Can we be as clever as a sperm whale?

Efficacy of Counter-Measures to Reduce Sperm Whale Depredation on Demersal Longlines in the Gulf of Alaska

Wild, Straley, Thode, Liddle, Mathias, O'Connell, Behnken, Falvey, Andrews, Kauffman

SCRIPPS INSTITUTION OF OCEANOGRAPHY UCSD

UAS UNIVERSITY OF ALASKA SOUTHEAST learn · engage · change

SITKA SOUND SCIENCE CENTER

Alaska SeaLife Center Seward, Alaska

C S E A SAINT PAUL

Cascadia Research Collective non-profit research and education since 1979

Alaska Longline FISHERMEN'S ASSOCIATION

- Sperm whales (*Physeter macrocephalus*) remove fish from commercial fishing gear worldwide.
- In the Gulf of Alaska they are targeting longline fishing vessels catching black cod (sablefish)
- Reported since 1970s
- Encounters becoming more frequent

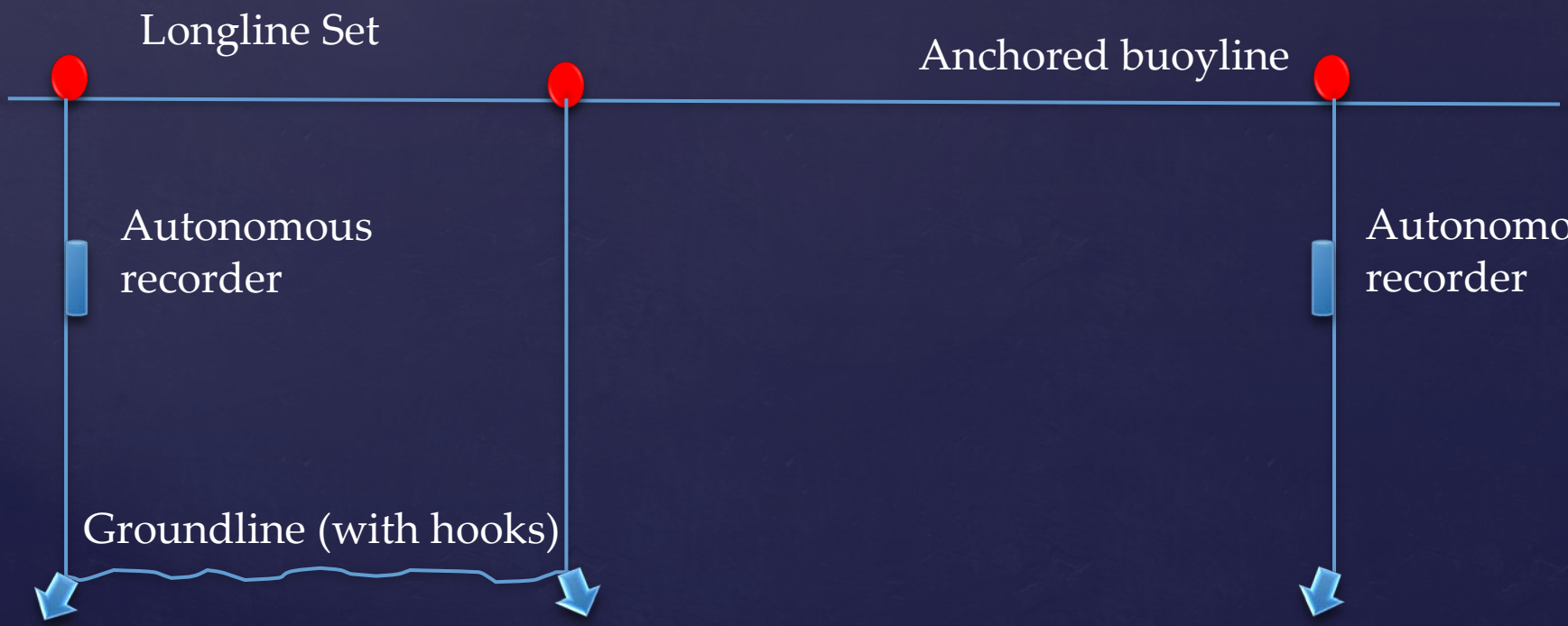
Southeast Alaska Sperm Whale Avoidance Project (SEASWAP)

Cooperative research between scientists, fishermen, and fisheries managers

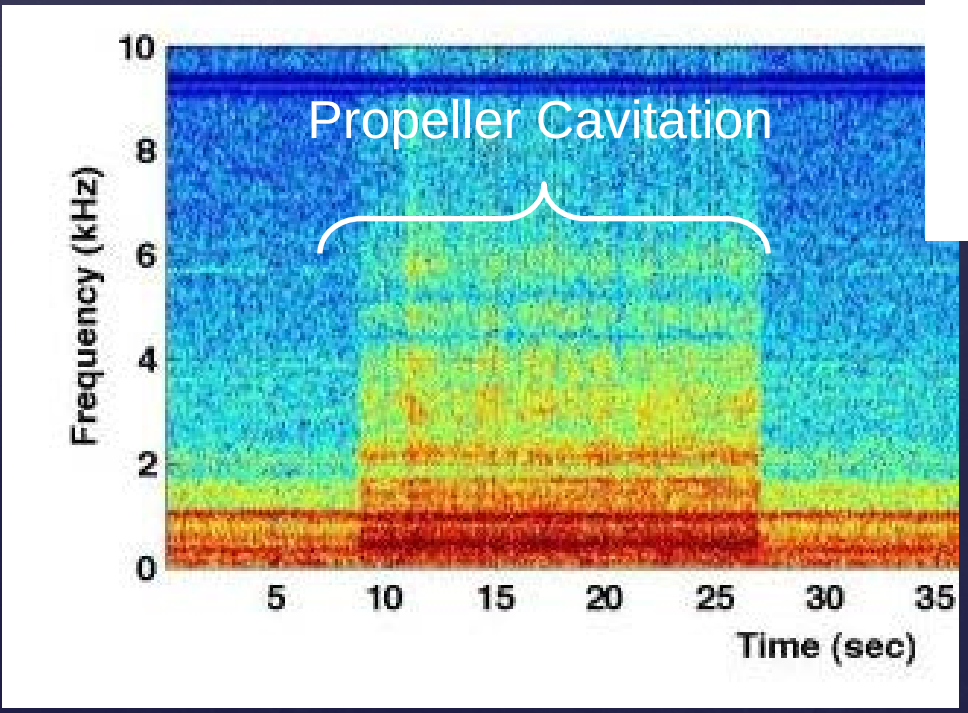
Acoustics

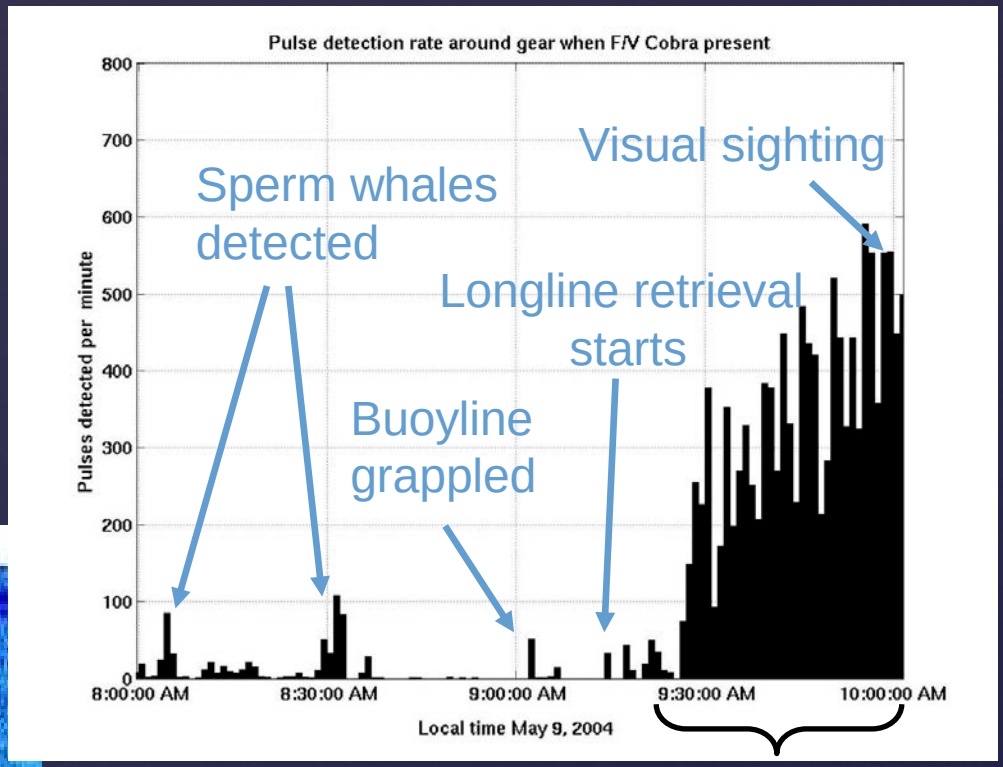
- Acoustically active
- Constantly producing echolocation signals.

Photo: SEASWAP's acoustic recorders



Acoustic Cue: Engine Cycling (Thode *et al.* 2007)





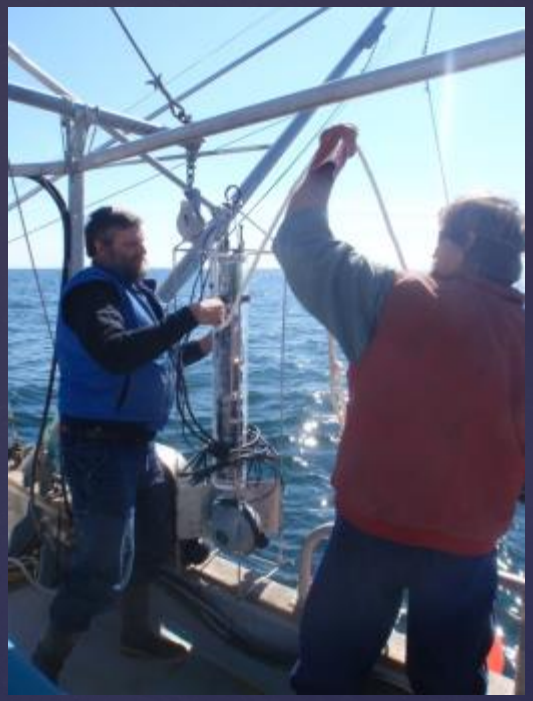
When engines begin to engage, sperm whale click rates increase rapidly.

Testing countermeasures

From the potential, to the wacky…

- Metal on the line: flashers, spoons
- Electrical charge through line
- Snaps vs. fixed?
- Playback: transient killer whales, white noise, FM Sweeps
- Blaring heavy metal music?
- Beads
- Avoidance?
- Decoy
- Future: Pods? Bubbler? Jammer?

Playback: killer whales, white noise, FM sweeps



- Playback device with underwater Lubell speakers up to 21kHz, 180dB re 1 uPa
- Played series of white noise, FM sweeps, and killer whale vocalizations
- Found no reactions from whales in the initial review of acoustic or visual data

Take home message:

Whales had little reaction to playback, and creak rates remained high during the haul.

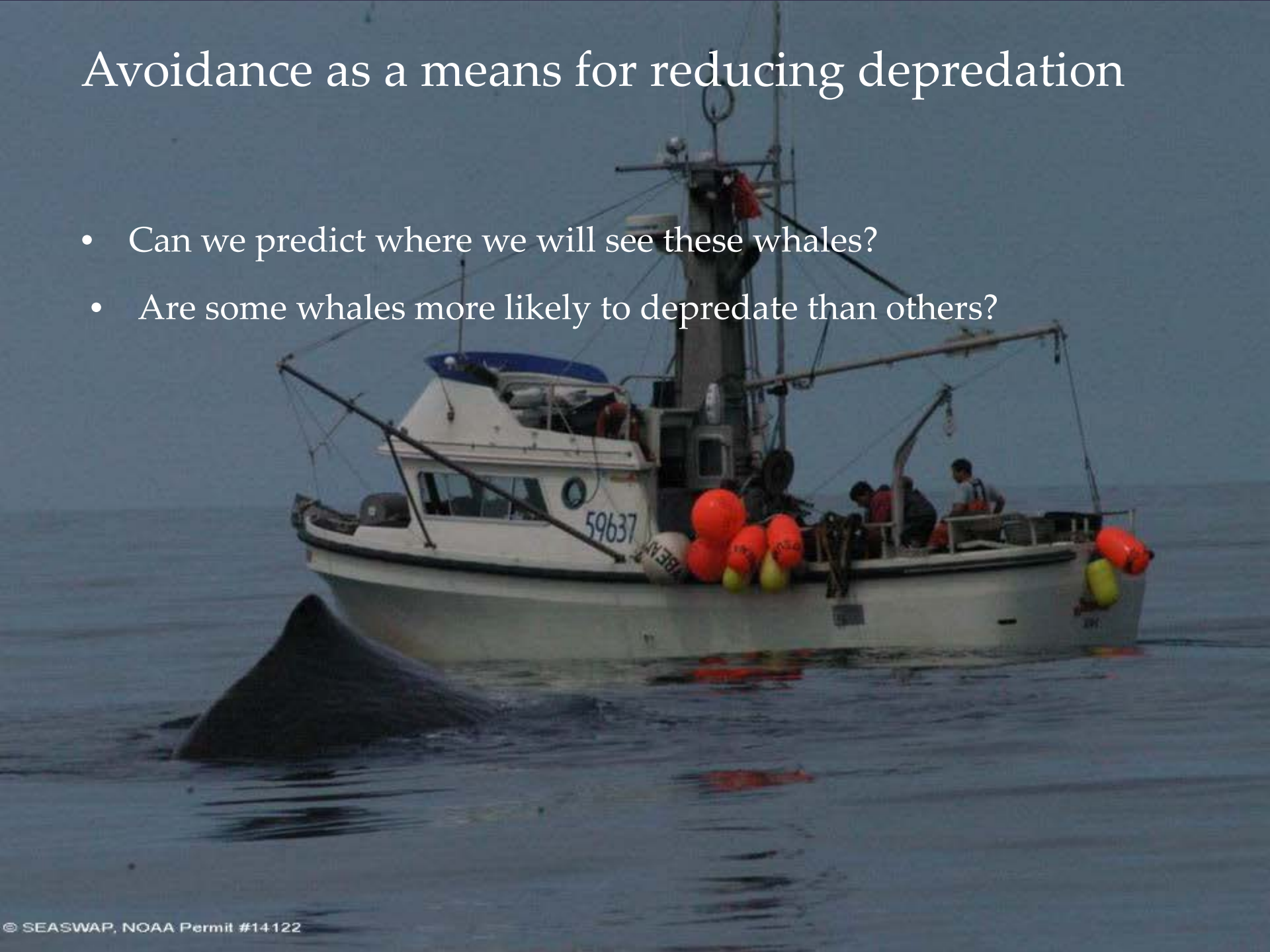
Beads

- Acoustic return of a black cod
- Every hook looks like a fish
- More trouble than its worth to feed off line?

Take home message: statistically not significant, possibly attract fish though?

Avoidance as a means for reducing depredation

- Can we predict where we will see these whales?
- Are some whales more likely to depredate than others?



Testing countermeasures

From the potential, to the wacky…

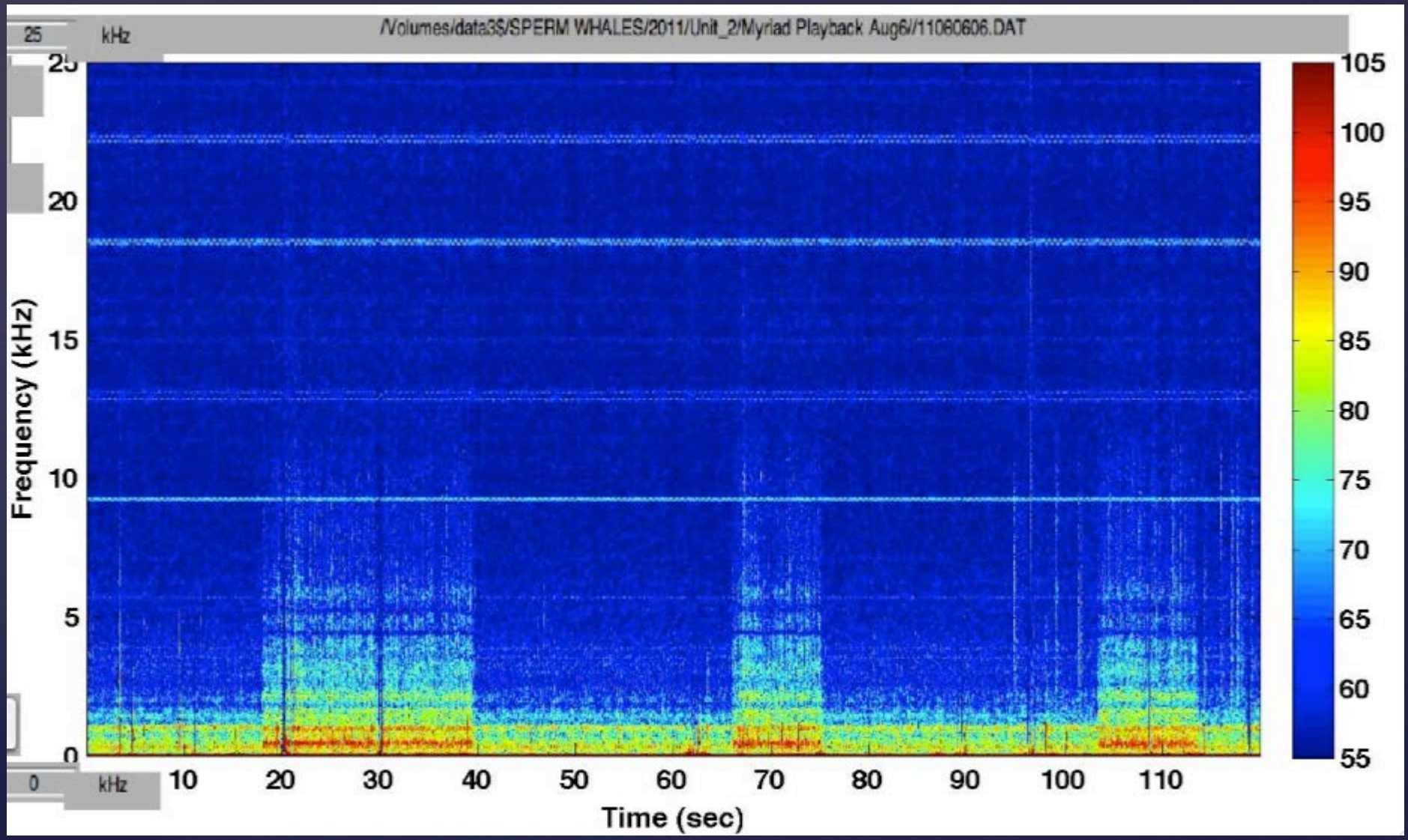
- Metal on the line: flashers, spoons
- Electrical charge through line
- Snaps vs. fixed?
- Playback: transient killer whales, white noise, FM Sweeps
- Heavy metal?
- Beads
- Avoidance?
- **Decoy**
- Future: Pod? Bubbler? Jammer?

Acoustic Decoys: can we be as clever as a sperm whale?

- Playbacks designed to deter whales from longline haul Not effective (2009)

- Decoy designed to attract whales away from the true longline haul

Decoy: engine sounds, the acoustic cue!



Thode *et al*. 2007, JASA

Decoy: experimental design

- Playback device fit with clips of engine cycling from a SEASWAP member vessel.

- VHF communication allows captains to remotely activate playback from up to 10nm away

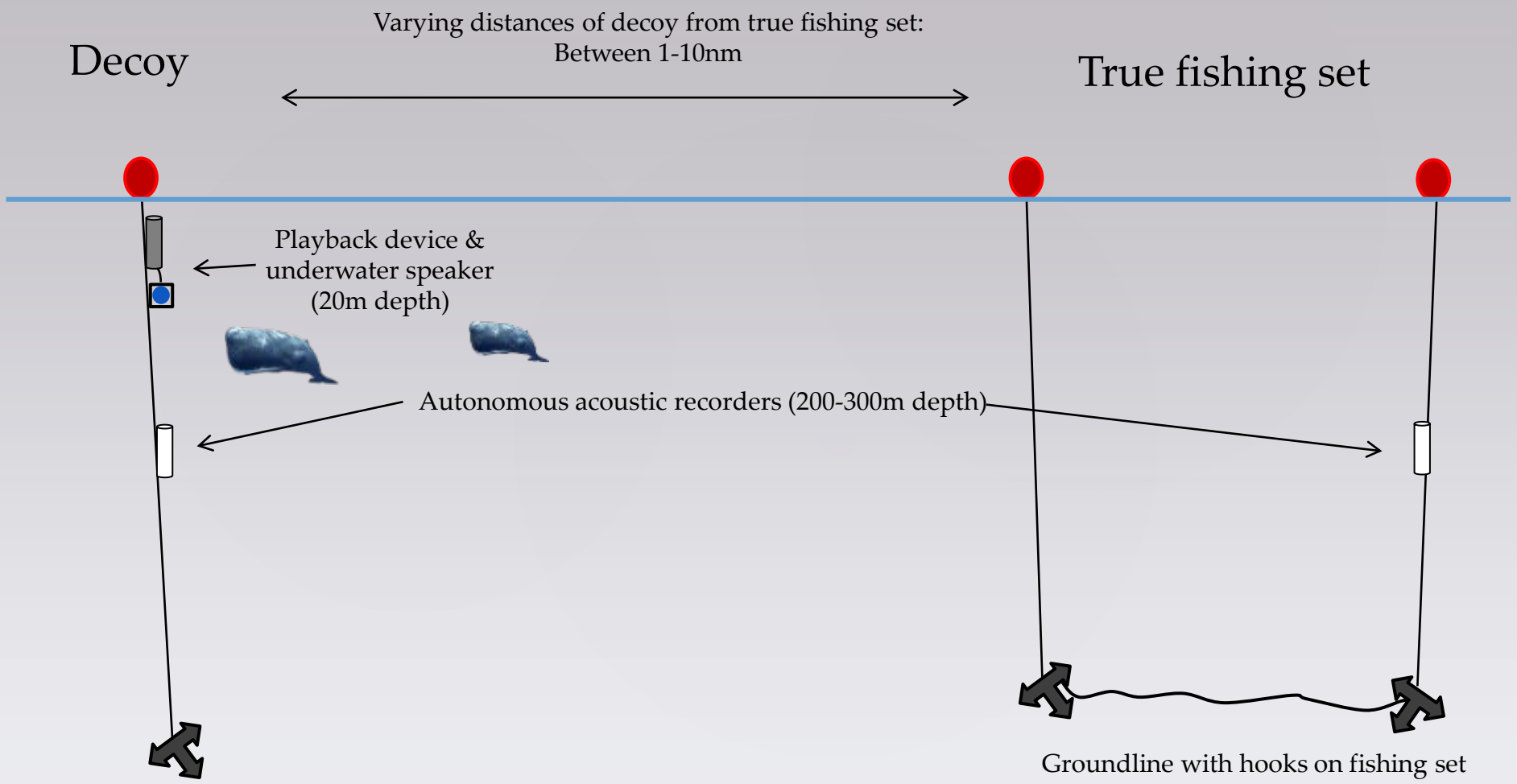
Speaker capabilities:

- Frequency range = 250Hz-20kHz
- SPL = 194dB/uPa/m @ 10.6kHz
- Depth=5-20ft.

Decoy speakers (Lubell LL9162T)

Playback device, custom design SEASWAP Acoustic Lab, Scripps Institution of Oceanography

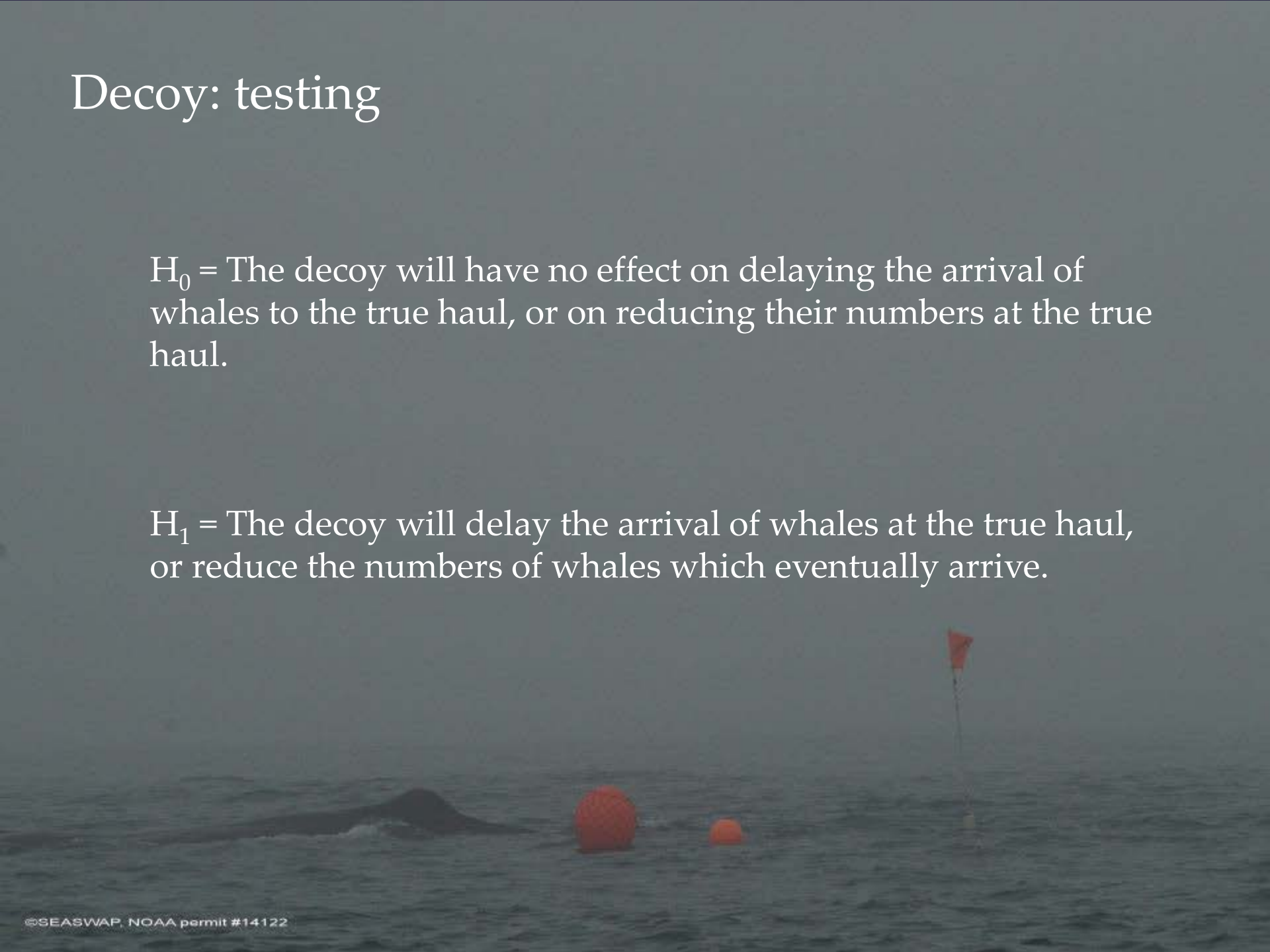
Decoy Deployment:



Decoy: testing

H_0 = The decoy will have no effect on delaying the arrival of whales to the true haul, or on reducing their numbers at the true haul.

H_1 = The decoy will delay the arrival of whales at the true haul, or reduce the numbers of whales which eventually arrive.



Response Variables:

- Proportion of time haul is whale-free

$$p = \frac{t_0}{T}$$

t_0 = time (min) where set is free from whales

T = length of time for set to be hauled

$$\log\left(\frac{p}{1-p}\right) = a_0 + a_1 * d$$

- Number of whales that show up at haul

$$W = a_0 + a_1 * d$$

W = number of whales that show up at haul

d = distance between haul and decoy

Summer 2013: trials and initial deployments

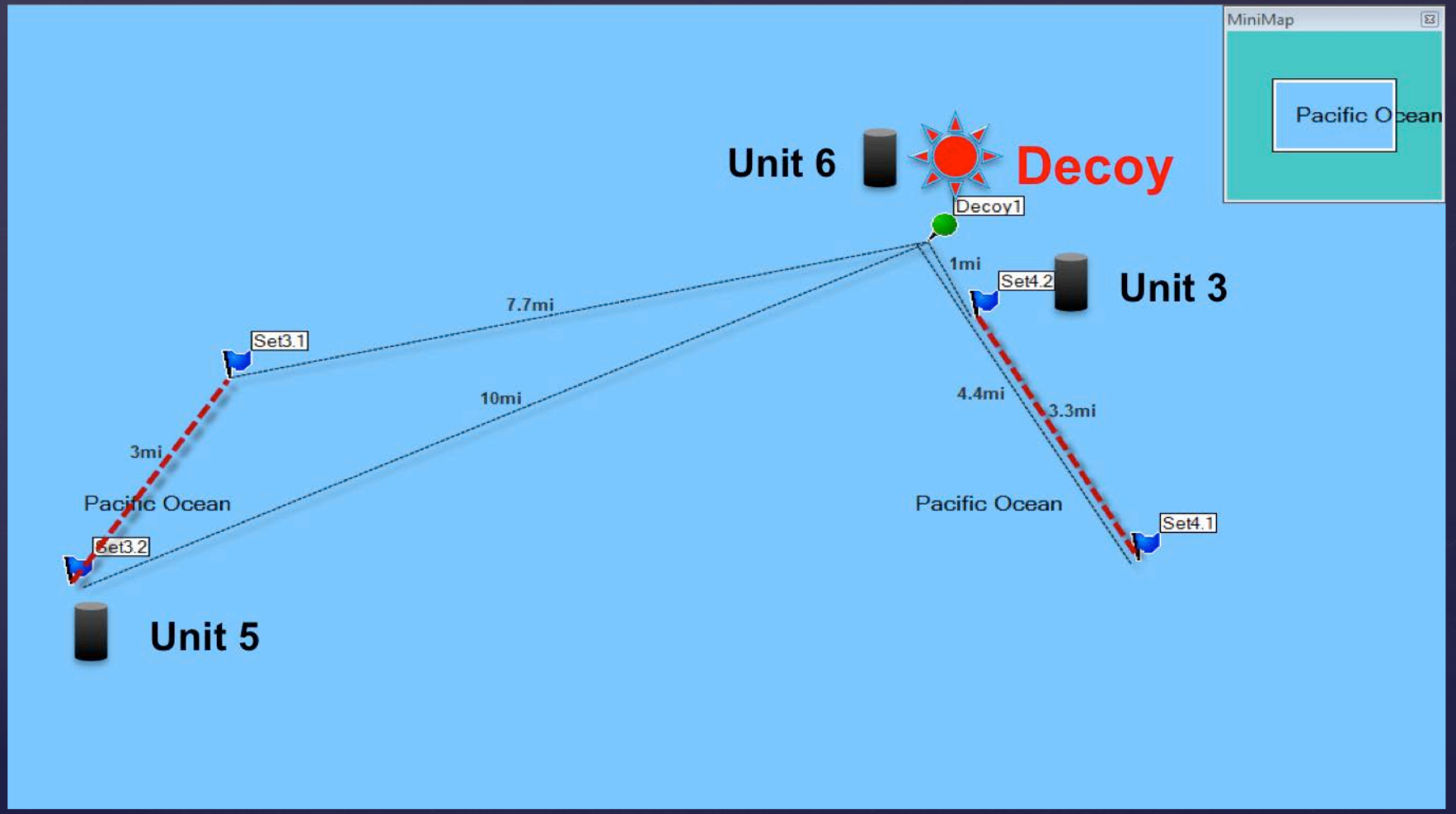
Single vessel: F/V Magia, skipper Stephen Rhoades
Single area: Western Gulf

28 initial deployments

- Technical issues (clock reset when batteries charged)
- Some gear hauled backwards due to current (recorder hauled first, no acoustic recordings present during haul to record whales)
- Some gear broke off (finished haul from recorder end, no acoustics)
- No whales on some sets (9/28)
- Distance between decoy and vessel too far to activate decoy

10 usable sets

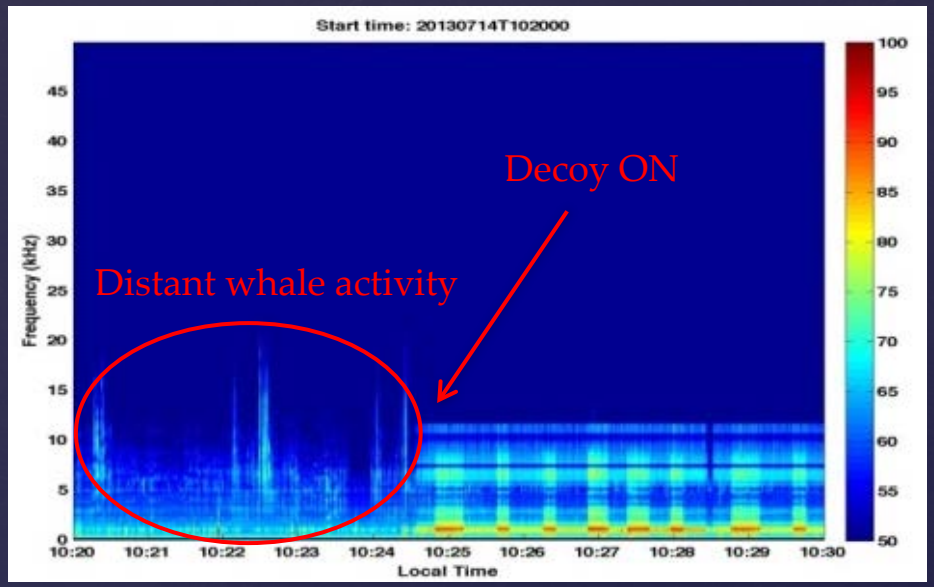
Decoy: example deployment July 14, 2013



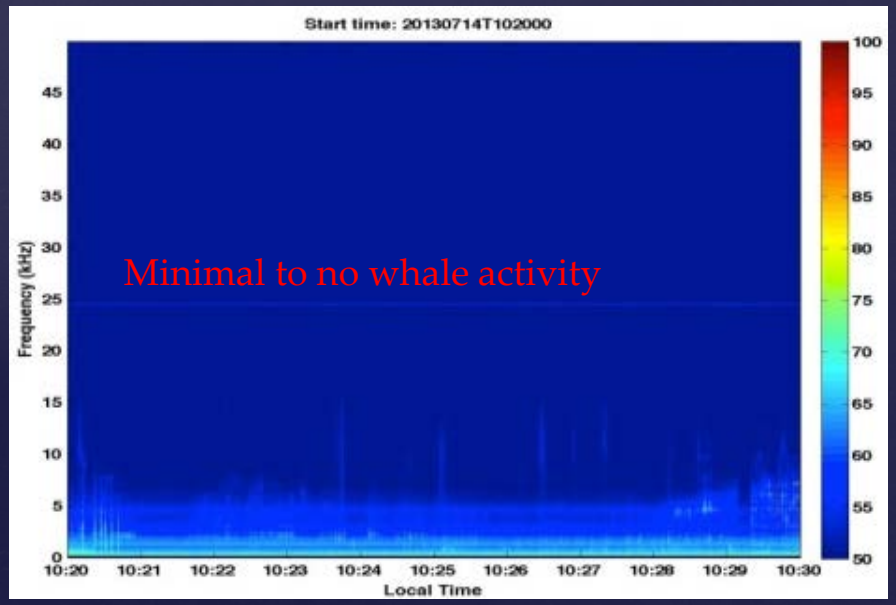
Decoy: tracking whales with acoustics

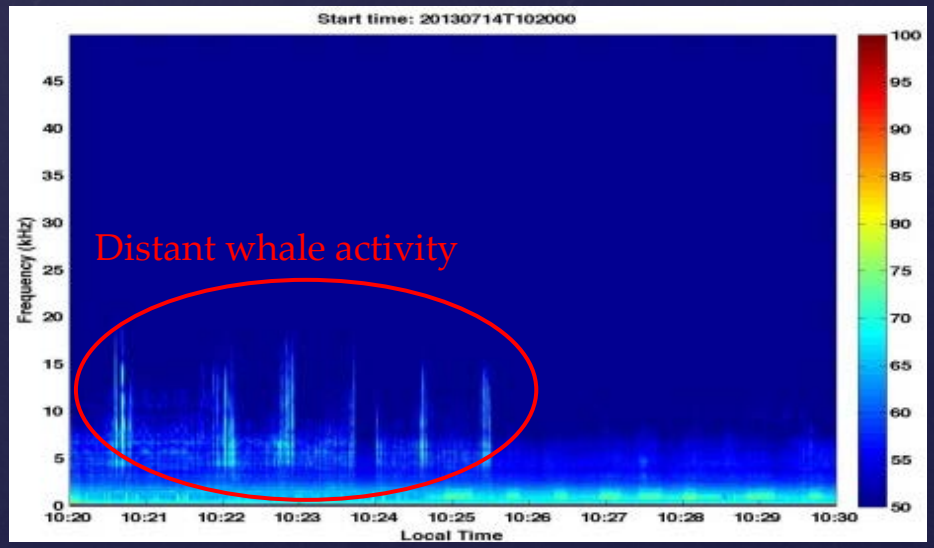
Long-term averaged spectrograms allow us to look at whale activity over long periods of time

10:24am – Decoy activates

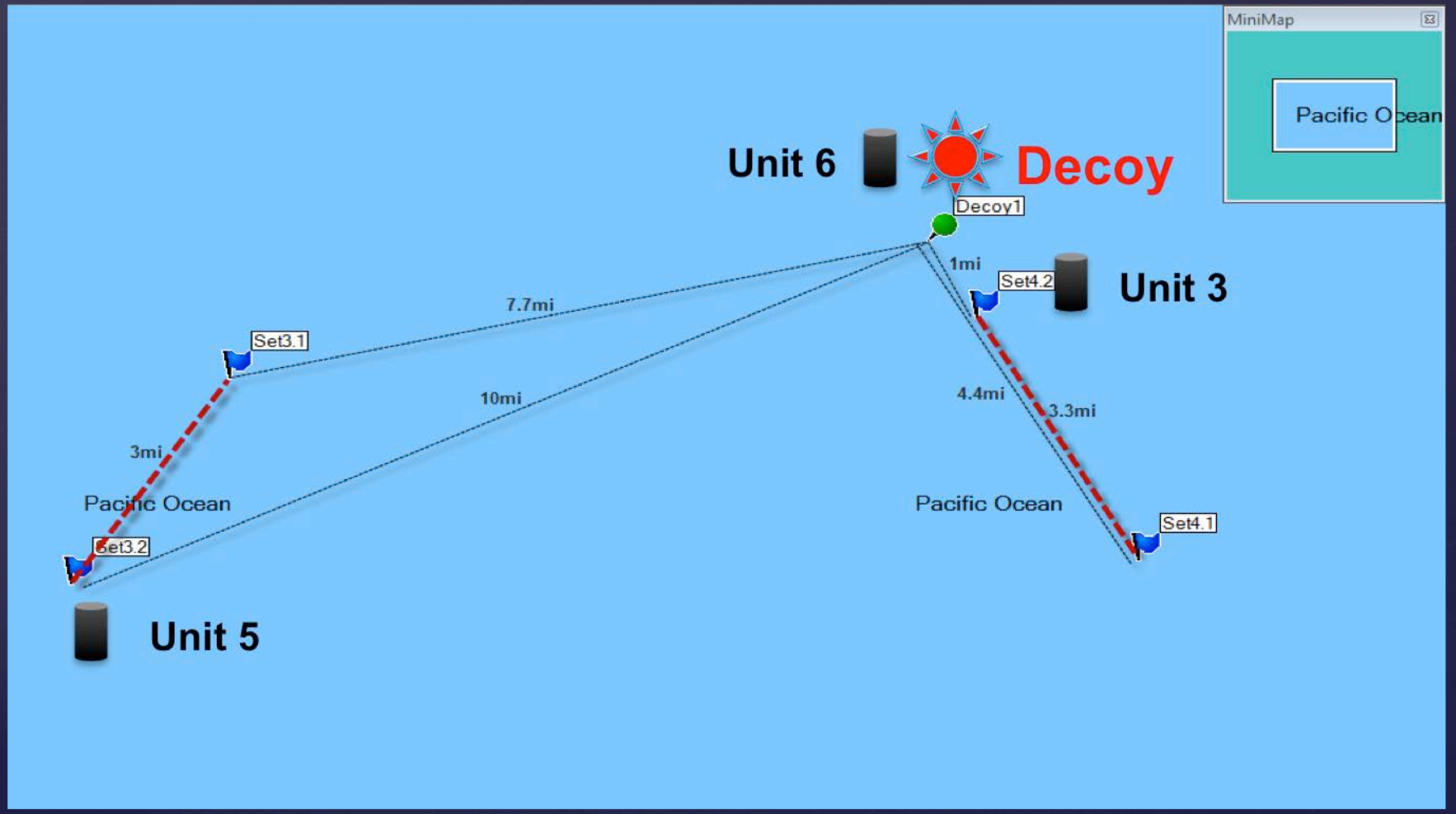


Minimal whale activity at the set 7nm away



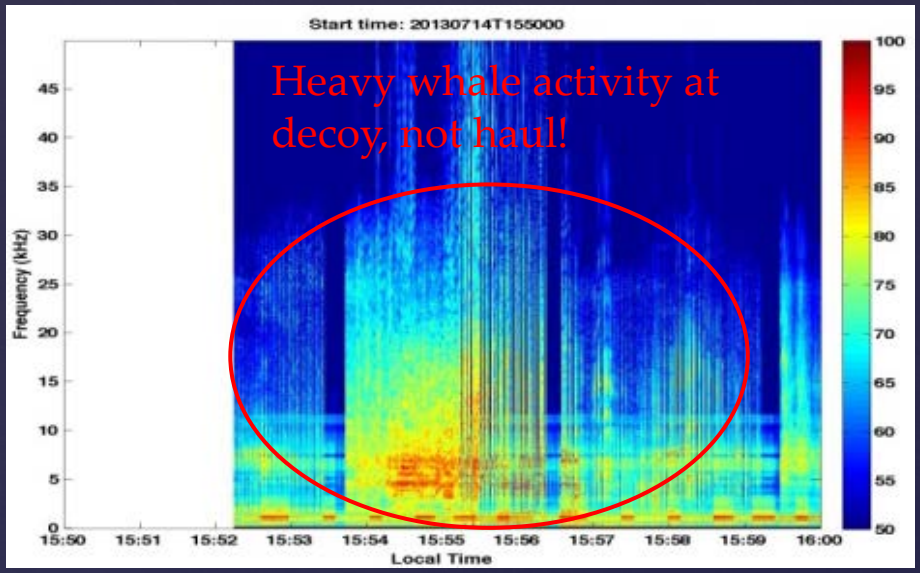


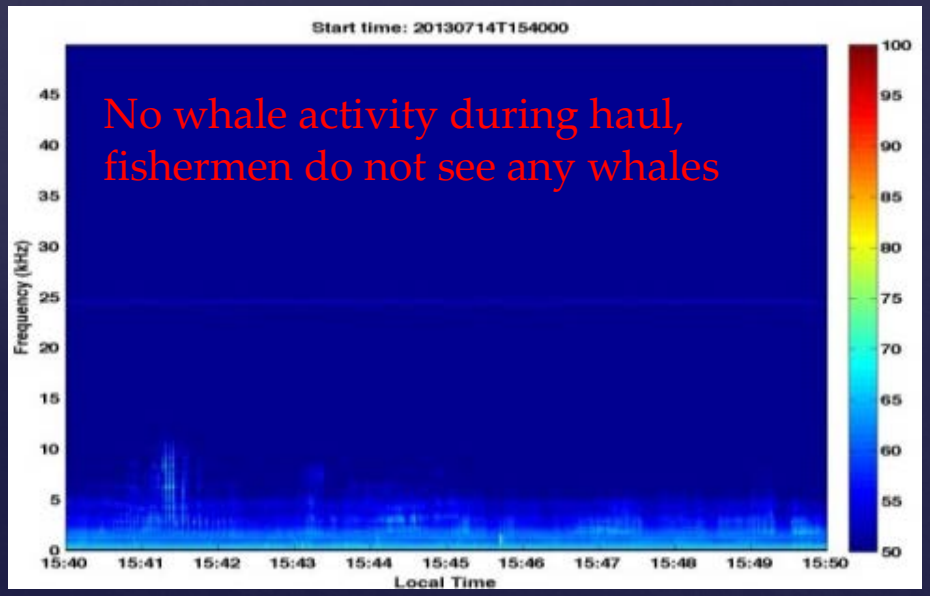
Decoy: example deployment July 14, 2013

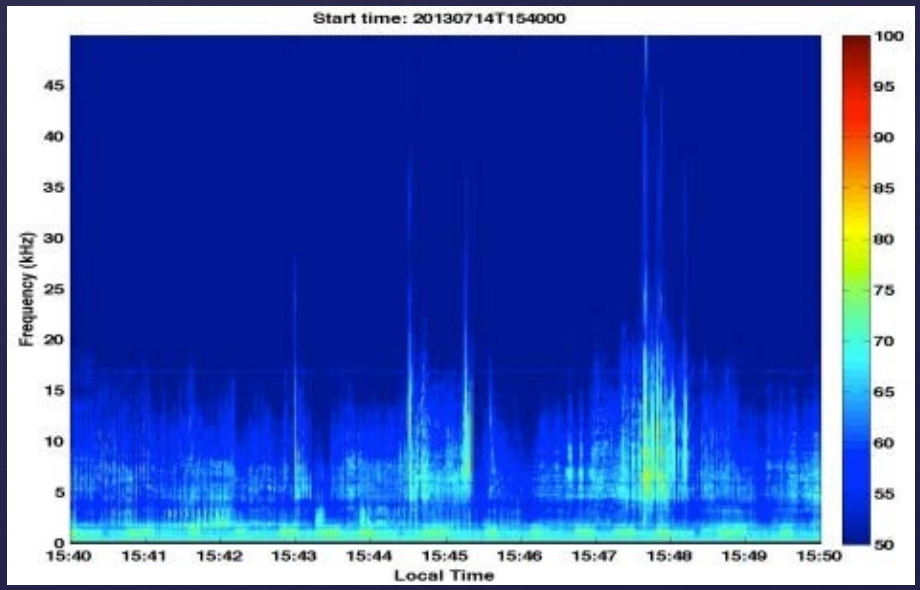


Decoy: example deployment July 14, 2013

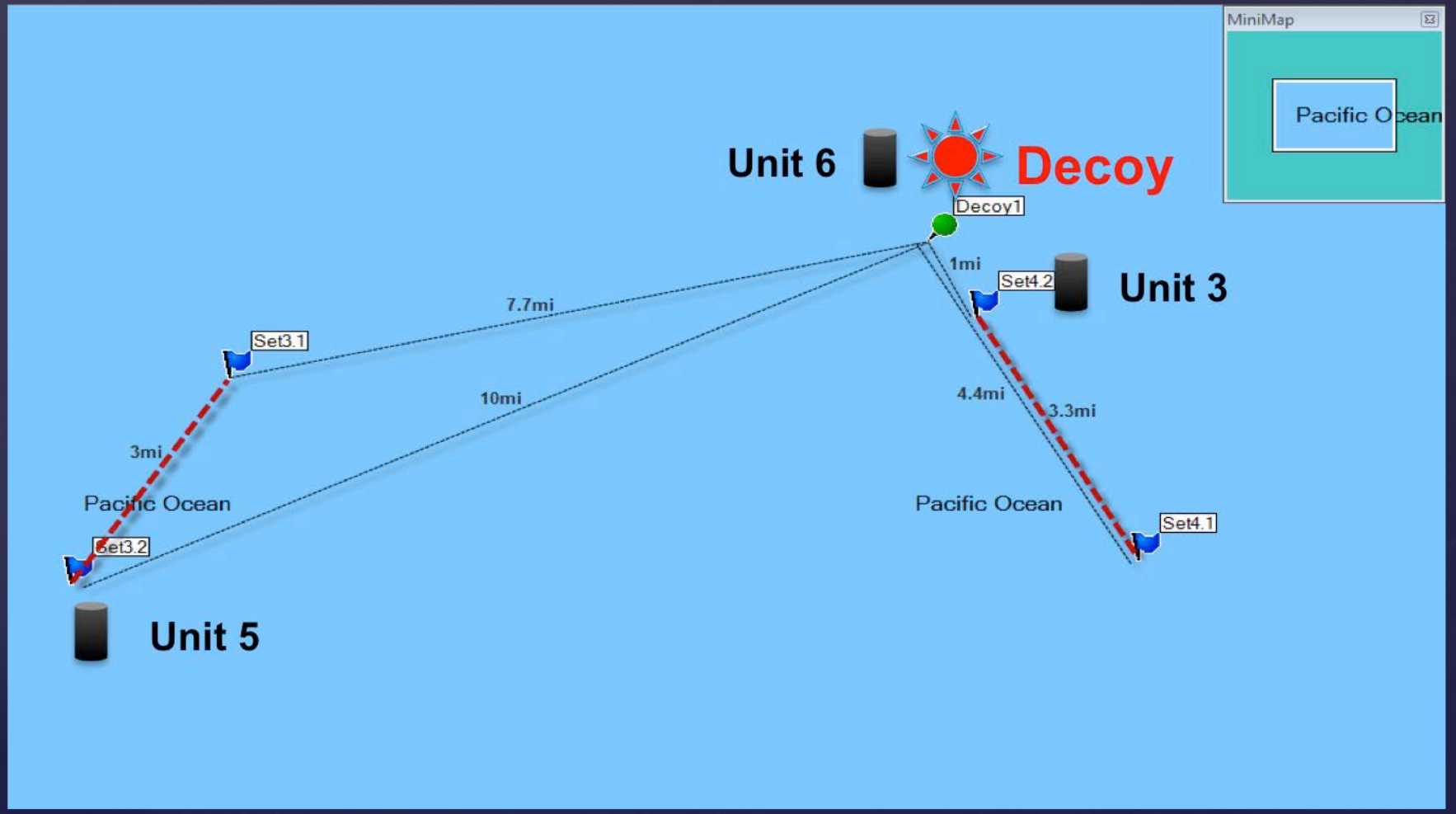
15:40 – Haul of first set begins







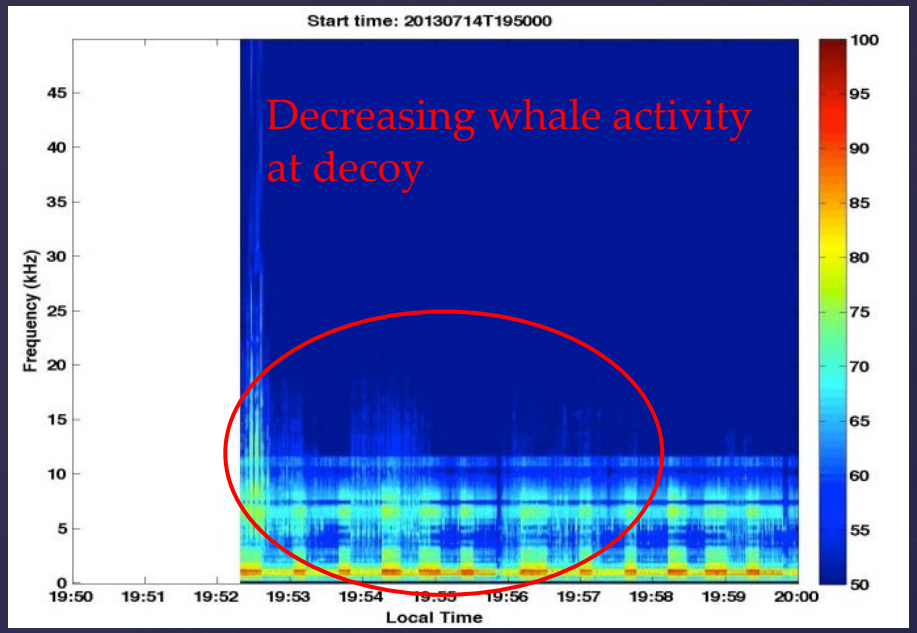
Decoy: example deployment July 14, 2013



Decoy: example deployment July 14, 2013

19:55– Haul of second set begins

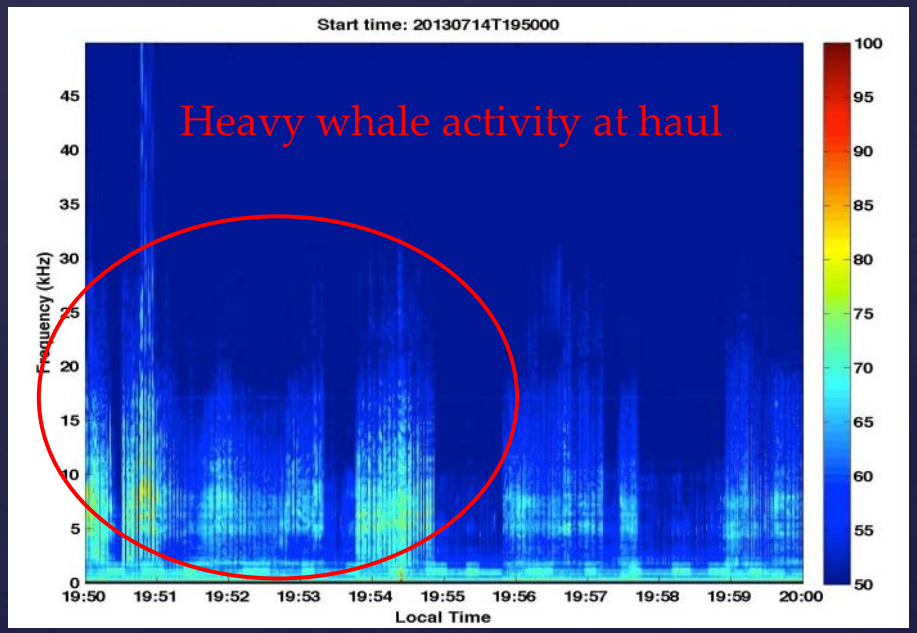
Fishermen report whales immediately on their gear



Whales likely waited there during the first haul

When decoy turned on, found the vertical lines for the set 1nm away?

Too much trouble to travel 7nm to first set, so waited by 2nd set?



Decoy: Preliminary Results

- Whales showed up at the true haul 7/10 sets
- Proportion of time the haul was whale-free – no significance
- Number of whales arriving at the gear
  - Regression showed significance at the 5% level with respect to distance ($p=0.04$)
  - The farther the decoy was, the fewer whales showed up at the true haul
- Acoustic analysis in progress: did whales approach the decoy? If so, did they stay there?

We are halfway through testing, with 15 more sets to accomplish this field season

Decoy being deployed as we meet

Future work…

Bubbler, Jammer, Protective Pods?

Bubbler

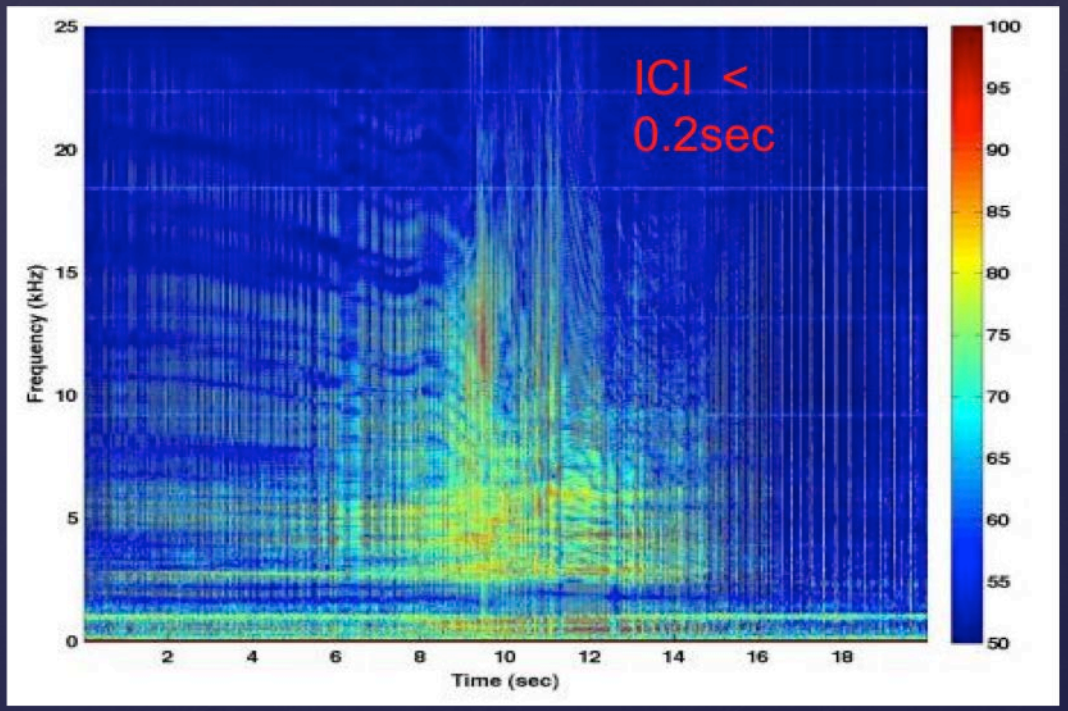
Still in the R&D phase
How do we produce enough bubbles?

< 500 m

Bubbler

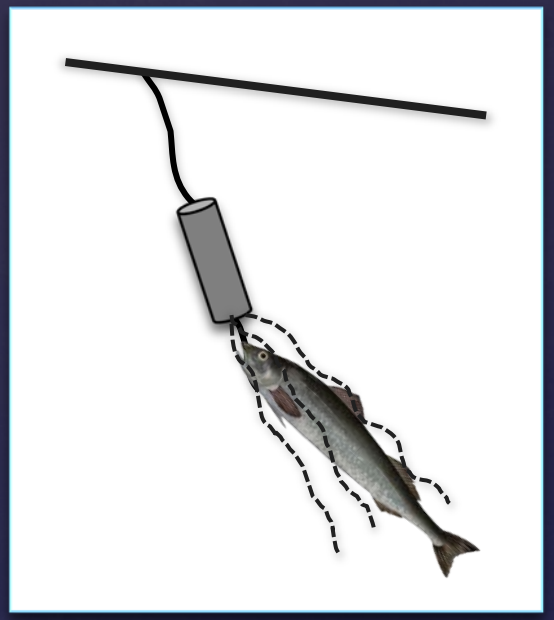
Jammer

- Based on bat research: playback acoustic jamming sonar to interrupt whale sonar



Deterrence Pods:
Who wants to take a bite out of a metal chain?

- Attaches to gagnion
- When fish jerks on line, pod triggers
- Chain or metal bead lines are released
- Trail along fish as they are hauled
- Compare every other hook for efficacy



- Modeled after Australian researchers (Hamer and x 2013) deterrence experiment; pelagic longlines, depredation issues there as well

- Pursuing funding for testing new prototype

Thank You!

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Sitka Sound Science Center

Alaska SeaLife Center Seward, Alaska

C-Saint-Paul

Alaska Longline Fishermen's Association

Decoy: What about habituation?

- There are theoretical reasons why sending a decoy signal would be more robust to habituation than standard playback signals:
- The playback signal for a decoy is designed to be detected at a distance, and is thus faint and noisy->signal fidelity not as much as an issue.
- There are many more samples of different vessel hauling noise available->replication less of an issue.
- If animals learn to ignore distant hauling cues, so much the better