PorCC: A new high-accuracy click classifier to study harbour porpoises in the wild

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Introduction

Harbour porpoises (*Phocoena phocoena*) are difficult to observe at sea because of their small size and cryptic behaviour. However, they produce narrow-band high-frequency (NBHF) echolocation clicks, hence they are well suited for passive acoustic monitoring (PAM). PAM systems are coupled with a classification algorithm to identify the likely porpoise signals among other transient signals. We present a new harbour porpoise click classifier (PorCC) for full-waveform signals, with an improved performance over current classifiers [1].

Material and Methods

PorCC uses the coefficients of two logistic regression models in a decision-making pathway (Fig. 1) to assign each signal to one of three categories: high-quality click (HQ), low-quality click (LQ), or high-frequency noise (N) (Fig. 2). The first model uses click duration and $\underline{Q_{RMS}}$ (RMS-bandwidth / centroid frequency) to separate HQ from N. The second model uses click duration, Q_{RMS}, ratio between peak and centroid frequency, peak cross-correlation coefficient (against a model click), centroid frequency, and -3dB bandwidth to separate LQ from N.

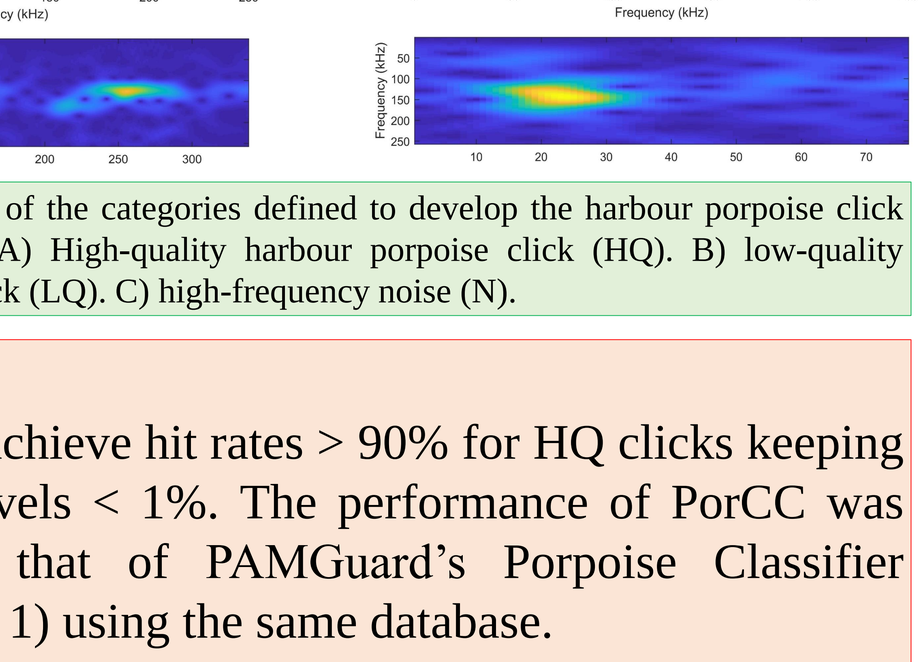

Figure 2. Examples of the categories defined to develop the harbour porpoise click classifier (PorCC). A) High-quality harbour porpoise click (HQ). B) low-quality harbour porpoise click (LQ). C) high-frequency noise (N).

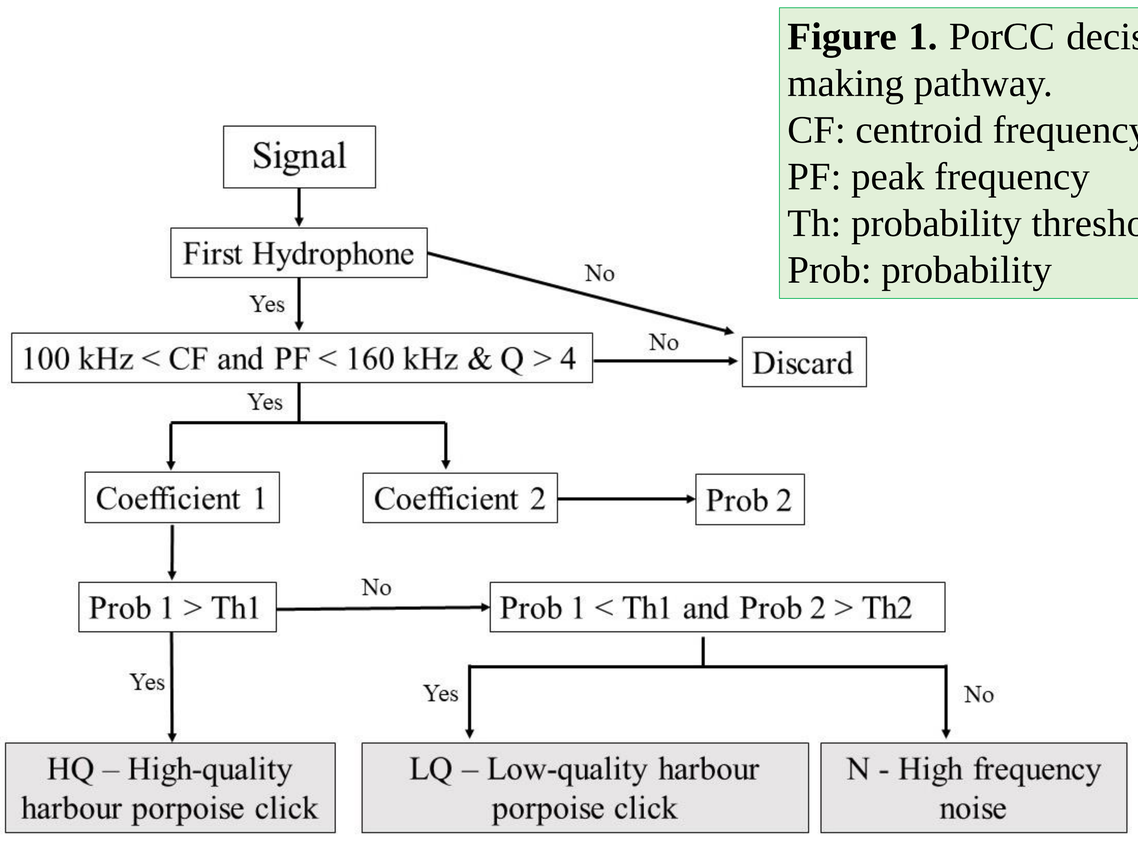

Figure 1. PorCC decision-making pathway.
CF: centroid frequency
PF: peak frequency
Th: probability threshold
Prob: probability

Results

PorCC could achieve hit rates > 90% for HQ clicks keeping false alarm levels < 1%. The performance of PorCC was compared to that of PAMGuard's Porpoise Classifier module (Table 1) using the same database.

Table 1. Performance of the classifiers using standard settings.

	Total (n = 284,231)	**PAMGuard (n = 3,017)**		**PorCC (Th1 = 0.9999, Th2 = 0.55)**		
		HQ & LQ	N	HQ	LQ	N
HQ	1,833	564*	1269¥	1209	511	113¥
LQ	965	375*	590	23	388	554
N	281,433	477 + 1,601 #*	279,355	25#	1374	280,034

*Of the total of 3,017 clips highlighted by PAMGuard as potential harbour porpoise clicks, 1,601 had QRMS < 4 and peak and centroid frequencies outside of the 100 and 160 kHz range, therefore they were not captured by PorCC, as they were discarded at the first step. # False alarm (N clips classified as HQ clicks divided by the total number of N clips) ¥ Missed clicks (HQ clicks classified as N divided by the total number of HQ click).

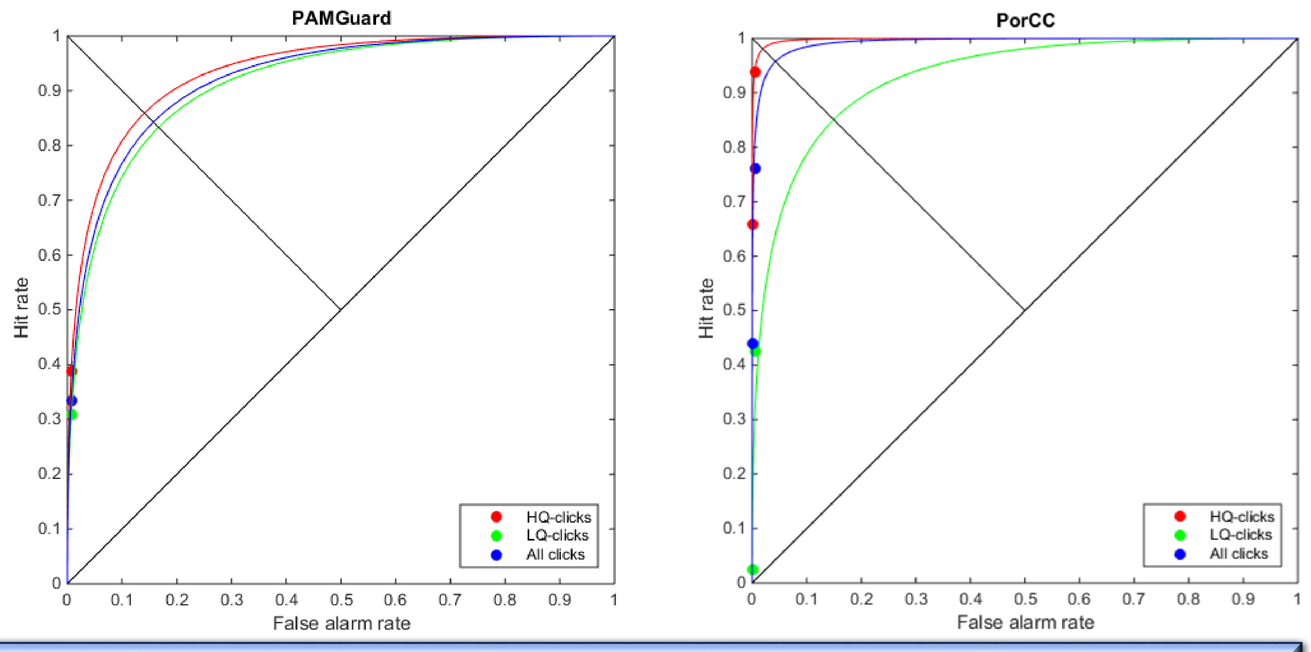

Figure 3: Receiver operating characteristics (ROC) curve for the two classifiers. Red dots indicate HQ-clicks, Blue dots LQ-clicks and green dots HQ+LQ clicks. PorCC (right) evaluated with a strict criterion (only clicks classified as HQ) and a relaxed criterion (all clicks classified as LQ or HQ). Curves show best fitting ROC curves.

Conclusions

Results show PorCC is a rapid, highly accurate method to classify narrow-band high-frequency (NBHF) clicks. PorCC could be applied for real time monitoring to study harbour porpoises and potentially other NBHF species from data collected using towed hydrophones or static recorders.

REFERENCES: [1] Gillespie, D., Gordon, J. C. D., Mchugh, R., Mclaren, D., Mellinger, D. K., Redmond, P., … Deng, X. Y. (2009). PAMGUARD: Semiautomated, open source software for real-time acoustic detection and localisation of cetaceans. Proceedings of the Institute of Acoustics.

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