Hong Kong Offshore LNG Terminal Project
Marine Conservation Enhancement Fund

The unknown facets of conservation ecology of Hong Kong cetaceans: Night-time habitat use, diurnal acoustic environment, and impacts of anthropogenic noise on Chinese white dolphins and Indo-Pacific finless porpoises

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Completion Report
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Declaration

I hereby irrevocably declare to the Management Committee and the Steering Committee of the Fund, that all the dataset and information included in this Completion Report have been properly referenced, and all necessary authorisations have been obtained in respect of the use of information owned by third parties in the Funded Project.

Any opinions, findings, conclusions or recommendations expressed in this Completion Report have been given or expressed without consultation with or reference to the Grantors and the Fund, and do not necessarily represent the views of the Grantors or the Fund.

EXECUTIVE SUMMARY

Chinese white dolphins and Indo-Pacific finless porpoises in Hong Kong waters are threatened by multitude of anthropogenic impacts, many of which involve intensive round-the-clock operations, raising concerns about continuous presence of Hong Kong cetaceans in this increasingly degraded coastal environment. However, the effectiveness of conservation strategies remains constrained by insufficient knowledge of their population processes that underpin their ecological resilience. One of the least known aspect of their daily lives is the nocturnal part of their circadian cycle; what is their nocturnal pattern of occurrence and habitat use, and their acoustic environment?

This Project was specifically designed to address these primary knowledge gaps in the ecology of Hong Kong cetaceans during the night-time, which cannot be achieved by other conventional visual methods (e.g., photo-ID or visual line-transect). We deployed stationary acoustic recorders at four key locations in southern Hong Kong waters, which offered a powerful tool for round-the-clock monitoring of not only the presence and behaviour of both dolphins and porpoises, but also the marine soundscape and spatio-temporal patterns of anthropogenic noise. The application of underwater acoustic data-loggers towed along systematically designed night-transects provided the only effective means to detect cetaceans and investigate their night-time distribution and abundance across open waters.

All intended work of field data collection and analyses pertaining to long-term passive acoustic monitoring (PAM) and night-time acoustic line-transect surveys have been successfully completed along the Project framework. A large volume of acoustic data was collected across western and southern Hong Kong waters, which facilitated multi-faceted (spatial, diurnal, seasonal) analyses of habitat use and diurnal acoustic environment of dolphins and porpoises.

Our analytical results reveal site-specific spectral features with considerable spatio-temporal heterogeneity in the marine soundscape. Advanced sound-source separation models effectively dissected the complex acoustic profile and successfully identified four distinct sound sources, including two types of fish choruses, crustacean sound, and shipping noise. While all three types of biological sounds (fish and crustacean) exhibit clear diurnal cycles with heightened activity at night, the spatial and seasonal patterns of their acoustic activities differ substantially from one another. Furthermore, the acoustic environment is filled – to varying extent at different locations – with broad-spectrum shipping noise, which indicates wide-ranging anthropogenic impacts on the acoustic space.

While finless porpoises were detected at all four acoustic monitoring locations across southern Hong Kong waters, Chinese white dolphins were only detected sporadically at the westernmost recording station off south Lantau Island. Both species exhibit diurnal variations in their occurrence pattern, with their activities in coastal waters intensified at night. The nocturnal surge of porpoise activities appears to align with the time when their potential prey is most active, especially during winter months; time-series statistical analyses indicate significant correlations between the patterns of porpoise clicks and fish/crustacean sounds. This porpoise-prey dynamics suggest that prey availability is likely among the key factors determining the porpoises' fine-scale habitat use pattern. It is also

evident however that, despite the plasticity (adaptability) of porpoise behaviour, anthropogenic noise of maritime traffic has a significant impact on their occurrence pattern.

Spatial modelling analyses of night-time acoustic line-transect data indicate that at night Chinese white dolphins occur mostly in the inshore waters off West-Southwest Lantau, while waters off north Lantau are hardly ever used by the dolphins. The nocturnal range-use pattern corresponds to their day-time spatial pattern, which underscores the critical importance of the limited unaltered coastal habitat to dolphins' daily needs, not only during daytime but also throughout the night. Finless porpoises, on the other hand, exhibit a more widespread nocturnal range-use across southern Hong Kong waters and further away from the shore. Nevertheless, the porpoises are not exempted from the impacts of coastal development and heavy maritime traffic, and illegal trawling activities were frequently seen within their range at night. Both species experienced a range-shift in recent years, where previous key habitats have been abandoned under fast growing anthropogenic footprint. Our night-time acoustic data confirm this recent development. It is particularly acute in the case of dolphins, as it implies a major contraction of their habitable habitat. These current findings add to the mounting evidence that questions the usefulness of the currently designated and proposed marine protected areas and, more broadly, the effectiveness of current marine/coastal conservation strategy.

Through high-resolution acoustic triangulation, the spatial location and perpendicular distance to each acoustically detected dolphin/porpoise was accurately estimated, and was subsequently used to model the detection probability of dolphins and porpoises using standard distance-sampling techniques. The total night-time abundance of Chinese white dolphins and finless porpoises across the current study area are estimated at 51 dolphins (CV = 23.67%; 95% CI = 32–81), and 54 porpoises (CV = 26.05%; 95% CI = 31–84). While the overall pattern of night-time density/abundance per survey sector is comparable to that during day-time, the nocturnal dolphin abundance estimate is slightly higher in comparison. This diurnal difference may be attributed (at least partially) to the difference in detection methods (acoustic *vs.* visual), and therefore caution has to be taken while interpreting such diurnal comparison.

In overall, this project furnished a much-needed baseline information on night-time occurrence and habitat use of Chinese white dolphins and Indo-Pacific finless porpoises, and their diurnal acoustic environment in Hong Kong waters. By doing so, it offers means for generating better-informed assessments of potential impacts of future environmental change, coastal developments, reclamation projects, maritime traffic, and other such activities in the region. Soon after the completion of this Project, in conjunction with our ongoing multi-year socio-demographic study of Chinese white dolphins across the Pearl River Estuary, we will be able to take the next step in making factual data-driven recommendations for the conservation of Hong Kong cetaceans based on scientifically-sound quantitative evidence. Furthermore, this Project has demonstrated that acoustic techniques offer an effective sampling means for monitoring cetacean populations even in noisy environment with complex coastal physiography and soundscape, such as Hong Kong waters. We recommend that acoustic line-transect surveys and long-term soundscape monitoring be incorporated as part of the cetacean monitoring program, in both day-time and night-time surveys, and that region-wide empirical data that represents the 24-hour diurnal cycle be included in comprehensive evaluation of current conservation measures to better inform effective management decisions.