day in Indo-Pacific humpbacked dolphins and Indo-Pacific finless porpoises habitats in the HK waters;	√	30
2. To identify and document the vessel type and speed that pose interaction risk with cetaceans and reveal the unsuspected vessel interaction 'hot spots' by analyzing the AIS-cetacean population density data in the HK waters;	√	20
3. To document and describe the types of suspected trauma-inflicting instrument using 3-D surface scanning technique, leading to injury induced by vessel interaction in stranded cetaceans	√	30
4. To combine the 3-D models obtained from virtopsy (internal) and 3-D surface scanning data (external) and perform matching analysis of the injury induced by vessel interaction and suspected injury-inflicting instrument using 3-D surface scanning technique, virtopsy and conventional necropsy findings;	√	20
5. To compile postmortem findings collected by original field notes, 3-D surface scanning, virtopsy and conventional necropsy, as well as the overlaid AIS-cetacean population density data, and transcribe into cetacean postmortem multimedia analysis platform for first time all-in-one real-databased models of the stranded cetacean for geometric comparison of patterned injuries with the presumed types of vessel interaction.	√	20

Part D: Research Output

12. Peer-reviewed journal publication(s) arising directly from this research project

The Latest Status of Publications				Author(s) *(denote the corresponding author with an asterisk*)*	Title and Journal/Book *(with the volume, pages and other necessary publishing details specified)*	Attached to this report *(Yes or No)*	Acknowledged the support of MEEF *(Yes or No)*
Year of publication	Year of Acceptance	Under Review	Under Preparation				
		March 2020		Brian C.W. Kot*, Derek K.P. Chan, Tabris Y.T. Chung, Henry C.L. Tsui	Image Rendering Techniques in Postmortem Computed Tomography: Evaluation of Biological Health and Profile in Stranded Cetaceans (Journal of Visualized Experiments)	Yes (Appendix 4)	Yes
		March 2020		*Brian C.W. Kot, Henry C.L. Tsui, Tabris Y.T. Chung, Amy P.Y. Lau	Postmortem Neuroimaging of Cetacean Brains Using Computed Tomography and Magnetic Resonance Imaging (Frontiers in Marine Science)	Yes (Appendix 5)	Yes
		March 2020		Henry C.L. Tsui, *Brian C.W. Kot, Tabris Y.T. Chung, Derek K.P. Chan	Virtopsy as a Revolutionary Tool for Cetacean Stranding Programs: Implementation and Management (Frontiers in Marine Science)	Yes (Appendix 6)	Yes

13. Recognized international conference(s) in which paper(s) related to this research project was / were delivered *(Please attach a copy of each conference abstract)*

Month/Year / Place	Title	Conference Name	Attached to this report *(Yes or No)*	Acknowledged the support of MEEF *(Yes or No)*
September 2019, Taiwan	The Effect of Marine Debris – Analysis of Current Situation in Asian Countries (Hong Kong, from the virtopsy prospects)	3rd Asian Marine Mammal Stranding Network Symposium and Workshops	Yes (Appendix 1)	Yes
September 2019, Taiwan	Diagnostic imaging in stranded marine mammals	3rd Asian Marine Mammal Stranding Network Symposium and Workshops	Yes (Appendix 2)	Yes
November 2019, Taiwan	Three-dimensional Surface Scanning in Postmortem Investigation of Stranded Cetaceans: A Step-by-step Guide for Carcass Surface Documentation	Advanced Imaging Technique for the Evaluation of Biological Health and Profile in Marine Mammals	Yes (Appendix 3)	Yes

14. Other impact

(e.g. award of patents or prizes, collaboration with other research institutions, technology transfer, Teaching enhancement, etc.)

N/A

Part E: Summary and Way Forward

15. Summary and Way Forward

Throughout 12 months, from 1 July 2019 to 30 June 2020, project entitled "Three-dimensional forensic scene investigation of marine vessel interaction in Indo-Pacific humpbacked dolphins and Indo-Pacific finless porpoises in the Hong Kong waters", has been ongoing progressively and its objectives have been 20-30% accomplished. Despite the social unrest and COVID-19 pandemic arose during the project, various research tasks (e.g. virtopsy, 3-D surface documentation techniques) and outreach activities (e.g. 12 workshops and 1 radio program interview) targeted to fulfill the captioned 5 objectives in this project were conducted within the 12-month timeframe.

The retrospective data collection and analysis of spatiotemporal patterns of vessel traffic and cetacean habitats in HK have been started since April 2020. Time has been taken to consolidate and verify the data. The vessel AIS data would later be integrated with the distribution of dolphin sightings to identify the "hot spots" of cetacean injury and death caused by marine vessel interaction. Once we have the initial results verified from these data, this methodology would be applied on prospective dolphin sightings and AIS data.

Since the commencement of this project, our team has been collecting 3 various sources of data from stranded cetaceans in HK, i.e. the virtopsy scanning data of the carcass internal condition, the 3DSS scanning data of the carcass external condition, and the 3DSS scanning data of the vessel. All these 3 sources of data would be combined and matched to analyse the injury on stranded cetaceans induced by marine vessel interactions and suspected injury-inflicting instruments.

Findings from this present project had attracted extensive media attention, with a number of local and international print media voiced rising concern on unusual surge of stranding numbers during the project period, with supplemented virtopsy findings reported from P.I. and his team on cetacean stranding blog.

For future prospect of the captioned project, there is an urging need to upgrade our established web-based database, CPMAP. At the inception stage of database development, the design of database (i.e. user interface) might not be user-friendly enough, and only provided some general and basic functions, such as import, export, searching. To make it more comprehensive and user-friendly, additional commercial web template would be expanded. Featured functions would be built, and focused on the development of display data tools, i.e. data filtering, statistical presentation and mapping. The statistical presentation would be included the tendency chart filtered by days, months and years, while the mapping would display the high-density stranding location. In addition to the user interface, new featured function, and additional license and image loading capacity could be upgraded in the AqNET client-viewer. A larger number of images that user allowed to attempt concurrently (up to 6,000 images) and more diverse 3-D reconstruction template setting and tool would be available in the upgraded version of CPMAP, which could facilitate a better presentation of injured and death findings.

With this, a consistent platform for collecting, collating, and visualizing cetacean biological health data would be provided, which could enhance visual identification of "hot spots" of cetacean injury and death for better management decisions and evaluations through a dynamic and user-friendly tool. The updated CPMAP could also aid emergency management responses to natural and anthropogenic emergencies by assessing changes in cetacean health before, during, and following the event and enhance communication and collaboration amongst cetacean health scientists and veterinarians, resulting in better understanding of the relationship between health and environmental factors.

Part F: Complete statement of accounts

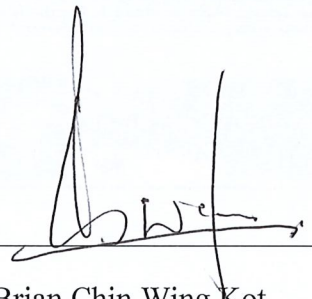
I hereby irrevocably declare, warrant and undertake to the MEEF Management Committee and the Steering Committee of the relevant Funds including the Top-up Fund, that I myself, and the Organisation:-

1. *do not deal with, and are not in any way associated with, any country or organisation or activity which is or may potentially be relevant to, or targeted by, sanctions administered by the United Nations Security Council, the European Union, Her Majesty's Treasury-United Kingdom, the United States Department of the Treasury's Office of Foreign Assets Control, or the Hong Kong Monetary Authority, or any sanctions law applicable;*

2. *have not used any money obtained from the Marine Ecology Enhancement Fund or the related Top-up Fund (and any derived surplus), in any unlawful manner, whether involving bribery, money-laundering, terrorism or infringement of any international or local law; and*

3. *have used the funds received (and any derived surplus) solely for the studies or projects which further the MEEF Objectives and have not distributed any portion of such funds (including any derived surplus) to members of the recipient organisation or the public.*

Principal Investigator

Signature : 

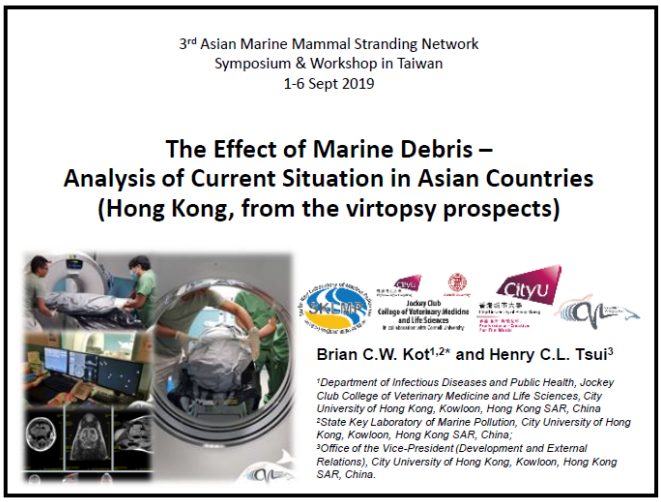
Name of Project Leader : Brian Chin Wing Kot

Date : 2.7.2020

Official Chop : 

Appendix 1: PowerPoint slides of conference presentation

Oral presentation at the "3rd Asian Marine Mammal Stranding Network Symposium and Workshops" from 1 to 6 September 2019 in Taiwan



Appendix 2: Abstract of conference proceedings

Oral presentation at the "3rd Asian Marine Mammal Stranding Network Symposium and Workshops" from 1 to 6 September 2019 in Taiwan

Diagnostic imaging in stranded marine mammals

Brian CW Kot[1,2], Henry CL Tsui[3],
[1] State Key Laboratory of Marine Pollution, City University of Hong Kong
[2] Department of Infectious Diseases and Public Health, Jockey Club College of Veterinary Medicine and Life Sciences, City University of Hong Kong
[3] Office of the Vice-President (Development and External Relations), City University of Hong Kong

Abstract
Different diagnostic imaging modalities are used individually or in combination for the ante- and post-mortem diagnosis of diseases and life stages and events evaluation in captive to free-ranging cetacean population. Adoption of digital imaging has led to significant efficiencies in imaging workflow. The shift from hardcopy images printed on film to digital archives has streamlined radiology file room processes, significantly reduced the problems caused by misplaced radiographs, and trimmed the capital costs of film development and storage. With the use of advanced imaging [computed tomography (CT), magnetic resonance imaging (MRI) and ultrasound] and 3-D reconstruction techniques, imaging can aid in the implications of lesions diagnosis and prognosis, the planning of corrective treatment or intervention, as well as the understanding of anatomy and biological profiles.

The unique ability of CT and MRI studies to overcome the limitations of tissue superimposition is invaluable. However, the need for familiarization with species-specific anatomy is critically essential, but without fundamental understanding of appropriate CT and MR image acquisition, image display parameters, and modality indications and contraindications, a study could be resulted incomplete at best or non-diagnostic at worst. Integrative consultation and reporting from specialists with human/veterinary radiology, cetacean medicine and forensic medicine background should always be adopted. Besides, anesthetization or tranquilization of the animal based on best veterinary practice, anticipating up to 10 minutes of sedation needed for handling for plain films and 30 minutes minimum for a CT or MRI study should be considered.

Most neck, thoracic, abdominal, vascular and musculoskeletal structures are able to be examined by ultrasound for clinical and research purposes. A comprehensive understanding on animal species, physiological status and nutritional conditions should be made for the preparation of and during ultrasound examinations, for accurate diagnosis. Equipment selection, scanning techniques and normal sonographic anatomy should be well-addressed, along with illustrations of cetacean pathologies identified. Limitations included machine inaccessibility, animal uncooperativeness, large body size, thick integument and blubber layers, which prohibited examination of some structures.

Diagnostic imaging modalities are also invaluable tools for the non-invasive examination of animals for evidence of gas and have been used to demonstrate the presence of incidental decompression-related renal gas accumulations in some stranded cetaceans. Diagnostic imaging has also contributed to the recognition of clinically significant gas accumulations in live and dead cetaceans and pinnipeds. Understanding the appropriate application and limitations of the available imaging modalities is important for accurate interpretation of results.

Virtopsy, using postmortem CT and postmortem MRI, provides a virtual alternative to the conventional necropsy for biological health investigation. Our team is the first worldwide to apply virtopsy on stranded cetaceans routinely in Hong Kong waters, augmenting conventional necropsy protocols. These volumetric image datasets provide invaluable initial or supplementary information of the cause of death in the stranded cetaceans prior to a conventional necropsy. With the advantages of being observer-independent, non-subjective, non-invasive, digitally storable and transferable, thereby facilitating a second opinion, virtopsy has become a valuable alternative technique to provide new insights of findings in stranded carcasses.

To enhance the use of radiology in cetacean medicine, we introduce our team website that has been developed as a centralized source to those working in the field of cetacean medicine. The goals of the website are to provide examples of normal diagnostic imaging studies, to showcase cases of interest to the cetacean professional community, and to provide information on the appropriate application of different diagnostic imaging modalities for the ante- and post-mortem diagnosis of diseases and life stages and events evaluation for corrective therapy and conservation measures. A centralized web-accessed database named "Cetacean Postmortem Multimedia Analysis Platform" has also been developed, which may eventually support the conservation and policy decision for Hong Kong waters, leading to a 'One Ocean−One Health' paradigm using cetaceans as sentinels of potential emerging hazards.

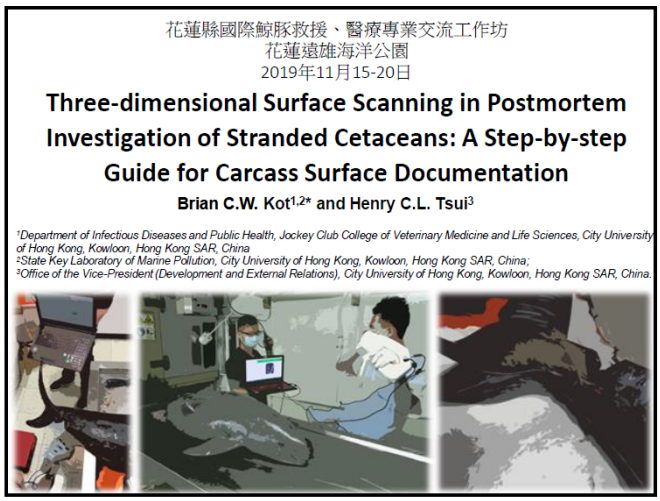
Acknowledgements

The authors would like to thank Agriculture, Fisheries and Conservation Department of the Hong Kong Special Administrative Region Government for the continuous support in this project. Sincere appreciation is also extended to veterinarians, staff and volunteers from Ocean Park Hong Kong, Ocean Park Conservation Foundation Hong Kong, Tung Wah College and Cetacean Virtopsy Lab, for paying great effort on the stranding response in this project. Special gratitude is owed to technicians in Veterinary Medical Centre, City University of Hong Kong and Hong Kong Veterinary Imaging Centre for operating the CT and MR units in the present study.

This project was financially supported by the Marine Ecology Enhancement Fund (grant number: MEEF2017014, MEEF2017014A and MEEF2019010), Marine Ecology Enhancement Fund, Marine Ecology & Fisheries Enhancement Funds Trustee Limited. Any opinions, findings, conclusions or recommendations expressed herein do not necessarily reflect the views of the Marine Ecology Enhancement Fund or the Trustee. The pioneer stranded cetacean virtopsy project received financial support from the Hong Kong Research Grants Council (Grant number: UGC/FDS17/M07/14).

Appendix 3: PowerPoint slides of conference presentation

Oral presentation at the "Advanced Imaging Technique for the Evaluation of Biological Health and Profile in Marine Mammals" from 15 to 20 November 2019 in Taiwan



Appendix 4: Abstract of manuscript

Submitted to Journal of Visualized Experiments and under final review for publication

Image Rendering Techniques in Postmortem Computed Tomography: Evaluation of Biological Health and Profile in Stranded Cetaceans

Brian C. W. Kot[1,2*], Derek K. P. Chan[3], Tabris Y. T. Chung[1], Henry C. L. Tsui[1]
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[3] School of Medical and Health Sciences, Tung Wah College
[*] Corresponding author: briankot@yahoo.co.uk

Abstract
With 6 years of experience in implementing virtopsy routinely into the Hong Kong cetacean stranding response program, standardized virtopsy procedures, postmortem computed tomography (PMCT) acquisition, postprocessing, and evaluation were successfully established. In this pioneer cetacean virtopsy stranding response program, PMCT was performed on 193 stranded cetaceans, providing postmortem findings to aid necropsy and shed light on the biological health and profile of the animals. This study aimed to assess 8 image rendering techniques in PMCT, including multiplanar reconstruction, curved planar reformation, maximum intensity projection, minimum intensity projection, direct volume rendering, segmentation, transfer function, and perspective volume rendering. Illustrated with practical examples, these techniques were able to identify most of the PM findings in stranded cetaceans and served as a tool to investigate their biological health and profile. This study could guide radiologists, clinicians and veterinarians through the often difficult and complicated realm of PMCT image rendering and reviewing.

Acknowledgements
The authors would like to thank the Agriculture, Fisheries and Conservation Department of the Hong Kong Special Administrative Region Government for the continuous support in this project. Sincere appreciation is also extended to veterinarians, staff, and volunteers from the Aquatic Animal Virtopsy Lab, City University of Hong Kong, Ocean Park Conservation Foundation Hong Kong and Ocean Park Hong Kong for paying great effort on the stranding response in this project. Special gratitude is owed to technicians in CityU Veterinary Medical Centre and Hong Kong Veterinary Imaging Centre for operating the CT and MRI units for the present study. Any opinions, findings, conclusions or recommendations expressed herein do not necessarily reflect the views of the Marine Ecology Enhancement Fund or the Trustee. This project was funded by the Hong Kong Research Grants Council (Grant number: UGC/FDS17/M07/14), and the Marine Ecology Enhancement Fund (grant number: MEEF2017014, MEEF2017014A, MEEF2019010 and MEEF2019010A) of the Marine Ecology & Fisheries Enhancement Funds Trustee Limited. Special thanks to Dr. María José Robles Malagamba for English editing of this manuscript.

Appendix 5: Abstract of manuscript

Submitted to Frontiers in Marine Science and under final review for publication

Postmortem Neuroimaging of Cetacean Brains Using Computed Tomography and Magnetic Resonance Imaging

Brian C. W. Kot[1,2*], Henry C.L. Tsui[1], Tabris Y.T. Chung[1], Amy P.Y. Lau[3]
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[2] Department of Veterinary Clinical Sciences, Jockey Club College of Veterinary Medicine and Life Sciences, City University of Hong Kong, Hong Kong, China
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*Correspondence: briankot@yahoo.co.uk

Abstract
Postmortem computed tomography (PMCT) and postmortem magnetic resonance (PMMR) imaging (PMMRI) have been applied to provide vital or additional information for conventional necropsy, along the pioneering virtopsy-driven cetacean stranding response program in Hong Kong waters. It is common for stranded carcasses to become badly degraded and susceptible to rapid cerebral autolysis and putrefaction. Necropsy on decomposed brains with limited sample analysis often defy a specific diagnosis. Studies on PMMR neuroimaging have focused on neuroanatomy and brain morphology in freshly deceased or preserved specimens. Moreover, the literature is devoid of any reference on the potential value of PMMRI examination of decomposed cetacean brains. To that end, this project evaluated the benefits of PMMR neuroimaging in situ in decomposed carcasses in comparison to PMCT. A total of 18 cetacean carcasses were studied by PMCT and PMMRI examinations. Anatomical brain structures and visible brain pathologies were evaluated and scored using Likert-scale rating. Intracranial gas accumulation was clearly depicted in all cases by all radiological techniques. Other features were more clearly depictable in PMMRI than in PMCT images. Results of this study indicated that superiority of PMMRI compared to PMCT increased with advanced putrefaction of the brain. The preservation of structural integrity was presented by PMMRI due to its superior capability to evaluate soft tissue. Brain PMMRI should be incorporated in postmortem investigation of decomposed stranded cetaceans.

Funding
This project was funded by the Hong Kong Research Grants Council (Grant No: UGC/FDS17/M07/14), and the Marine Ecology Enhancement Fund (Grant Nos: MEEF2017014, MEEF2017014A, MEEF2019010, and MEEF2019010A) of the Marine Ecology & Fisheries Enhancement Funds Trustee Limited. All the funding was awarded to BK (project leader and principal investigator of the funded projects).

Acknowledgements
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Appendix 6: Abstract of manuscript

Submitted to Frontiers in Marine Science and under final review for publication

Virtopsy as a Revolutionary Tool for Cetacean Stranding Programs: Implementation and Management

Henry C.L. Tsui[1], Brian C. W. Kot[1,2*], Tabris Y.T. Chung[1], Derek K. P. Chan[3]
[1] State Key Laboratory of Marine Pollution, City University of Hong Kong, Kowloon, Hong Kong
[2] Department of Veterinary Clinical Sciences, Jockey Club College of Veterinary Medicine and Life Sciences, City University of Hong Kong, Kowloon, Hong Kong
[3] School of Medical and Health Sciences, Tung Wah College, Hong Kong
*Correspondence: briankot@yahoo.co.uk

Abstract
On top of conventional necropsy, virtopsy (postmortem computed tomography and postmortem magnetic resonance imaging) has been integrated into the Cetacean Stranding Response Programme in Hong Kong since March 2014. To date, 177 out of 240 local stranded cetaceans have been examined by virtopsy. This integration has modernised the characterisation and documentation of cetacean biological health and profiles, and causes of death. During this 6-year period, critical pitfalls regarding logistics, carcass recovery, handling, and preservation have been identified. A strategic management scheme is crucial for the successful incorporation of virtopsy into this pioneer programme. This study explains the workflow of the Cetacean Virtopsy Stranding Response Programme in Hong Kong waters. Difficulties encountered are highlighted and practical solutions to address management issues are proposed to consolidate the stranding response network.

Funding
This project was funded by the Hong Kong Research Grants Council (Grant No. UGC/FDS17/M07/14), the Marine Ecology Enhancement Fund (Grant Nos: MEEF2017014, MEEF2017014A, MEEF2019010, and MEEF2019010A) of the Marine Ecology & Fisheries Enhancement Funds Trustee Limited. All the funding was awarded to BK (project leader and principal investigator of the funded projects).

Acknowledgments
We would like to thank the Agriculture, Fisheries and Conservation Department of the Hong Kong Special Administrative Region Government for the continuous support in this project. Sincere appreciation was also extended to veterinarians, staff and volunteers from the Aquatic Animal Virtopsy Lab, City University of Hong Kong, Ocean Park Conservation Foundation Hong Kong and Ocean Park Hong Kong. Special gratitude was owed to technicians in CityU Veterinary Medical Centre and Hong Kong Veterinary Imaging Centre for operating the CT and MR units in the present study. Any opinions, findings, conclusions, or recommendations expressed herein do not necessarily reflect the views of the Marine Ecology Enhancement Fund or Trustee. Special thanks to Dr. María José Robles Malagamba for English editing of this manuscript.