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High-resolution archival tags provide new insights into the underwater foraging and echolocation behavior of resident killer whales capturing Pacific salmon

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Dtags as a Tool for Behavioural Studies of Resident Killer Whales

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Digital Acoustic Recording Tags (Dtag)

(Johnson & Tyack 2003, IEEE J Ocean Eng)
Dtags deployed on 31 fish-eating northern resident killer whales in British Columbia (2009-2012)

17 true-positive foraging events by 7 individuals: 9 Chinook, 6 chum, 2 coho
probable point of fish capture

Salmon foraging dive (201.9 m)

beginning of chase?
Identifying Foraging Dives: Machine Learning

A Dive (>1 m) types were categorized using 16 kinematic variables.
A Dives with prey remains (n=17) used as a training set for iterative LDA.
A Results: 701 = foraging, 10,618 = other behaviours.
Foraging dives are kinematically distinct

foraging dives, n=701  other dives, n=10,618
Whales target depths used by Chinook salmon

Salmon Escape Response:
- Bottom topography
- Visual camouflage
- Air-breathing predator

- **fish swimming depth** (average, tagging studies)
- **foraging dive depth** (maximum, DTAGs)
Pre- versus Post-capture Echolocation Behaviour

During searching/pursuit (pre-capture), killer whales spent a greater proportion of dive time echolocating, and emitted clicks at greater rates.

- Proportion of time spent clicking:
  - Pre-capture: mean = 43%
  - Post-capture: mean = 20%

- Mean number of clicks per second:
  - Pre-capture: mean = 6.2
  - Post-capture: mean = 1.1
Buzzes: Close-range prey targeting

- Trains with >50% clicks having ICIs ≤ 20 ms
- Present in 13 of 17 foraging events: mean=2.5/capture; duration = 5.9 s
- Primarily pre-capture, often at depths >100 m
Crunches: Prey-processing sounds

- Present in 14 of 17 foraging events: mean=3.6/capture
- Primarily post-capture, near the surface
- Salmon typically broken apart prior to being eaten (regardless of prey sharing)
Conclusions: NRKW Dtag Study

- Foraging dives are deeper, higher velocity, involve greater path complexity and more body rotation.
- Max foraging dive depths reflect the deeper distribution of Chinook salmon & salmon escape responses – disturbance mitigation should consider this.
- Prior to fish captures, both click rates and proportion of time spent echolocating were greater.
- Buzzes and crunches may provide acoustic proxies for prey capture attempts and successes: measures of foraging efficiency?
- Concurrent NOAA Dtag data from SRKW provides a valuable opportunity for a comparative foraging study of the two populations.
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