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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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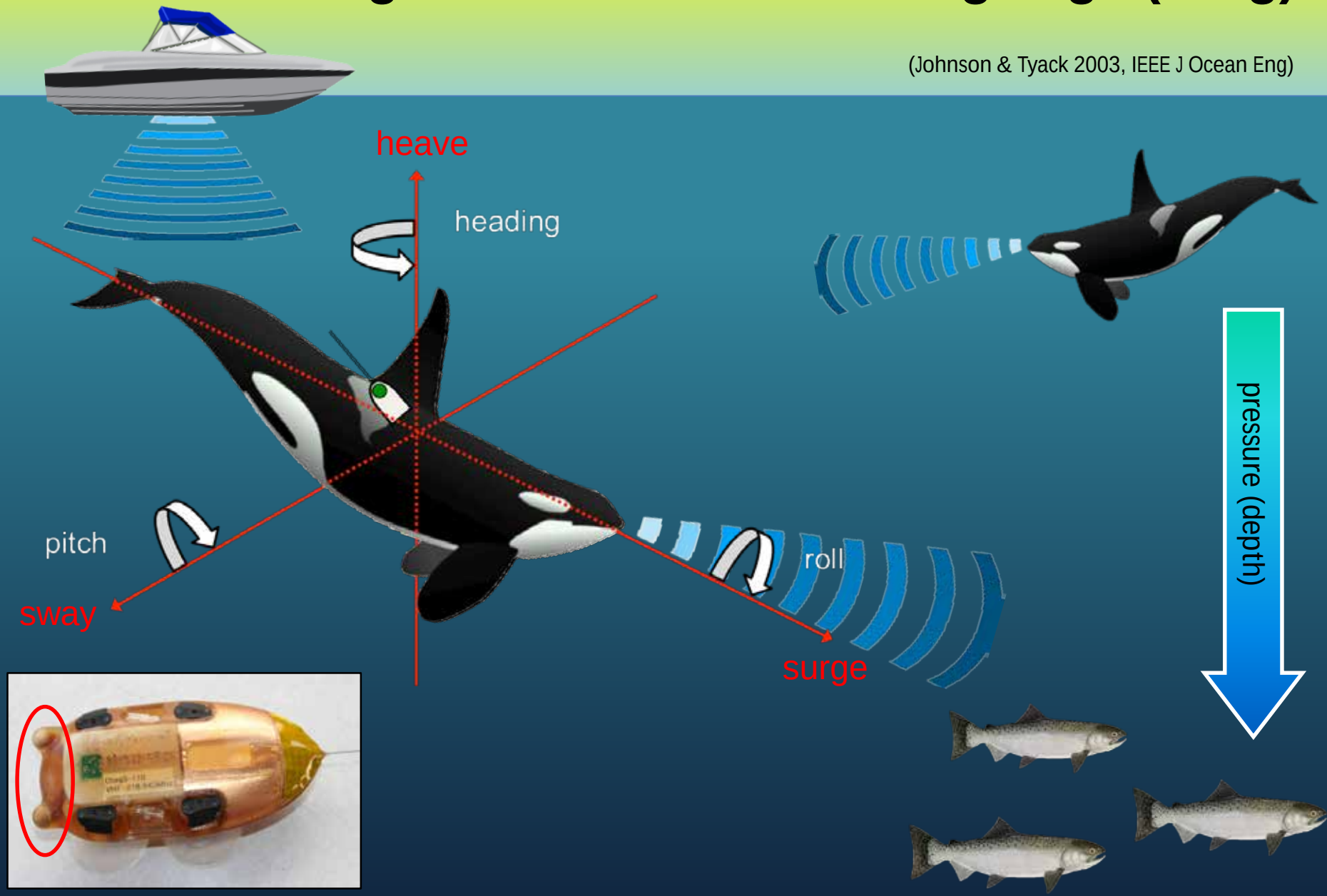
PHOTO: JARED TOWERS

Fisheries and Oceans Canada

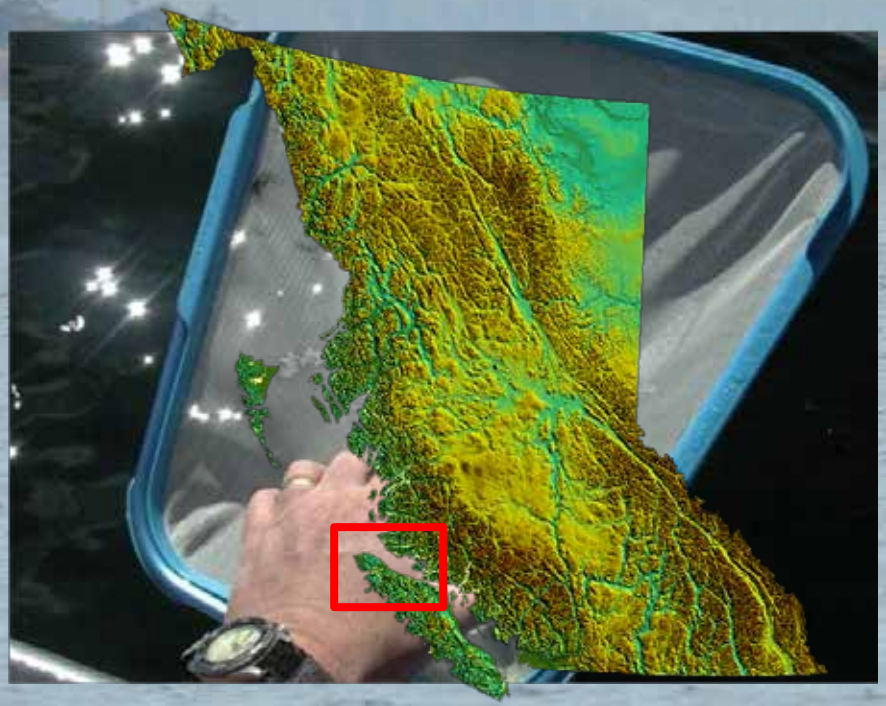
Digital Acoustic Recording Tags (Dtag)

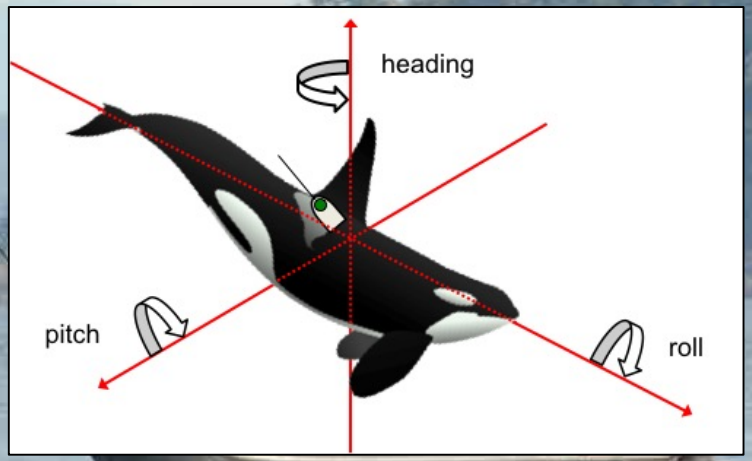
(Johnson & Tyack 2003, IEEE J Ocean Eng)



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





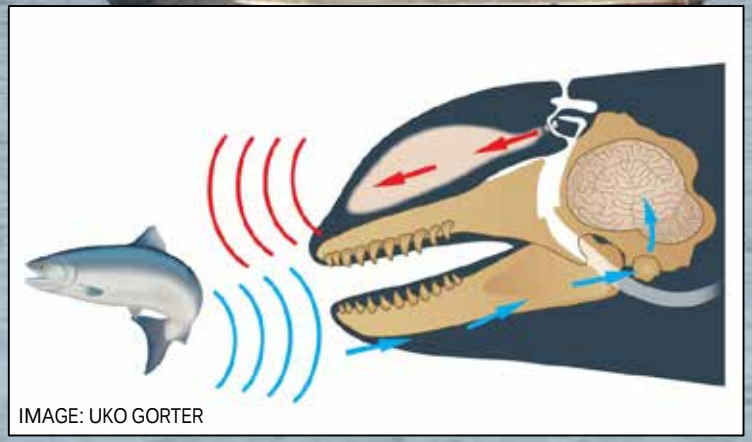
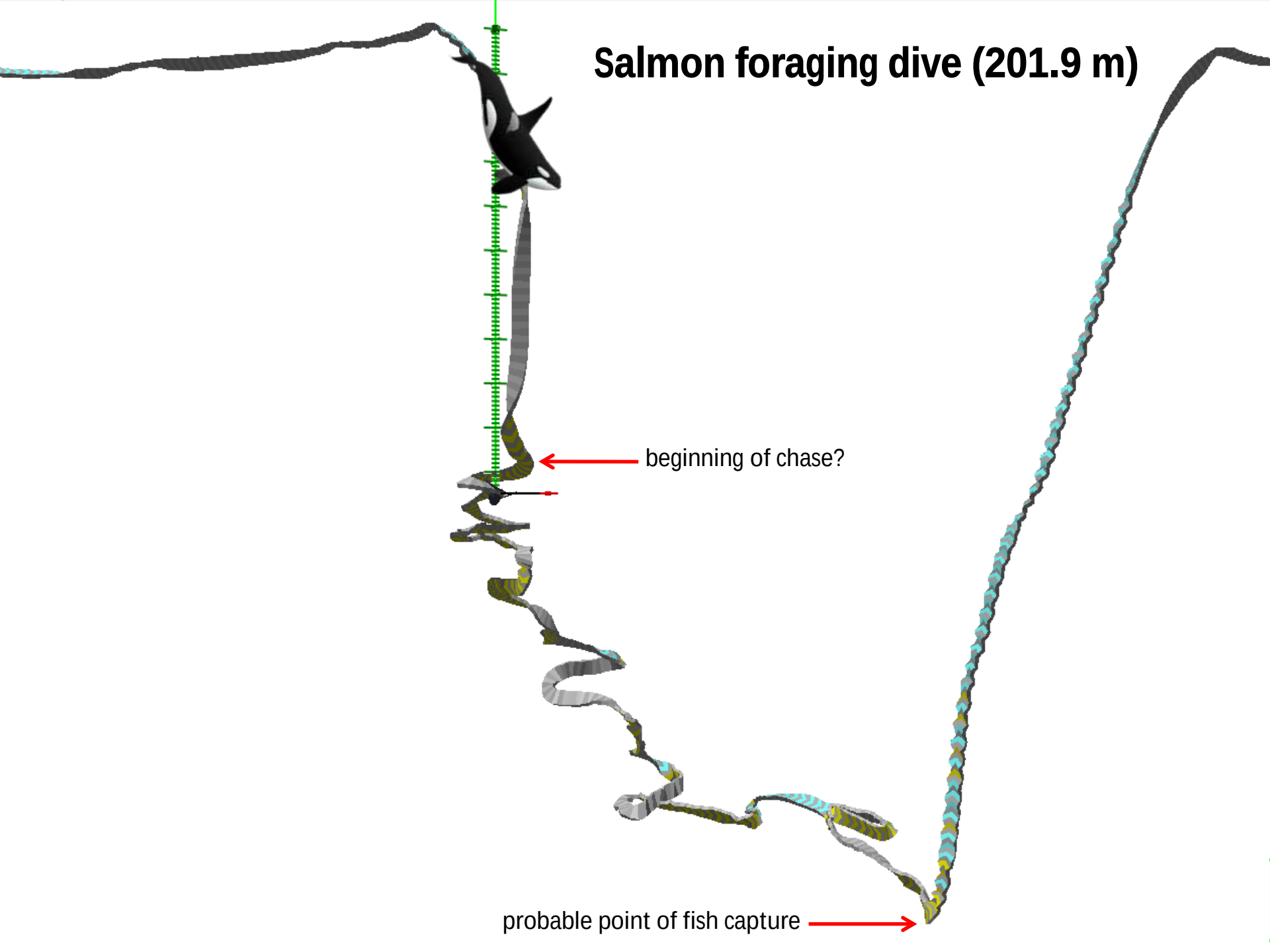
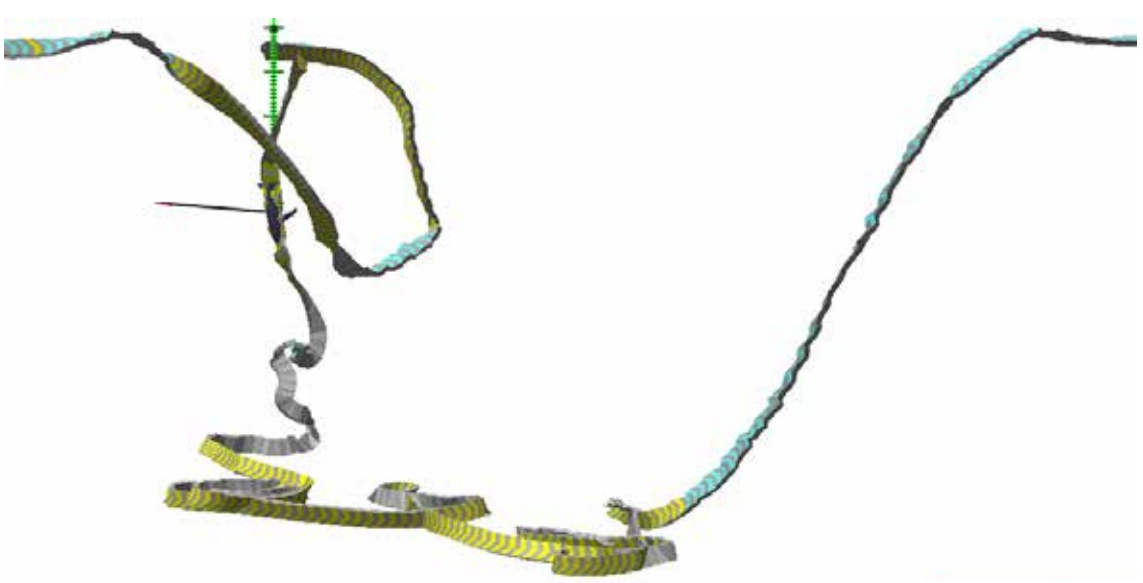


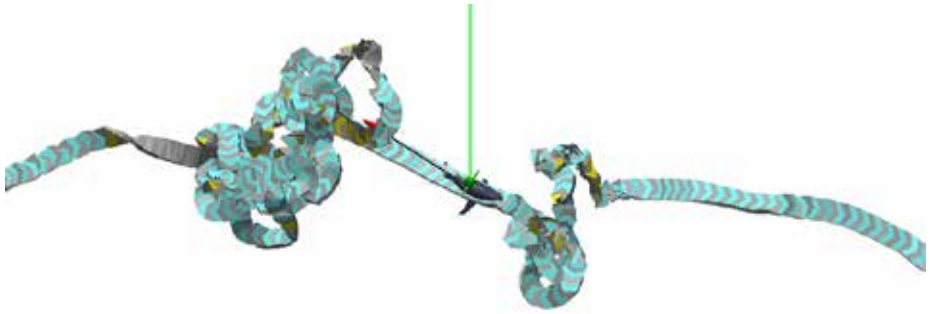
IMAGE: UKO GORTER

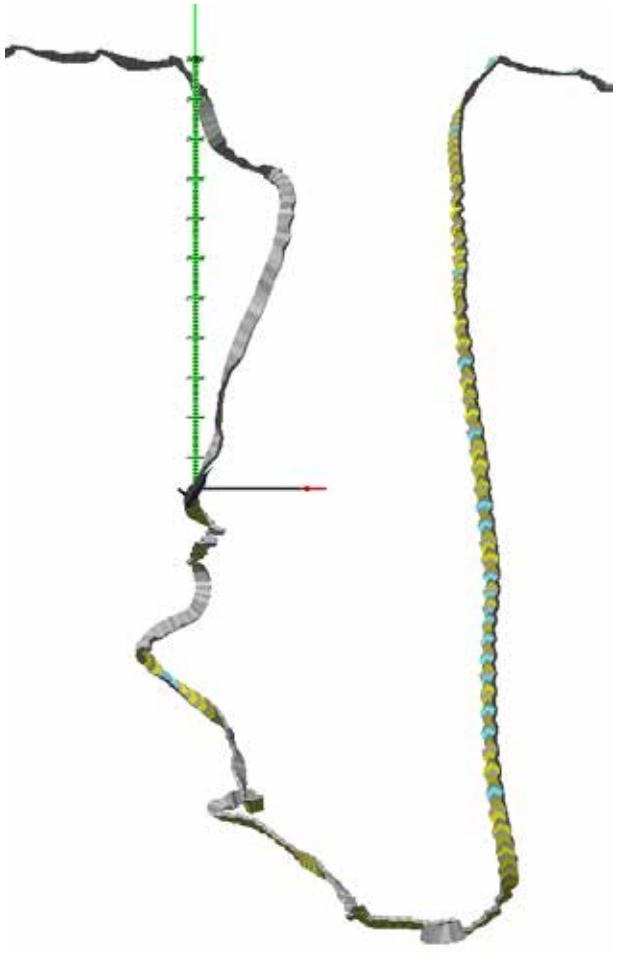
PHOTO: LANCE BARRETT-LENNARD


Salmon foraging dive (201.9 m)
beginning of chase?
probable point of fish capture

Identifying Foraging Dives: Machine Learning







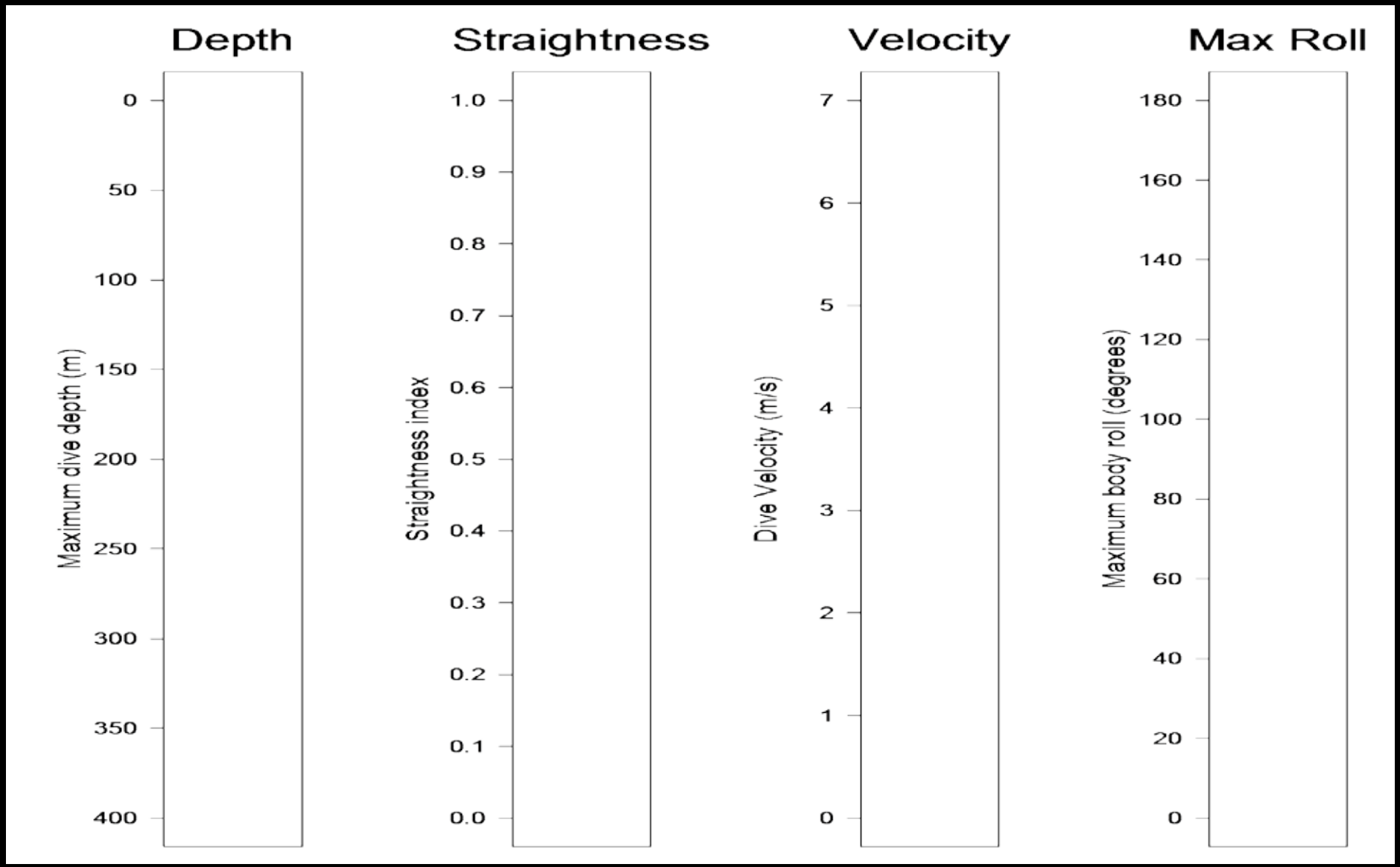
§ Dive (>1 m) types were categorized using 16 kinematic variables

§ Dives with prey remains (n=17) used as a training set for iterative LDA

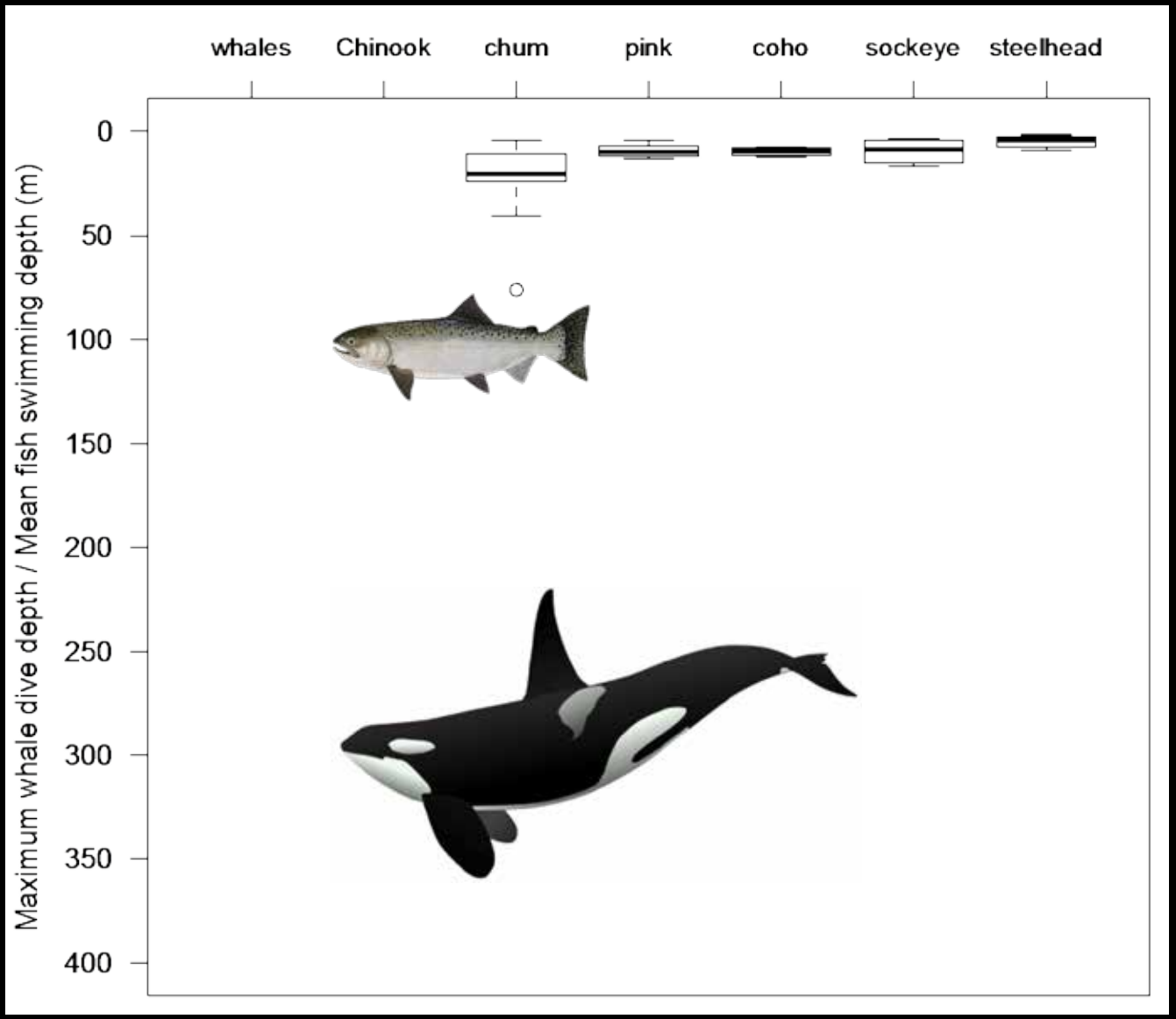
§ Results: 701 = foraging, 10,618 = other behaviours

Foraging dives are kinematically distinct

foraging dives, n=701 other dives, n=10,618



Whales target depths used by Chinook salmon



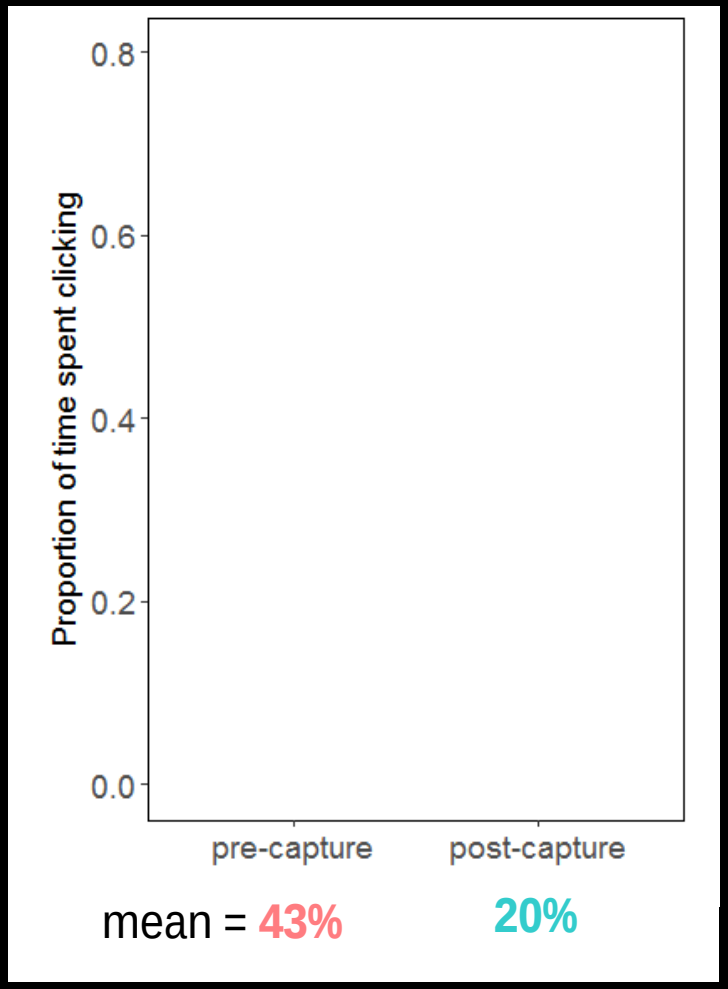
fish swimming depth
(average, tagging studies)

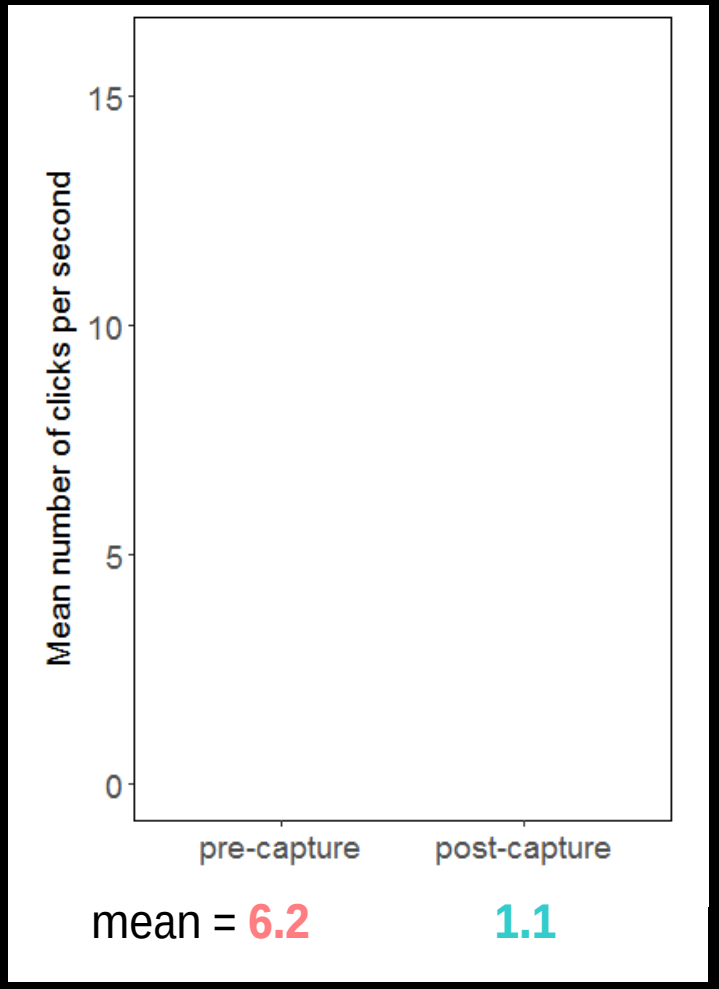
foraging dive depth
(maximum, DTAGs)

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

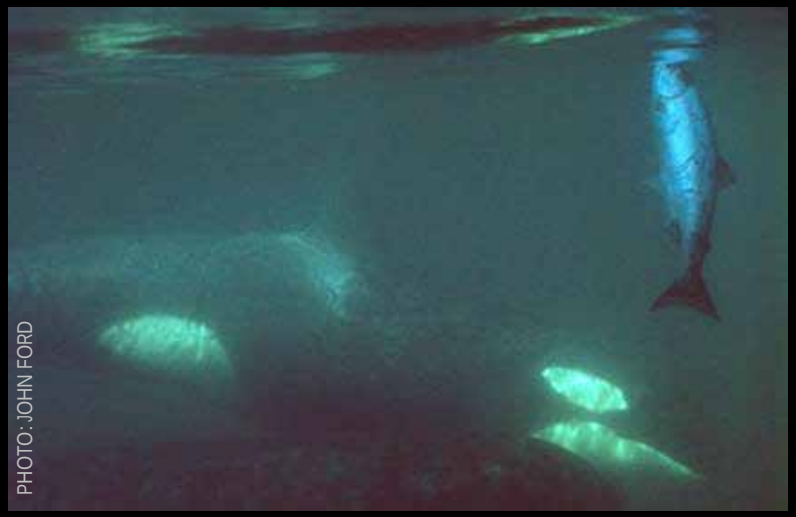
Pre- versus Post-capture Echolocation Behaviour

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

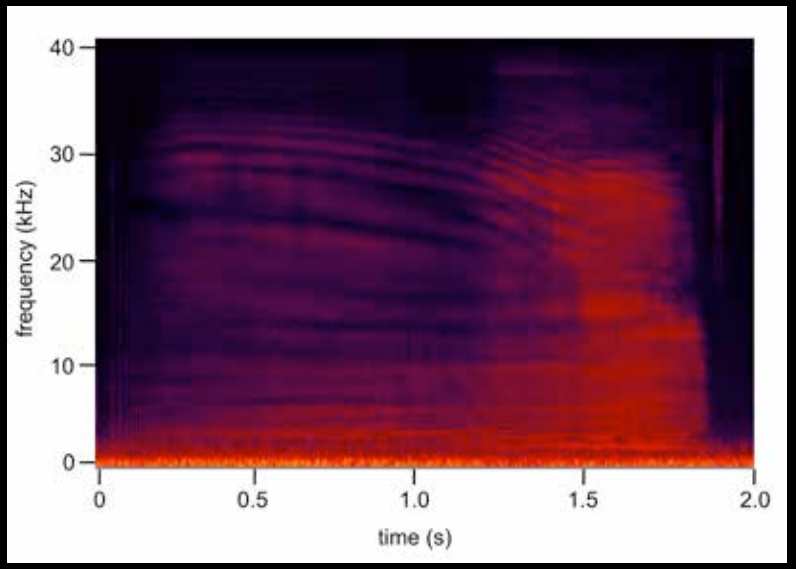


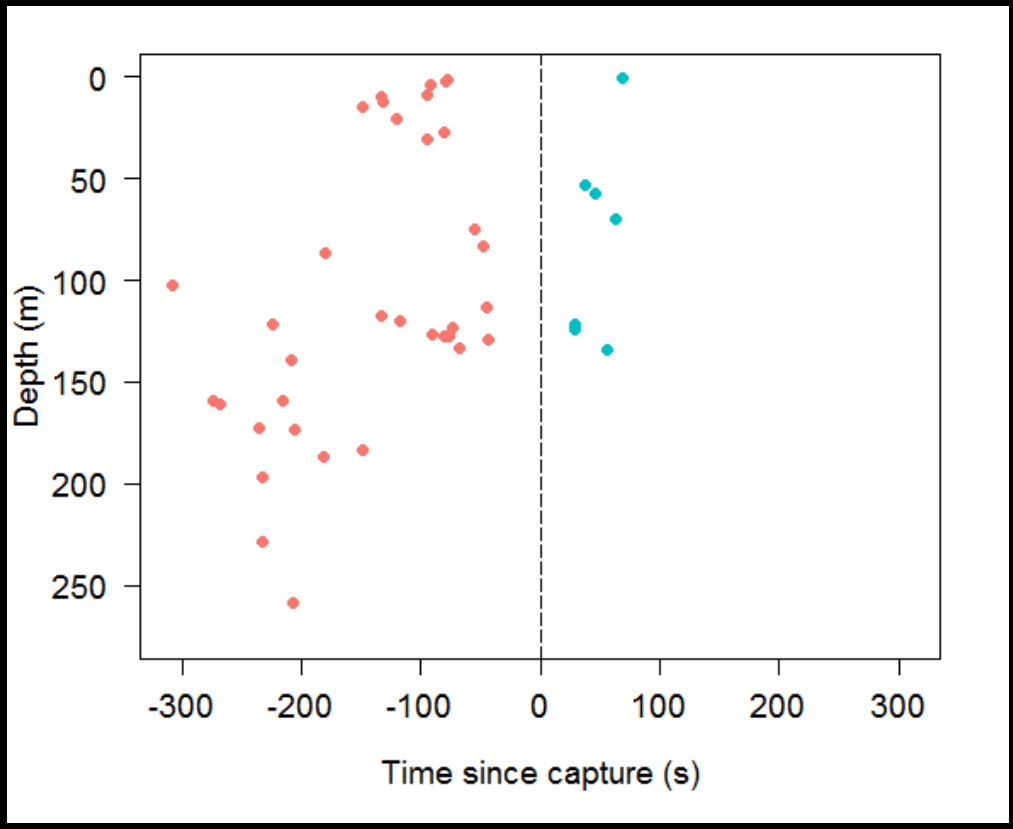


Buzzes: Close-range prey targeting



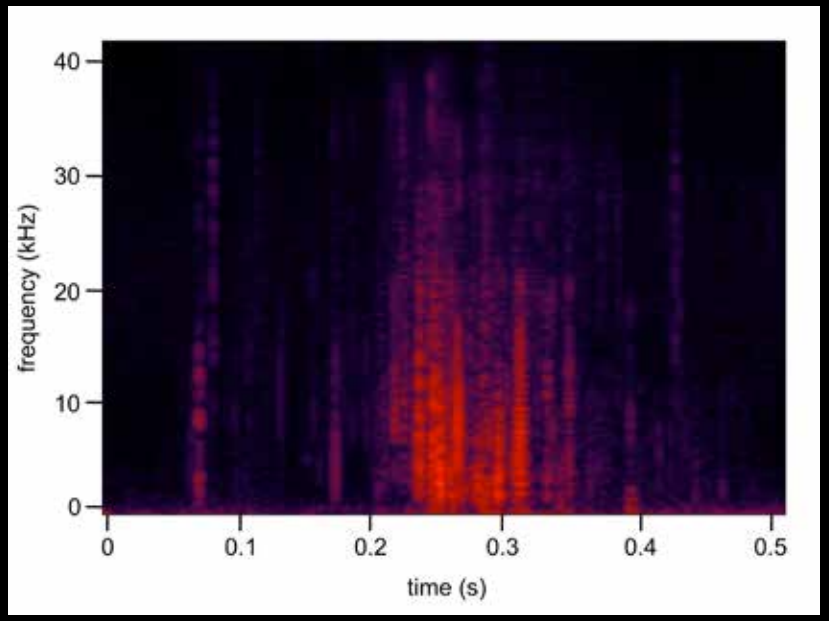
- Trains with >50% clicks having ICIs ≤ 20 ms
- Present in 13 of 17 foraging events: mean=2.5/capture; duration = 5.9 s
- Primarily **pre-capture**, often at depths >100 m

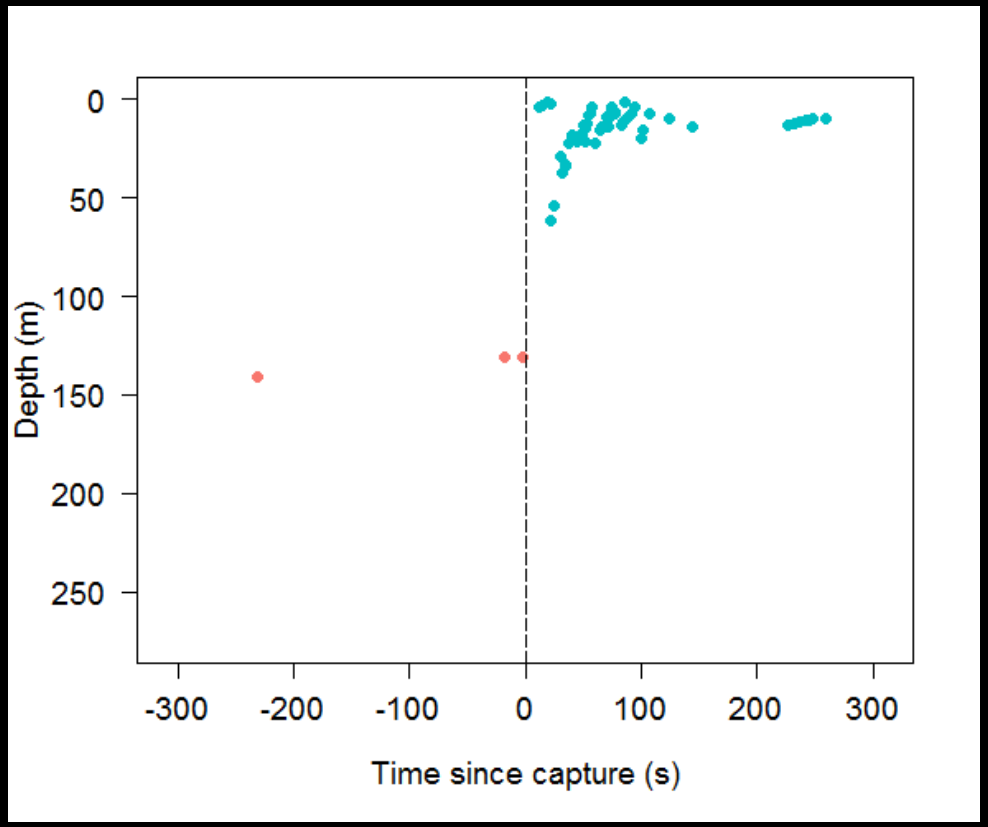




Crunches: Prey-processing sounds

- 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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