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Hidden Markov Models reveal complexity in the diving behaviour of short-finned pilot whales.

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The diving behaviour of short-finned pilot whales is often characterised by two states; deep foraging and shallow, non-foraging dives. Foraging behaviour is inferred primarily from depth and the presence of foraging buzzes. This simple classification ignores other possible behaviours that may occur during periods of subsurface behaviour. We used multi-state Hidden Markov Models to characterise diving behaviour and the transitions between states in short-finned pilot whales. We incorporated random effects to assess individual heterogeneity based on partial pooling that considers a common distribution for some individual level parameters. We used multiple dive variables from over a hundred dives from digital acoustic recording tags (DTAGs) deployed on 12 individuals off Cape Hatteras, North Carolina USA, to categorise the most probable non-observable state sequence of dives. The HMM consistently identified higher (>2) state models with no random effects, as better predictors of diving behaviour than lower state models. The state dependent distributions for the diving variables showed variation between states that are indicative of behaviors not readily classified from depth or presence of buzzes alone. The lack of random effects suggests that pilot whale diving states are broadly common across individuals. The proportion of dives within each state were not equal, and transition probabilities between states were higher for state persistence than state switching, indicating that same-state dives occur in bouts. This is the first categorisation of short-finned pilot whale diving behaviour using Hidden Markov Models and provides a categorisation of diving behaviour linked to multiple observed variables. Diving behaviour in this species is more complex than just a dichotomy of deep and shallow diving states. This variation may represent disparities in foraging success or prey availability and may be influenced by social factors.

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