

False Killer Whale Bioacoustics, Deterrents and Adaptations: Implications for long line bycatch

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(R. Andrews)

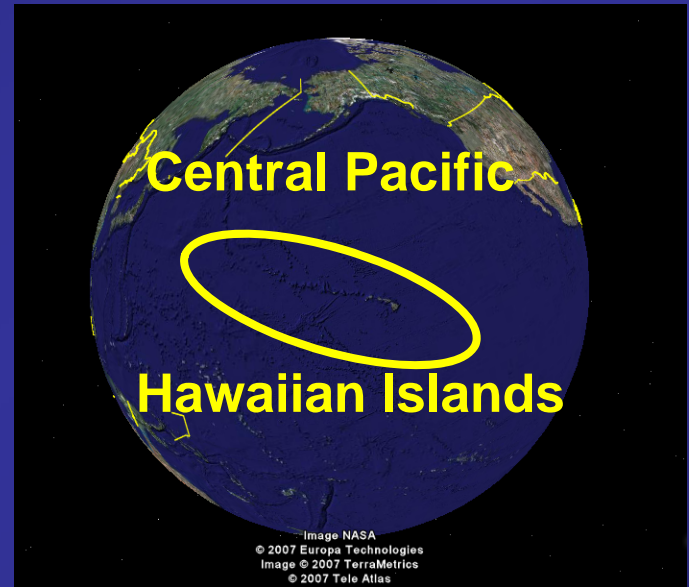
In Collaboration with Robin Baird (CRC), Peter Tyack (St. Andrews) and Paul Nachtigall (U. Hawaii)



False Killer Whales in Hawaii

- Wide-ranging, open ocean species inhabiting tropical and warm-temperate waters
- Hawaii → only known population to restrict movements to an island group

(Baird et al 2008; 2010)



- 3 Populations: Pelagic (n=1503)
 - NW Hawaiian Island (552)
 - Main Hawaiian Island (152) - Insular
- Potentially locally island adapted
- Insular = listed at Endangered in 2012

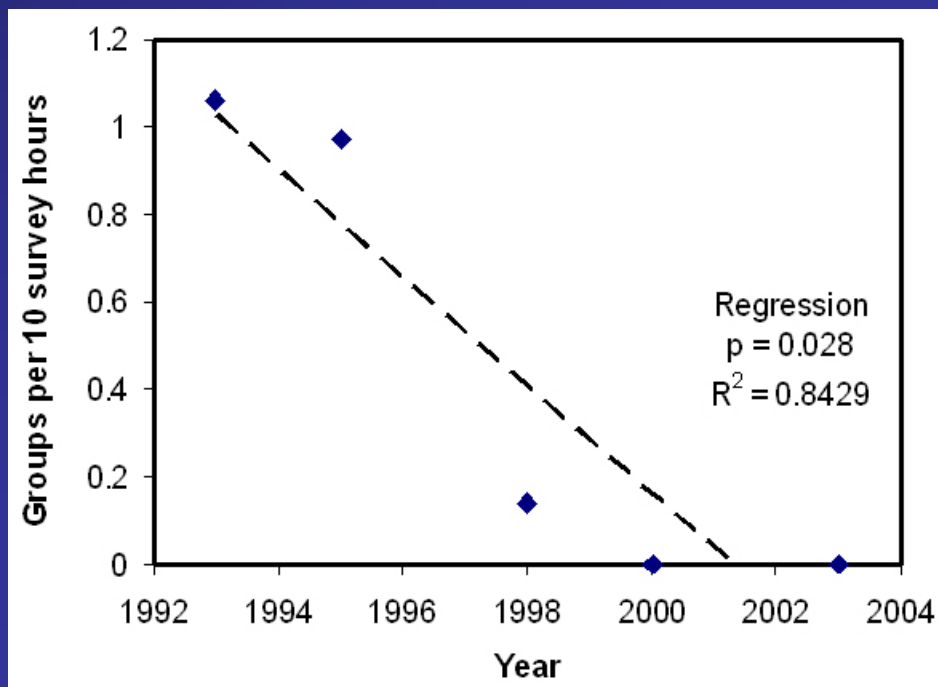
(Baird et al., 2012; NMFS SAR, 2012)

The Hawaiian Islands

- Feed on large pelagic fish (mahi, tuna, wahoo, marlin)
- Low and potentially decreasing population size → concern



Joe Mobley: Areal Survey Data



“Groups of more than 300 individuals were seen on three different days,.. The encounter rate, relative species ranking, and average group size from the 1989 survey were all substantially greater...., the population of false killer whales around the main Hawaiian Islands may have declined substantially since 1989.”

(from Reeves et al., 2009)

The Hawaiian Islands

- Feed on large pelagic fish (mahi, tuna, wahoo, marlin)
- Low and potentially decreasing population size → concern

Depredation: Coral Sea Example

- 3 vessels set 6,000 hooks
- Catch: ~900 fish
- Total loss (~18 tons; 20 kg/100 hooks)



- Hawaii bycatch exceeds the estimated Potential Biological Removal (0.3 and 9.1 for Insular and Pelagic stocks; takes estimated at 0.5 and 11.3)
- Line scaring and disfigurement

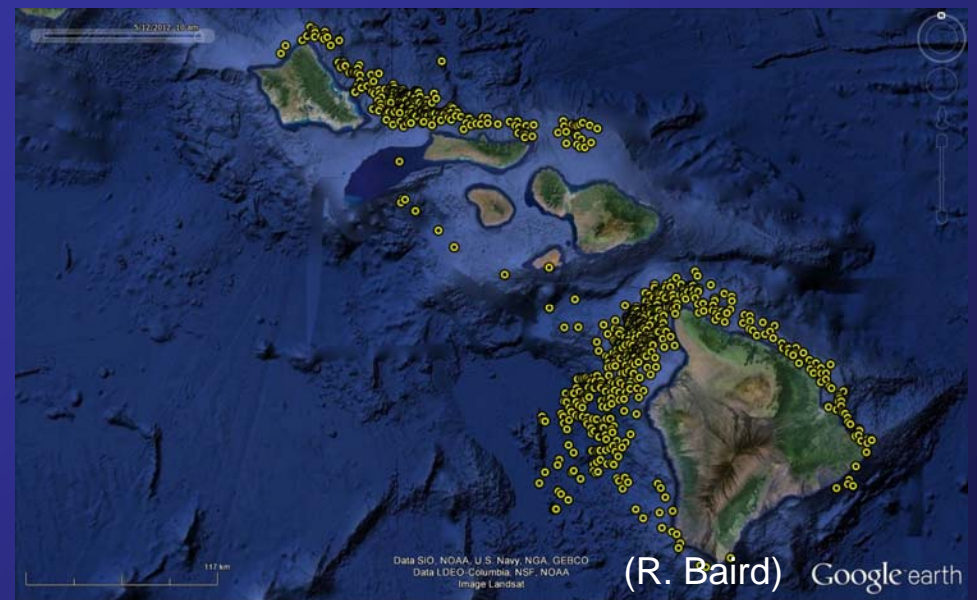
(Baird and Gorgone, 2005)

FKWs are Challenging

- Least abundant of Hawaii's 18 odontocete species
- Of 105 vessel days and 13,037 km:

1 Satellite tag and 1 DTAG (342 sightings of other species)

- Sat tagged 26 October 2011
- 199 days, the longest FKW attachment
- Social cluster 3 (only 6th individual)
- Habitat use generally similar; spent more time off the west side of Hawaii Island

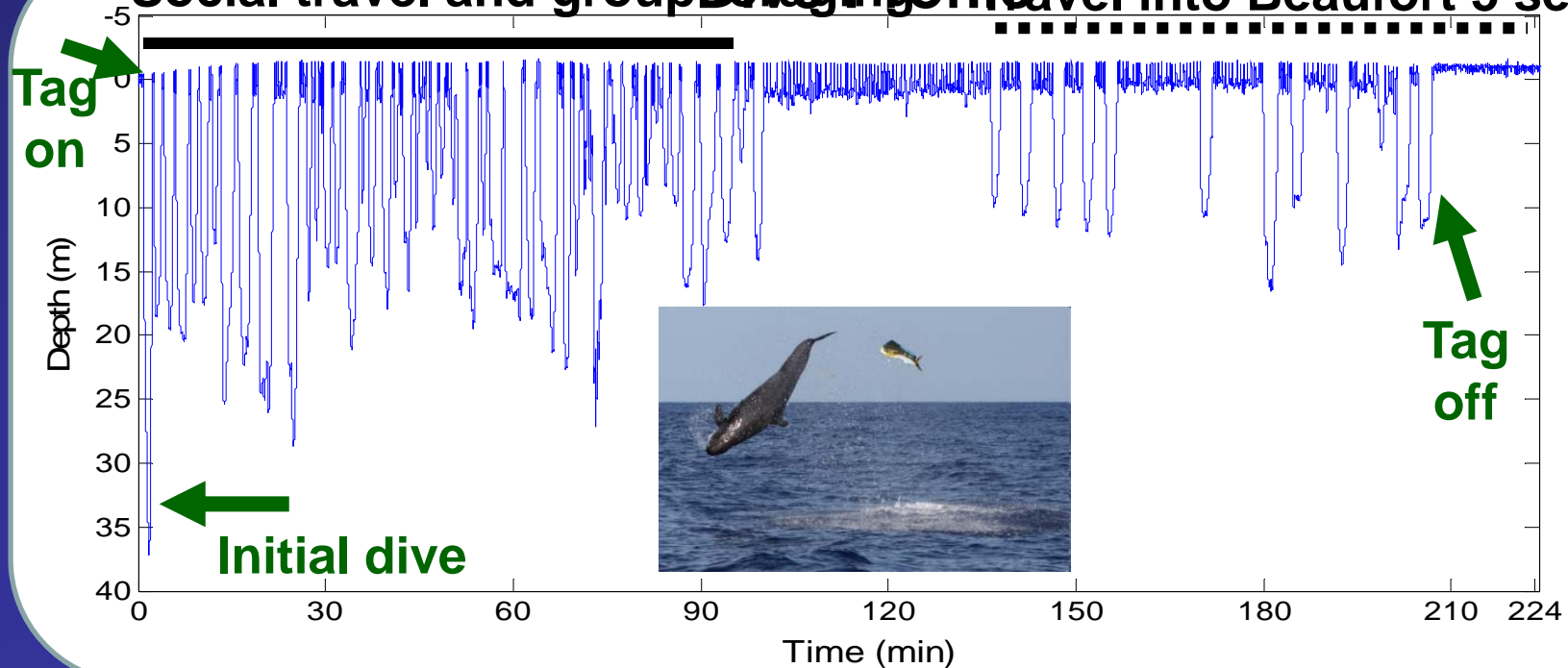


DTAG

- First 100 min (foraging) = 17.8 m dives (mean)
- Second 100 min (travel) = 12.6 m dives
- 3x more dives during foraging activity; 16x more whistles

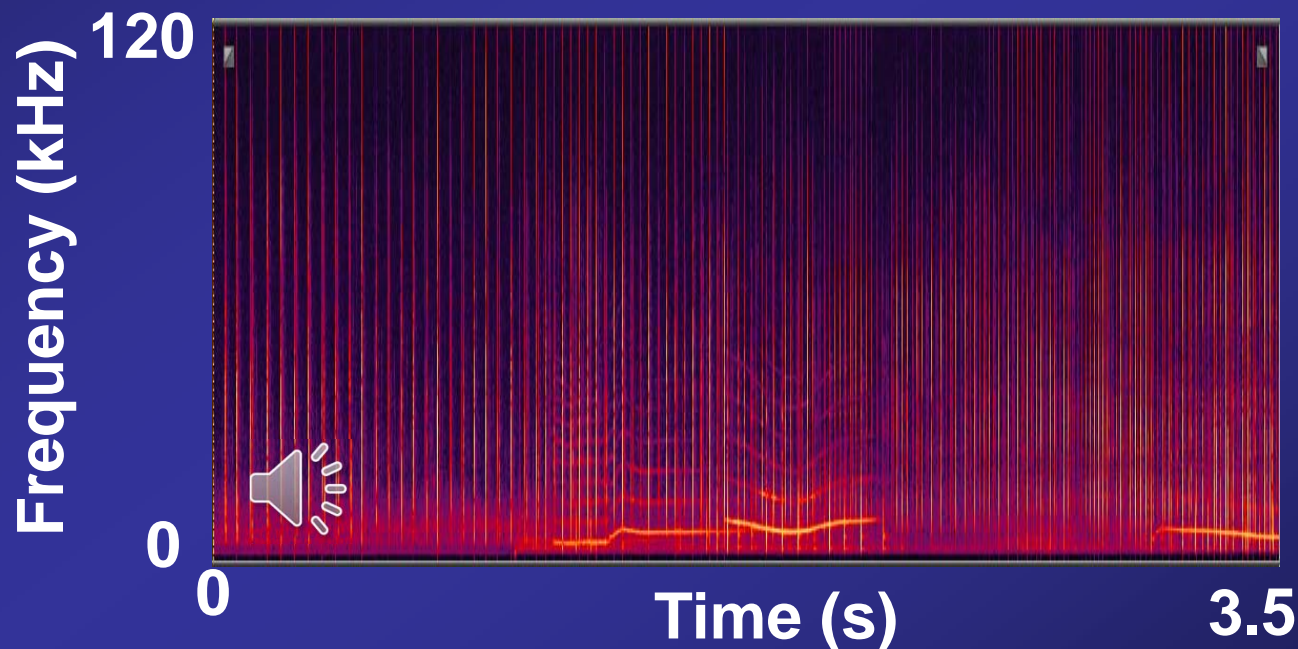
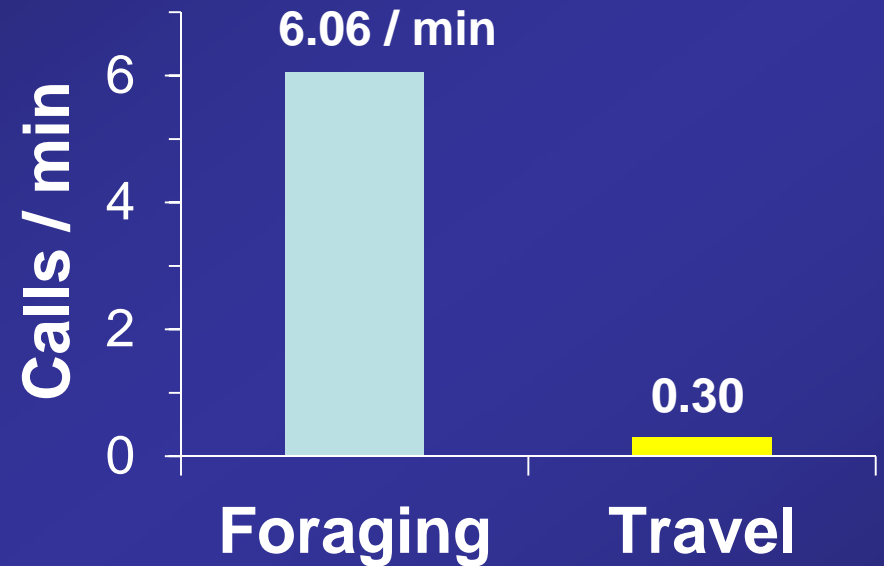


Social travel and group Dive Profile Travel into Beaufort 5 seas



DTAG - Acoustics

- Substantially more whistles detected during social-foraging
- Frequent 'bi-phonation' (simultaneous whistle-clicks) 71% of time (compared to whistles alone)

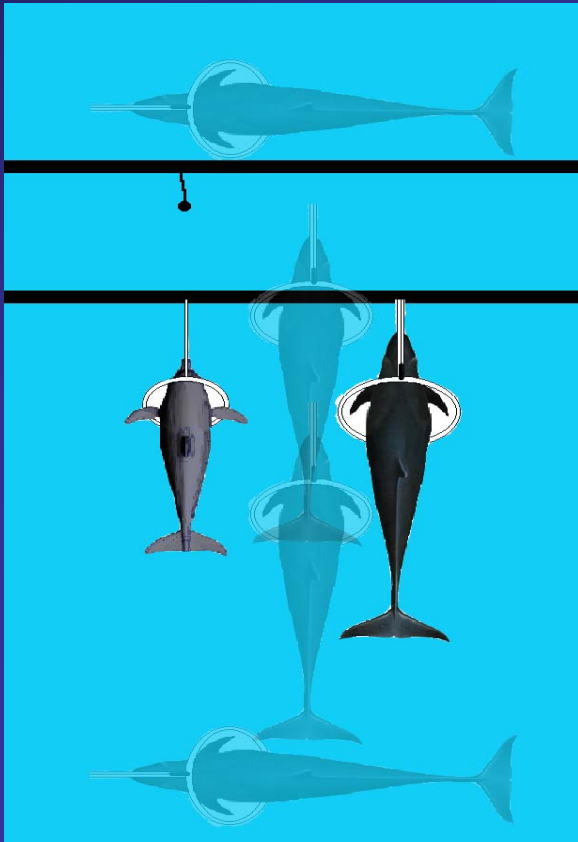


- Linear whistles similar to Bahamas tagged animals

Summary

- Field access and study of some species can be challenging

Comparison Lab Work



1) Replicating social interactions to quantify variations in noise and acoustic cues with animal position and head morphology

- Aliza Milette, U Hawaii MS student

Summary

- Field access and study of some species can be challenging

Comparison Lab Work

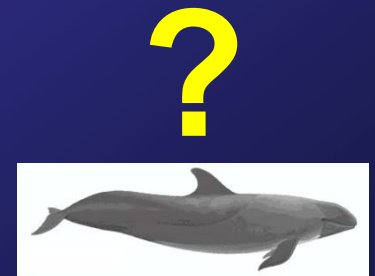
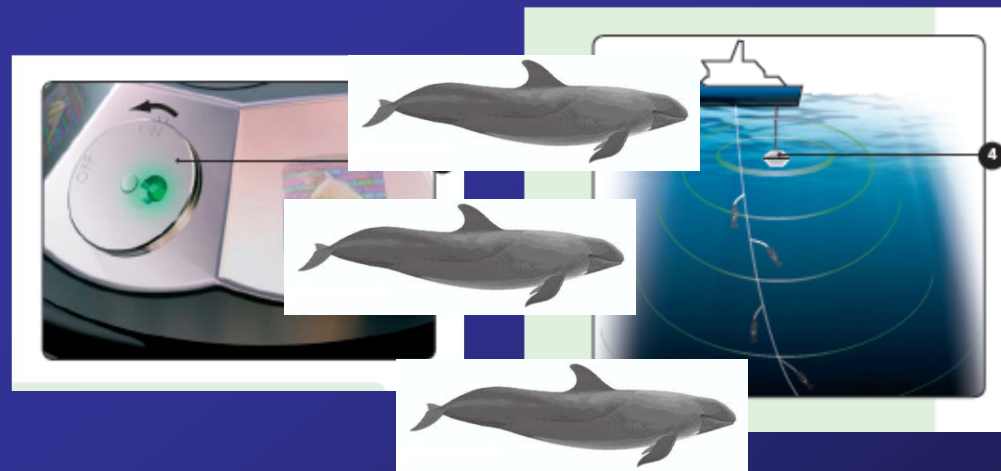
2) Acoustic deterrents, echolocation disruption and behavioral adaptation



The SaveWave Long Line Saver

- An Acoustic Deterrent tool designed to disrupt false killer whale echolocation and discourage from approaching the longline

- 1) Clip on to the Saver
- 2) Turn it on
- 3) Hang it off the side of the ship

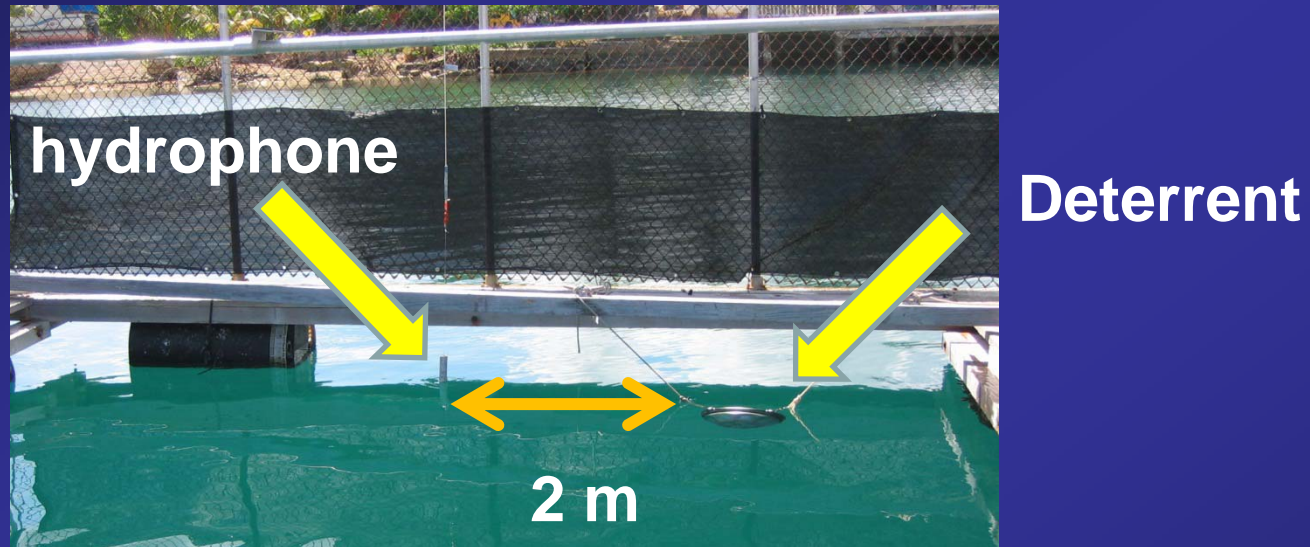


Experimental Goals

- Characterize the sounds produced by the deterrent device.
- Determine the deterrent's efficacy in reducing FKW echolocation performance.
- Evaluate the deterrent's potential to reduce depredation and FKW bycatch.

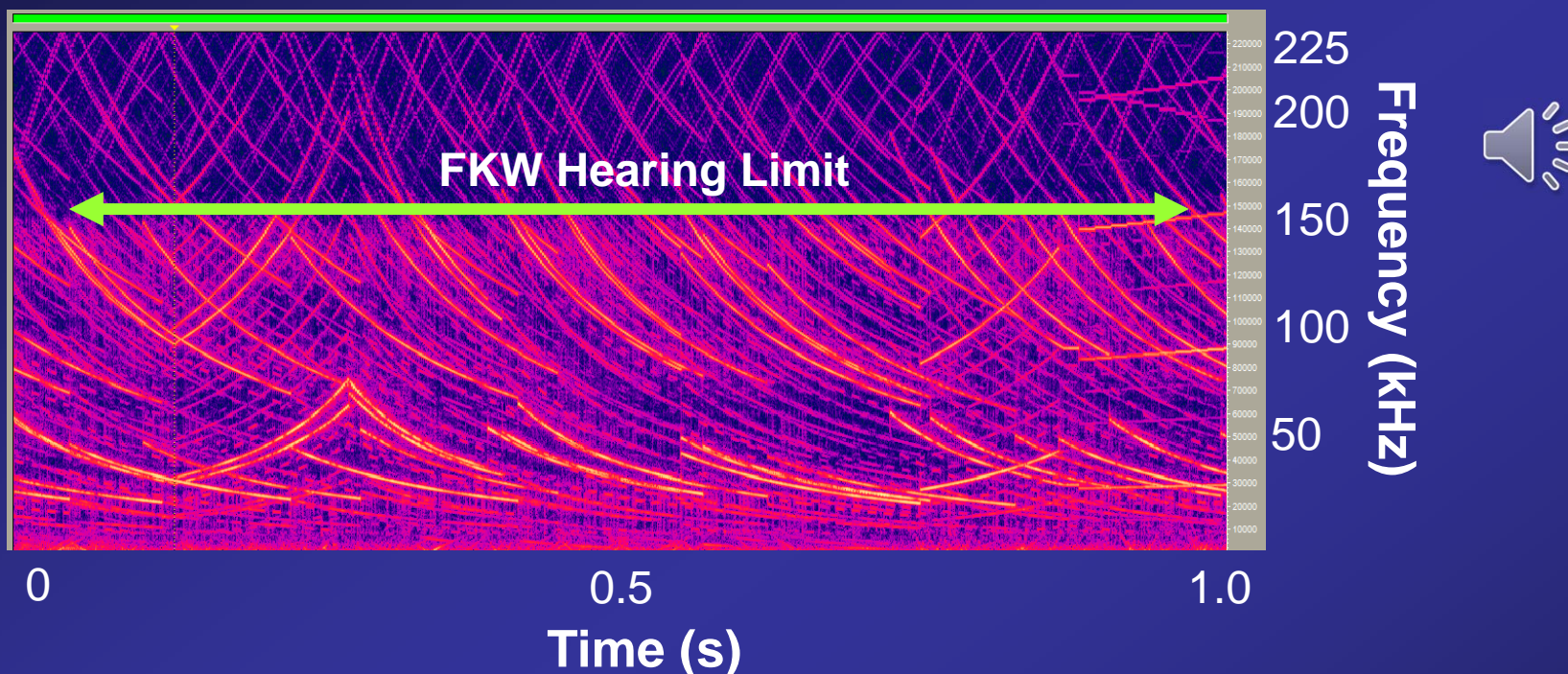


The Acoustic Characteristics



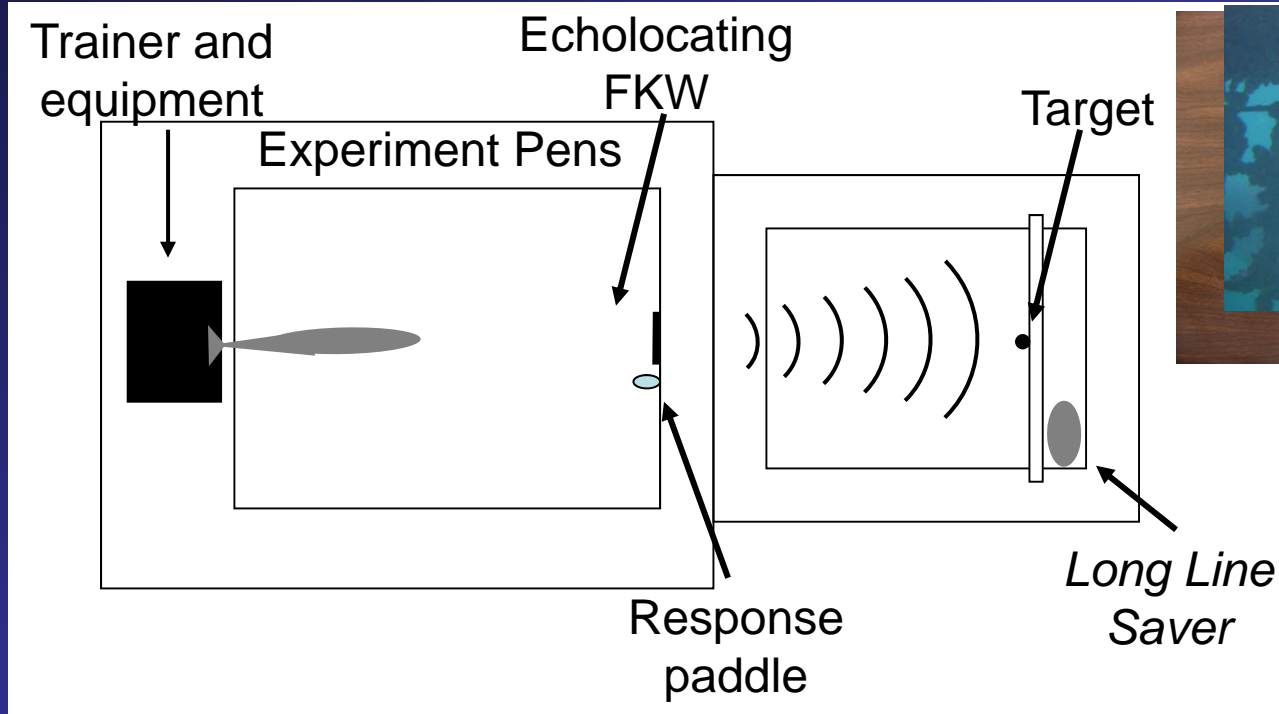
- 10x 1 sec sound files recorded 2 m from deterrent (before and after experiment)
- Front, side and back using broadband h-phone
- Sampled at 250 kHz (with 225 kHz lowpass filter) (National Instruments 6062E DAQ card)
- Reference tones: 20, 40, 60, 80 and 100 kHz

The Acoustic Characteristics



- Extremely broad band (up to 225 kHz)
- High source level of 180-182 dB re 1 μ Pa
(174 and 164 dB at side and back, respectively)
- Complex continuous signals with many harmonics
- Decreased by 20 dB during experiment (~25 hrs)

Echolocation Experiment

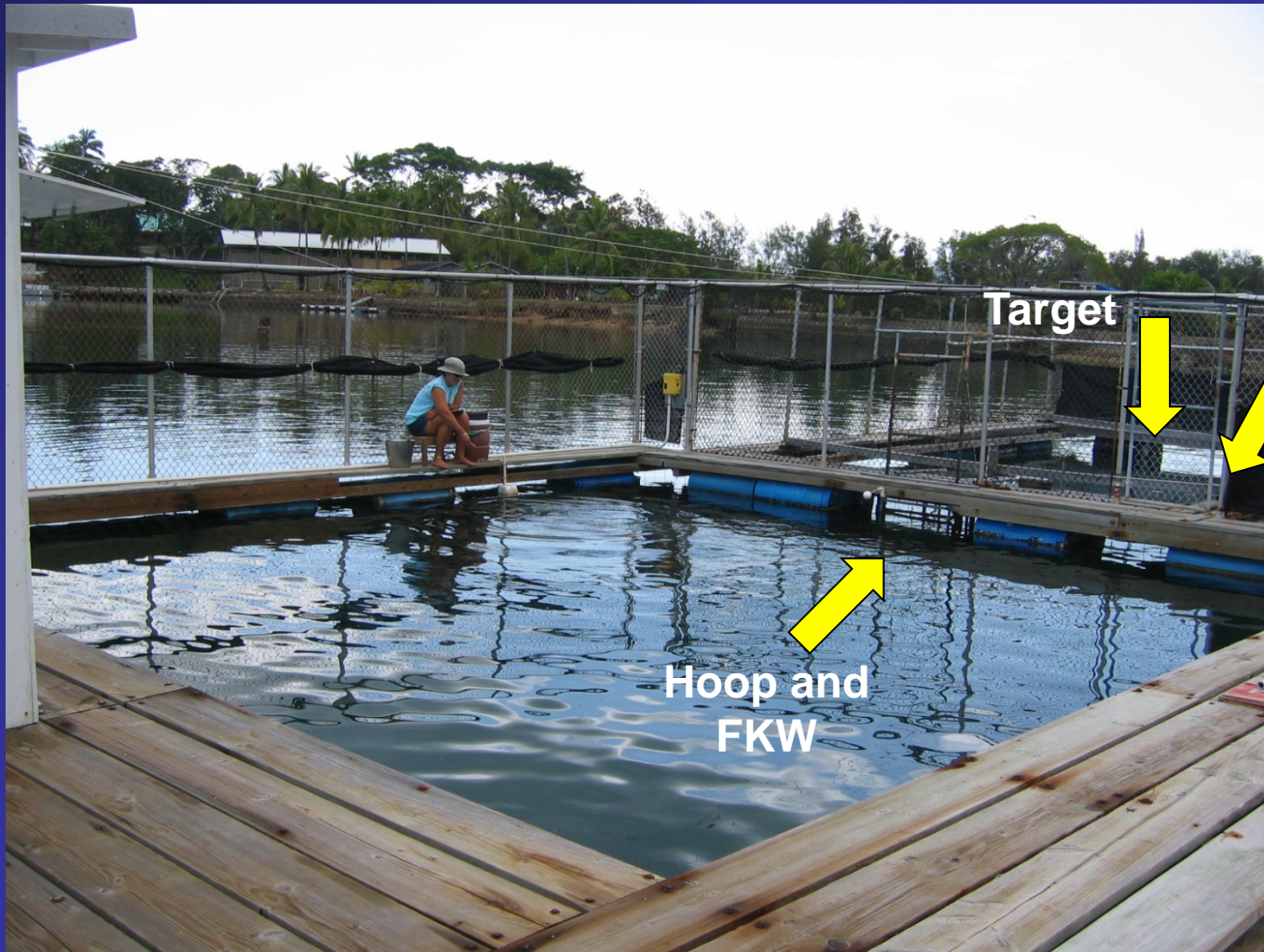


Measured

- FKW echolocates for target
 - Target detected → hits response paddle
 - No target detected → sits still
 - Trials with *Long Line Saver* on / off
 - 40-50 trials / session (15 sessions)
- Correct responses
 - # of clicks
 - Time to hoop
 - Time to make decision

Echolocation Experiment

Trainer and
equipment
shack



Target

Long line
Saver

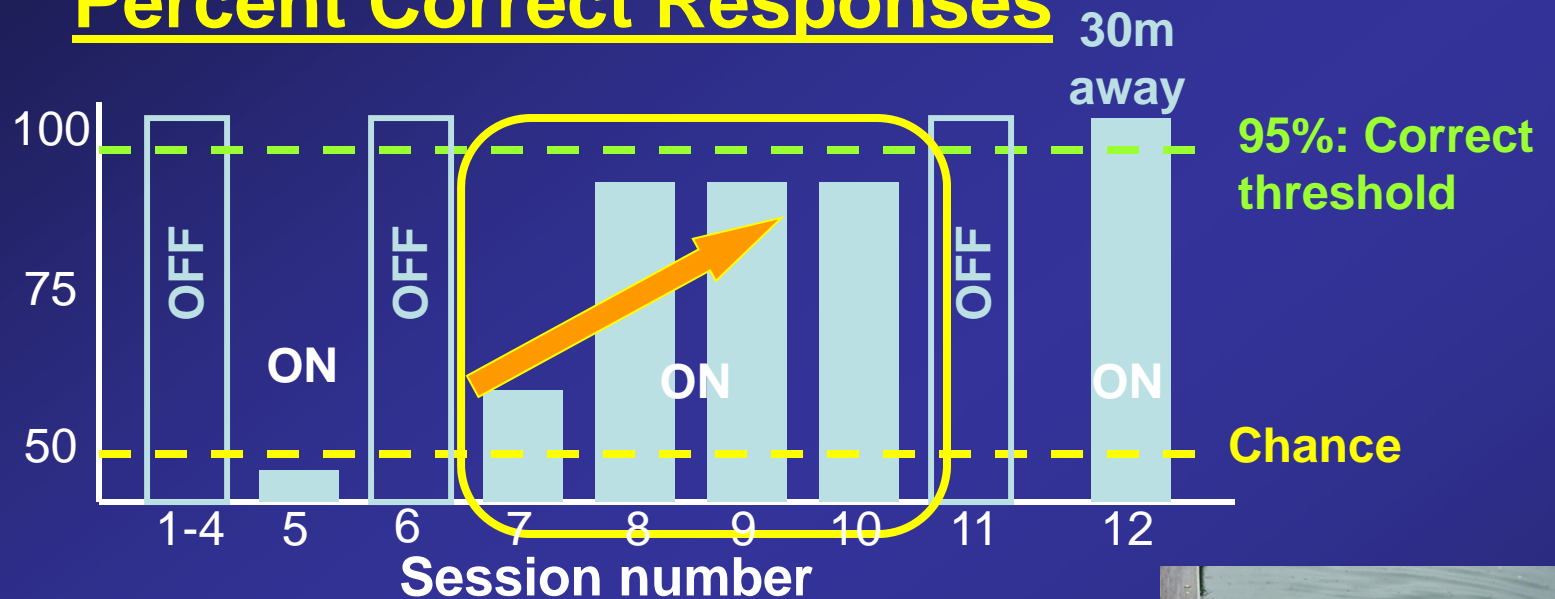
Hoop and
FKW

Percent Correct Responses

Sound is...

OFF

ON



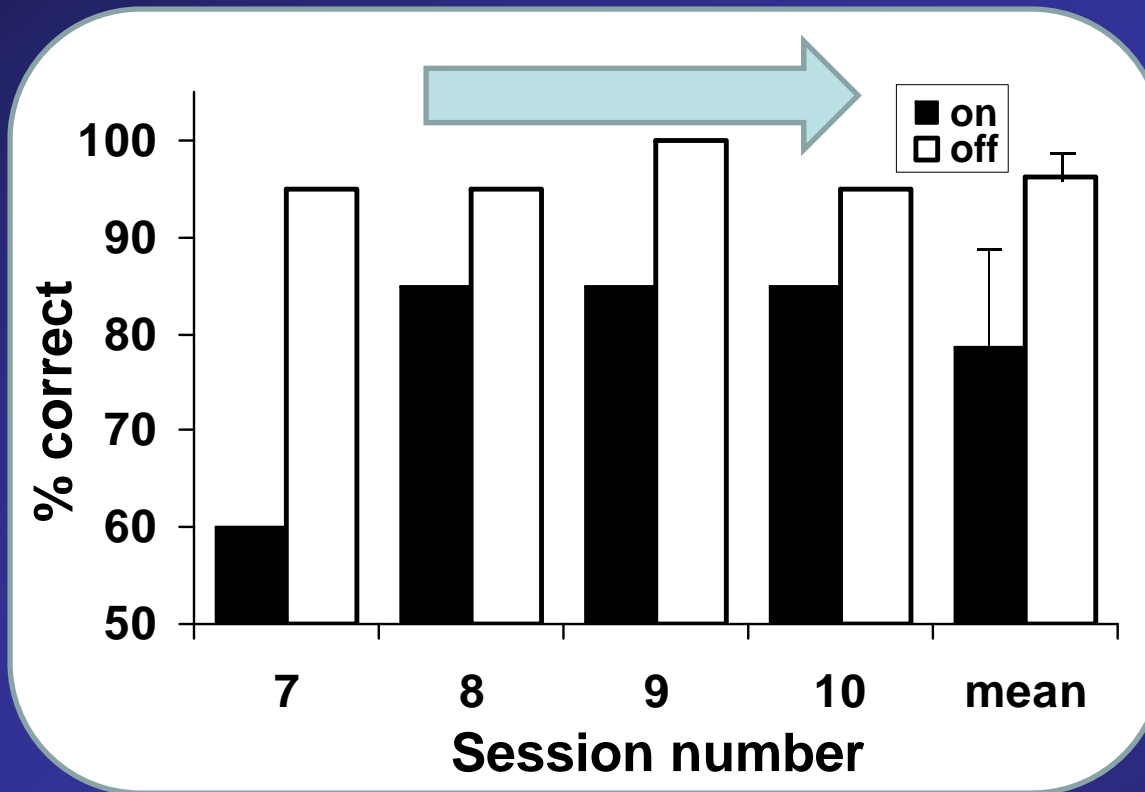
- 1) Baseline echolocation trials (4 sessions)
 - 97% correct detection of the target
- 2) *Saver* turned ON (for entire session):
 - 46% correct (chance = guessing)
- 3) Return to baseline (*Saver* OFF):
 - 96% correct (back to 'normal')
- 4) *Saver* ON, ABBA format
 - 79% correct



(Mooney et al., Can. J. Fish. Aqua. Sci. 2009)

ABBA Sessions

Each session is 40 trials = 10 off : 20 on : 10 off

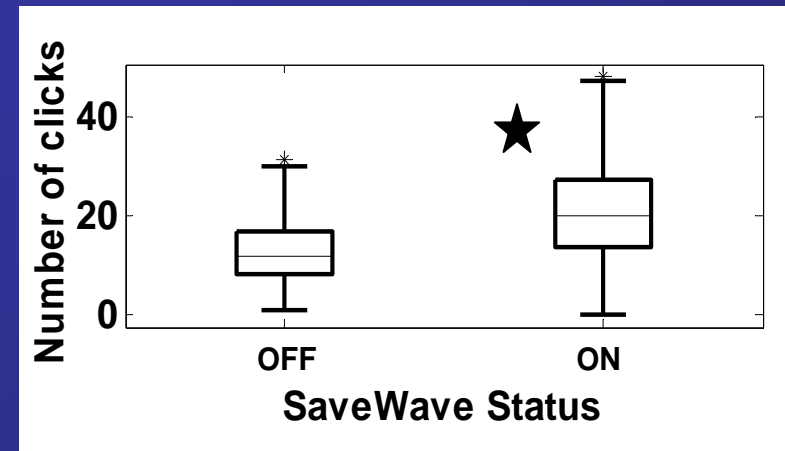
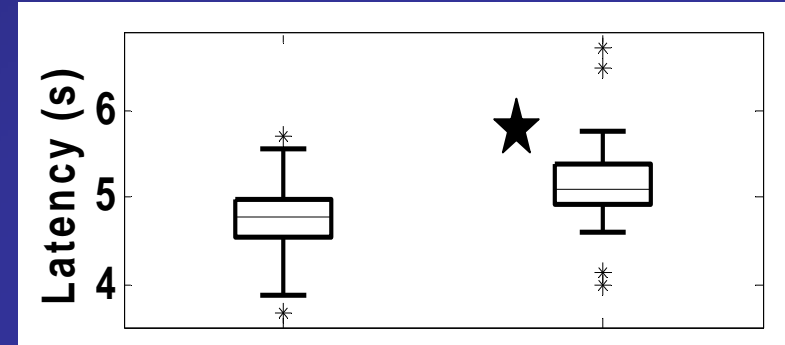


- First session on = only 60% correct
- Next 3 sessions all 85% correct (plateau)
- Increase in % correct but levels did not reach “OFF” trials

(Mooney et al., 2009)

Echolocation Parameters

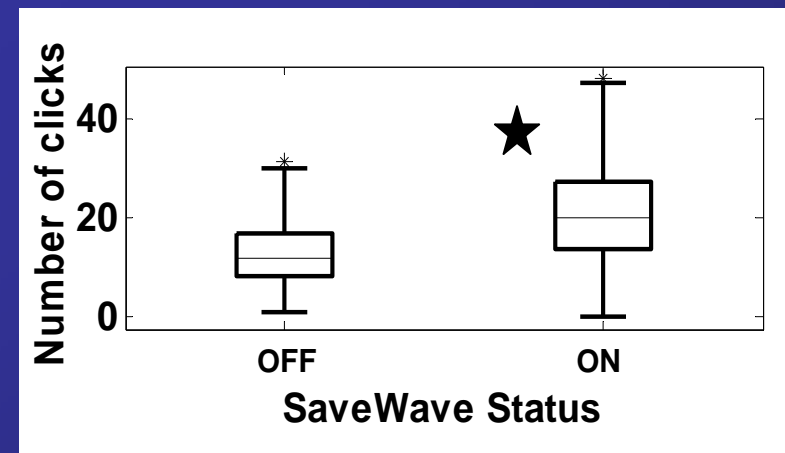
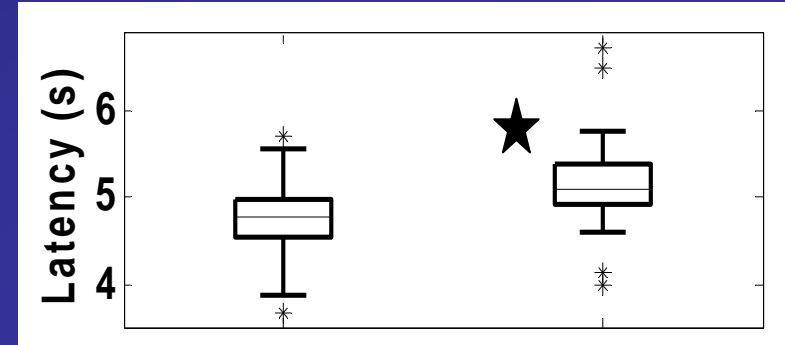
- Kina increased her latency to the hoop
- Doubled her echolocation clicks / trial when the *Saver* was ON
- Decision time did not increase
- No difference in echolocation parameters (correct responses, # of clicks, decision time) when *Saver* was OFF or 30 m away



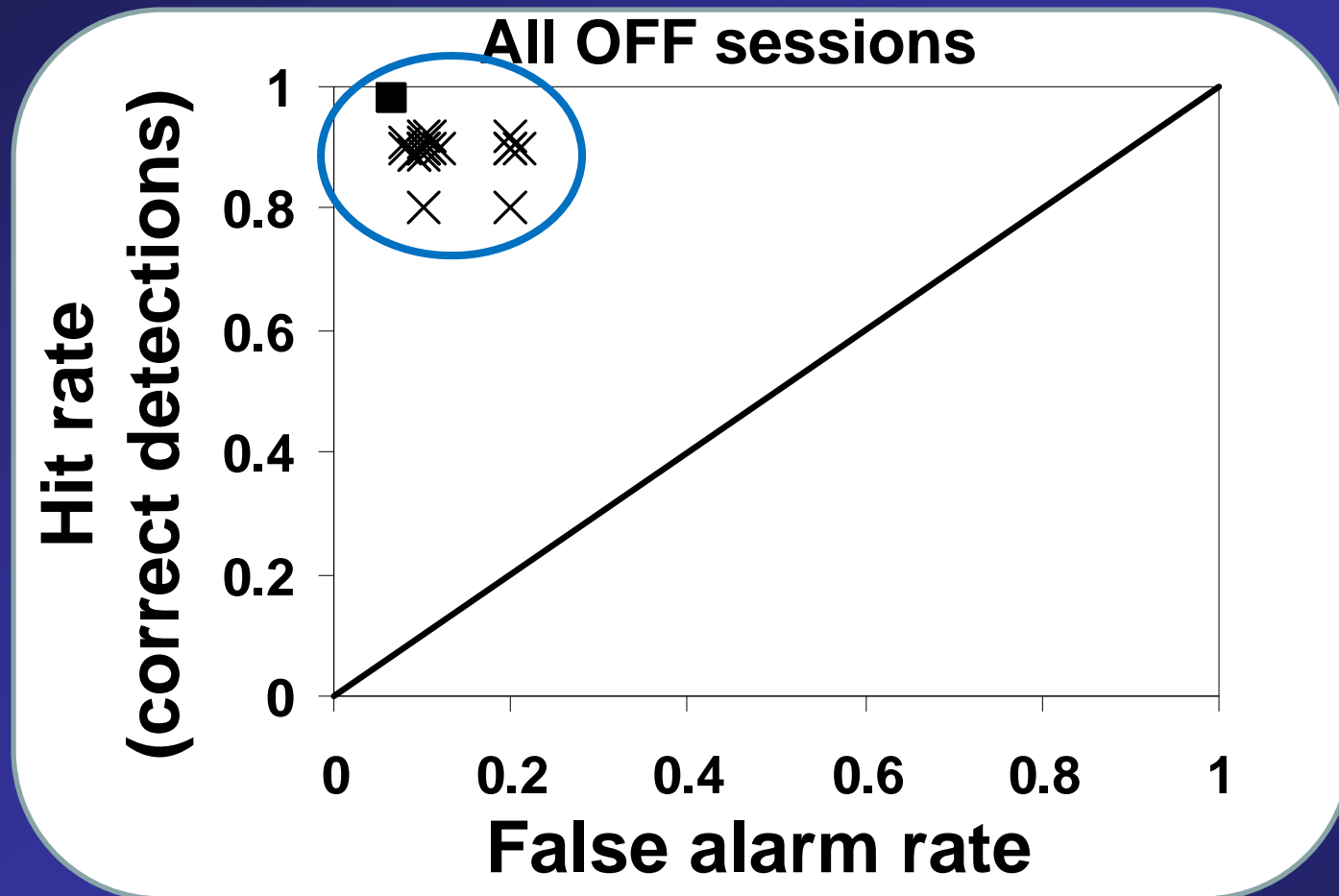
(Mooney et al., 2009)

Echolocation Parameters

- Kina increased her latency to the hoop
- Doubled her echolocation clicks / trial when the *Saver* was ON
- Decision time did not increase
- Seems to suggest: task was slightly more difficult and potentially adverse



Receiver Operating Characteristics

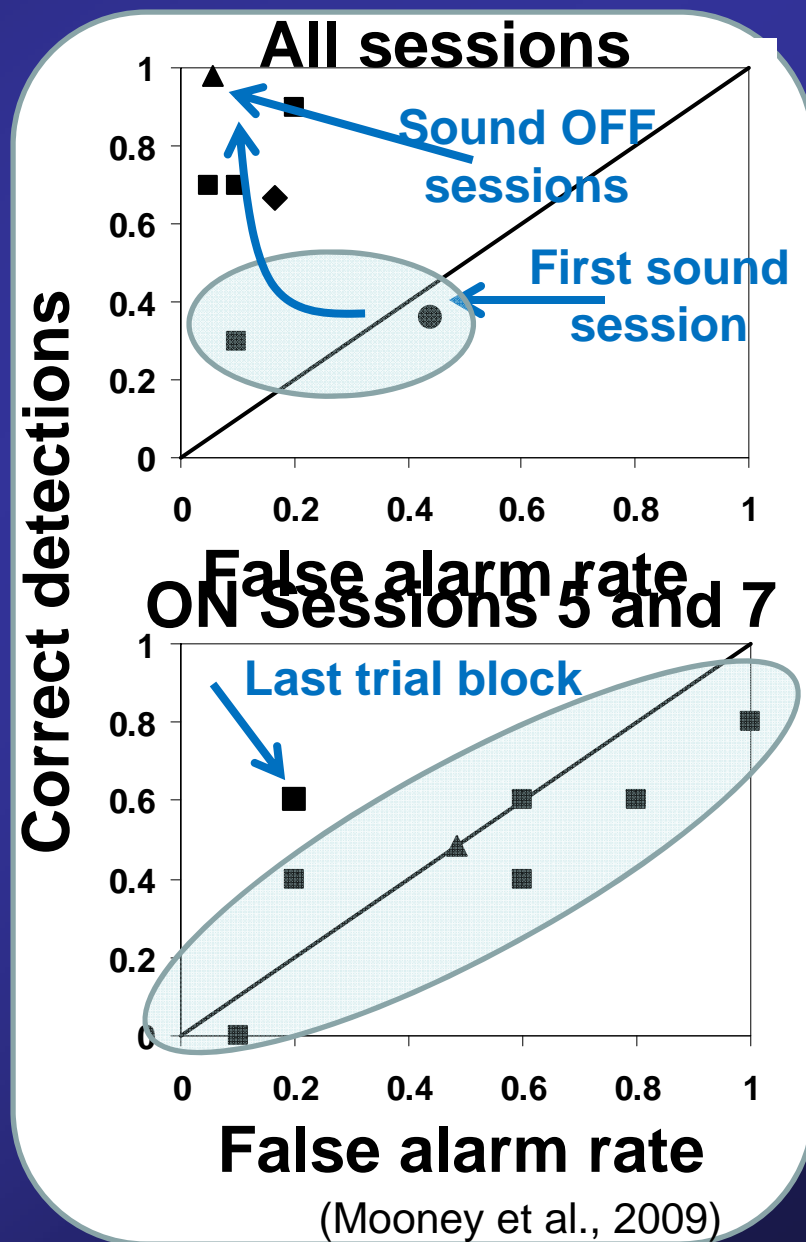


- High hit rate and low alarm rate → suggest the ease at standard target detection

(Mooney et al., 2009)

Receiver Operating Characteristics

- Early 'sound ON' trial:
likely guessing (liberal)
- Later sound sessions
show improvement and
becoming conservative
- Breaking down ON sound
trials into blocks of 10
- Diagonal = guessing or
searching for a strategy
- Improvement over time
(60% hit rate/ 20% alarm)
reflects success



Conclusions

1) Deterrent did little to reduce echolocation performance of a (well practiced) false killer whale

- Increased # of clicks suggests task more difficult
- Increased latency suggests potentially aversive
- Lower sound levels (moving device and decreased source level) improved animal performance

2) Apparent strategy switching to improve performance (Behavioral adaptation)

3) Field and lab show challenges of task ahead



Thank you & Questions

- Tim Werner, Kate McClellan and this meeting
- Robin Baird, Paul Nachtigall, Peter Tyack
- Russ Andrews, Daniel Webster, Greg Schorr
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- Paul Dalzell, WestPac
- Eric Gilman, IUCN
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- Whitlow Au,
- Marc, Julie, Alison, Mark, Michael, Laura, Alexis and Kim
- Michelle Yuen
- Amy Apprill
- Kina

Some of this work appeared in:

Mooney, TA, Pacini, AP, and Nachtigall, PE. 2009. False killer whale (*Pseudorca crassidens*) echolocation and acoustic disruption: Implications for long-line bycatch and depredation. Canadian Journal of Zoology. 87: 726-733.

