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A Convolutional Neural Network to detect bowhead whale vocalizations in passive acoustic data from the Arctic Ocean

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Climate change is causing significant environmental shifts in the Arctic Ocean, affecting the habitat suitability for marine mammal species inhabiting Arctic waters seasonally or year-round. Habitat degradation or habitat loss will particularly affect Arctic endemic species, such as bowhead whales (Balaena mysticetus). Bowhead whales possess a complex and temporally variable acoustic behavior that is utilized in reproductive and social contexts. They produce single calls, usually frequency modulated vocalizations between 50 and 500 Hz, as well as highly variable songs, referring to structured series of vocalizations. Passive acoustic monitoring (PAM) represents a non-invasive tool to collect crucial year-round and multi-year information on the occurrence of bowhead whales. Since manual detection of bowhead whale vocalizations in continuous PAM data is a challenging and time-consuming task, the Ocean Acoustics group of AWI teamed up with the Helmholtz Artificial Intelligence Cooperation Unit to develop an AI-based algorithm for bowhead whale detection. To this end, we train a Convolutional Neural Network (CNN) to recognize vocalization signatures of bowhead whales in spectrograms generated from PAM data. The algorithm divides data into short-duration snippets, indicating the presence or absence of bowhead whale signals for each snippet. This approach has the potential to significantly streamline the analysis process, while enhancing objectivity of call identification. The network will be applied for the analysis of an extensive acoustic dataset (spanning 2104 recording days) collected by AWI in Fram Strait between 2012 and 2021. For training we use more than 4000 humanly labeled individual whale calls over several days. In the future, we aim to provide easy operational inference from the trained network for new data. Analyzing this acoustic data will further our understanding of trends in bowhead whale occurrence, contributing to the development of effective conservation strategies.

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