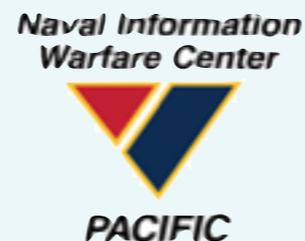


Quantifying the response of Blainville's beaked whales to Naval sonar exercises in Hawaii

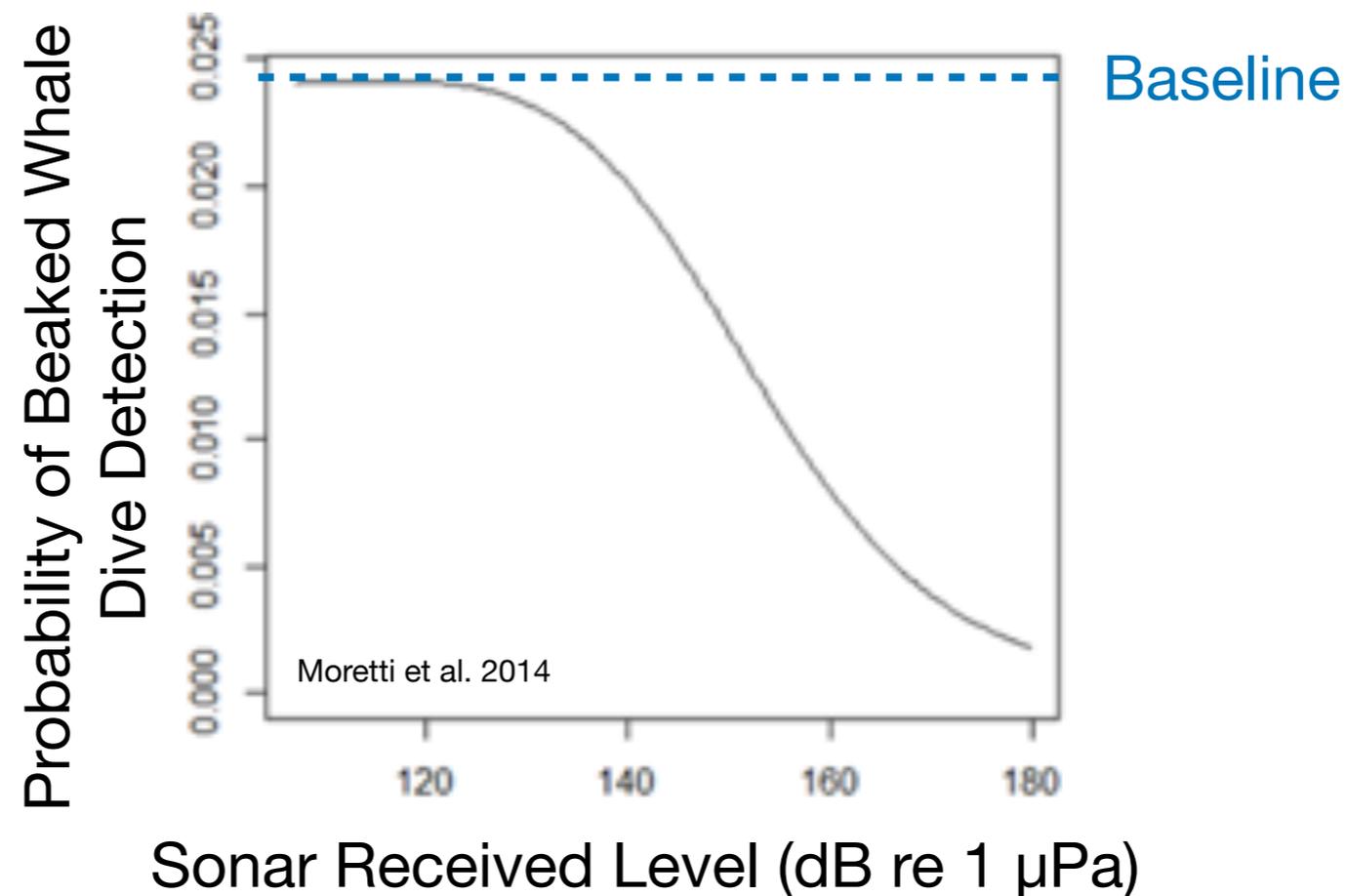
Eiren K. Jacobson, E. Elizabeth Henderson, Cornelia S. Oedekoven,
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Motivation

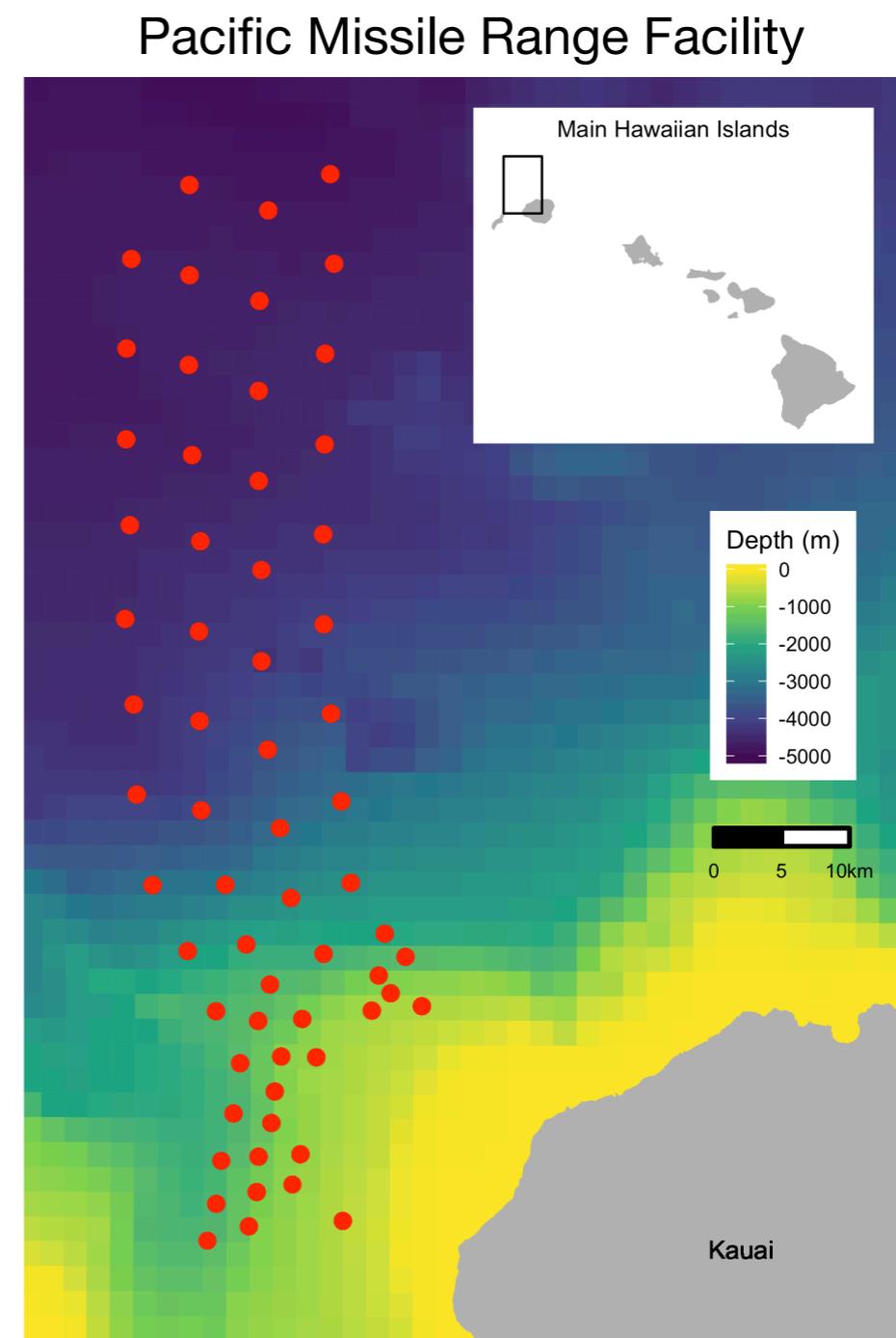
Beaked whales are known to respond to Naval mid-frequency active sonar



Goal was to quantify the response of Blainville's beaked whales in to Naval activity and sonar in Hawaii

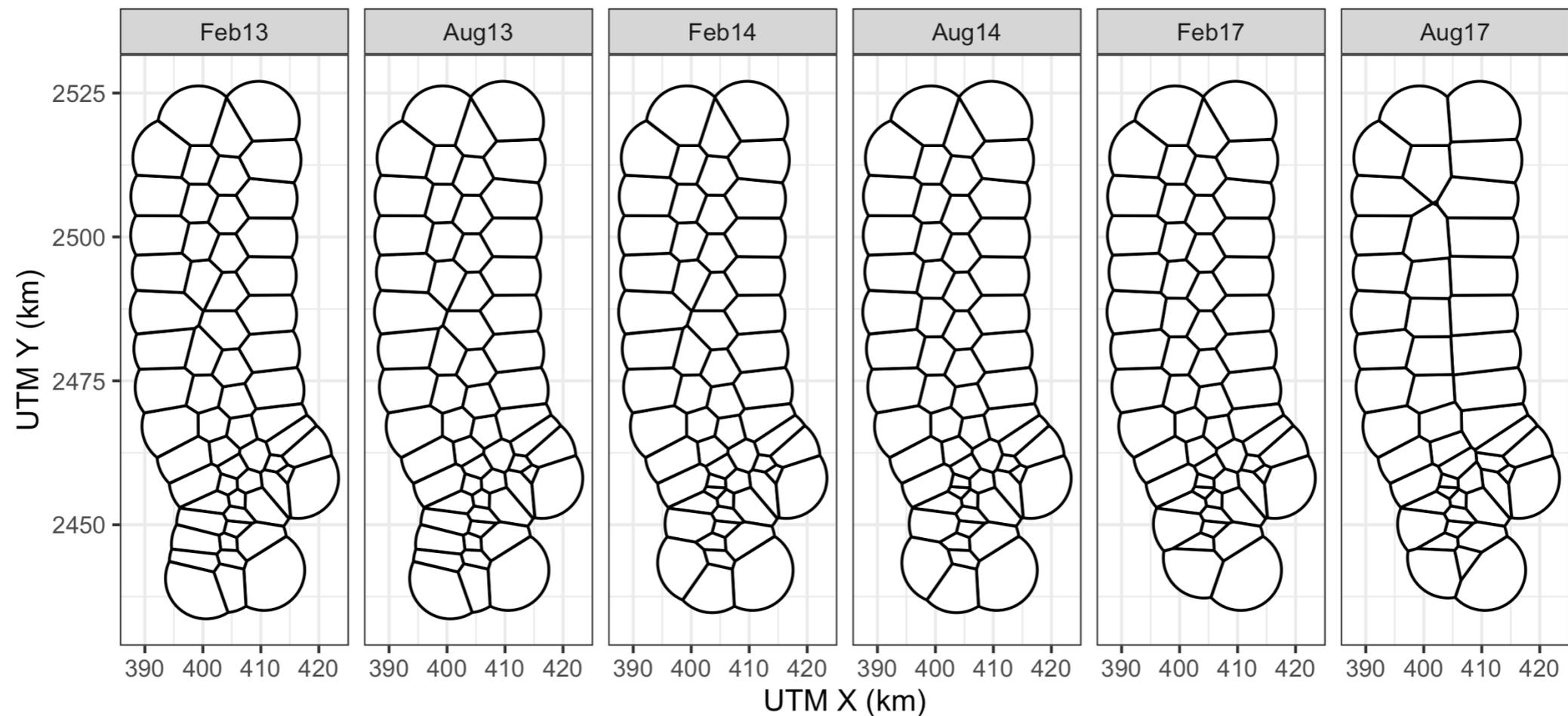
Data

- 62 cabled hydrophones NW of Kauai
- Data from before and during six training events over three years
- For each 30-min period:
 - Naval activity presence/absence
- For each hydrophone:
 - Sonar received level
 - Beaked whale presence*
- $n = 190,928$

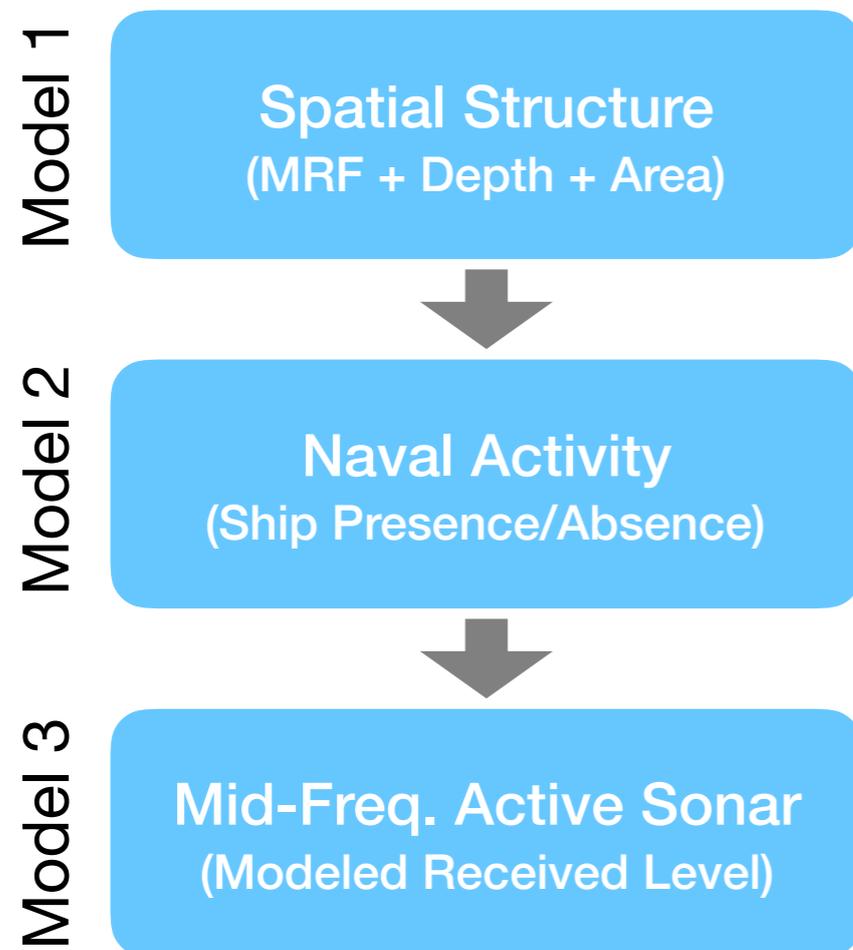


Approach

To account for non-uniform hydrophone spacing, we used a tessellation to determine effective area monitored

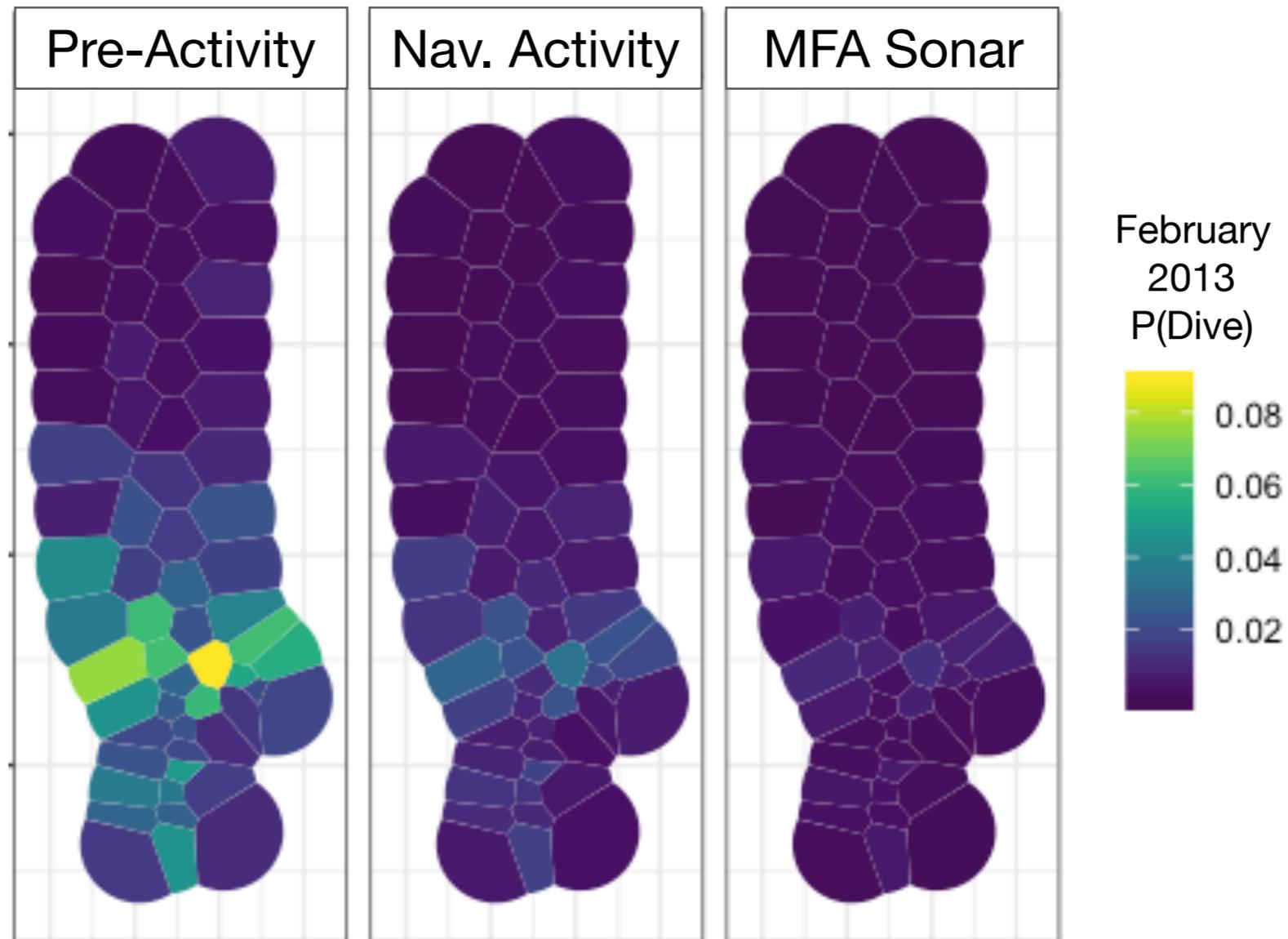


Approach



- Needed to account for spatial correlations between animal density and sonar intensity
- Used a multi-stage GAM modeling approach to isolate the effect of sonar
- The output of each model was used as an offset in the next
- Bootstrapped to propagate uncertainty through models

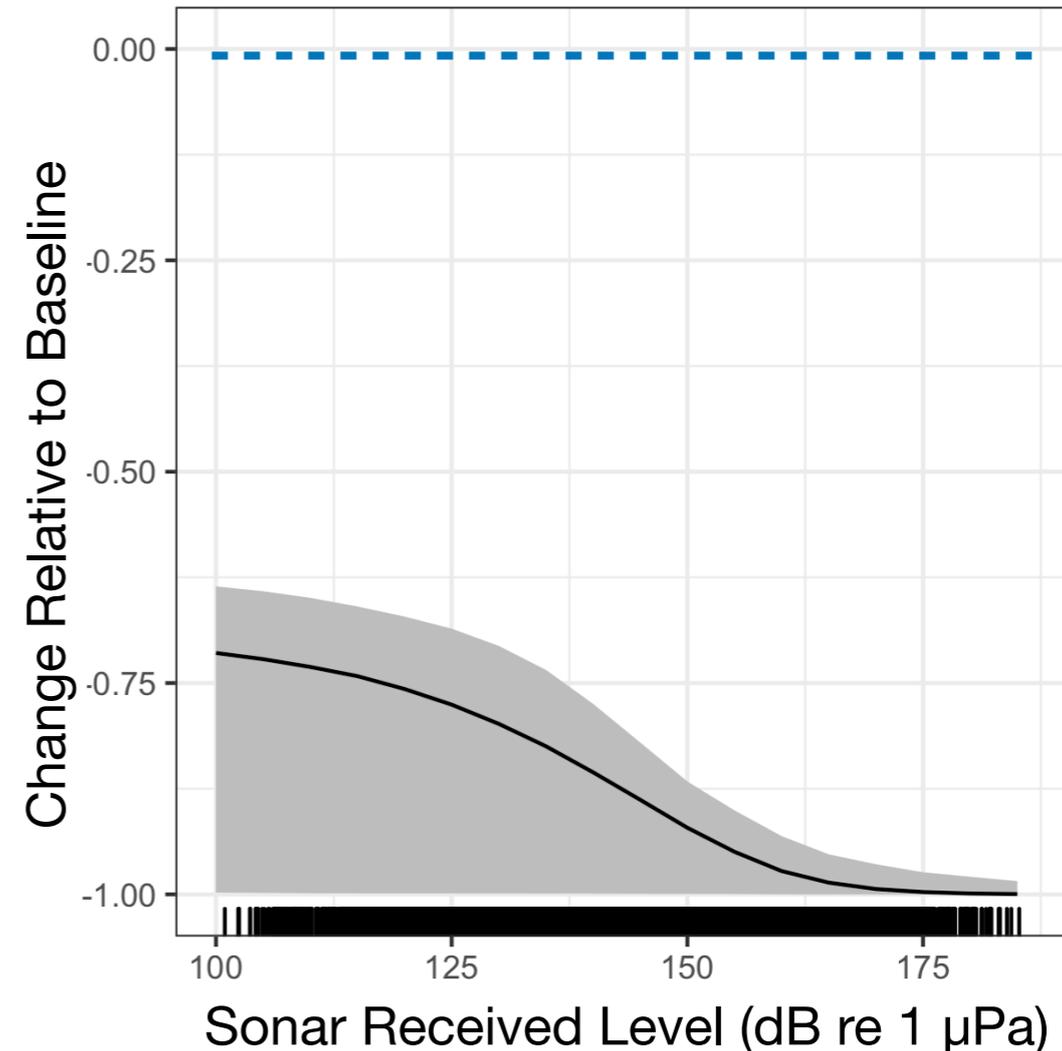
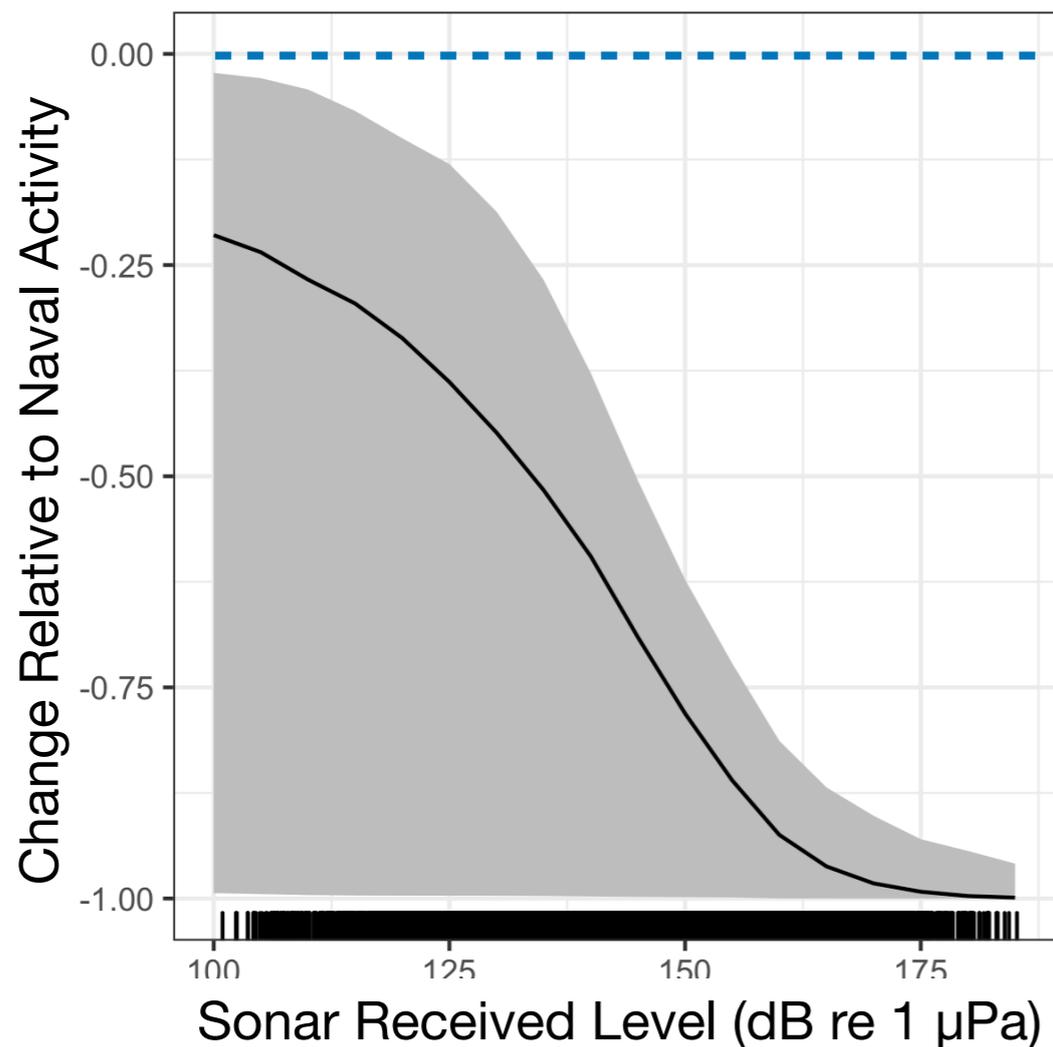
Results



Naval activity results in 64% (95% CI 59-68%) reduction in probability of beaked whale detection relative to baseline

Results

Sonar received level of **150 dB re 1 μ Pa** results in a 78% (95% CI 62%-100%) reduction relative to when Naval activity is present, but a **92% (95% CI 87%-100%) reduction relative to pre-activity period**



Conclusions

- Animals are responding to stimuli other than active sonar
 - Need to investigate possible mechanisms for observed response to presence of Naval activity
 - Periods when Naval activity are present are not representative control periods
- Probability of dive presence decreased by $>50\%$ relative to baseline with any level of sonar exposure

