Estimating population abundance for beaked whales from drifting acoustic recorders and other data sources

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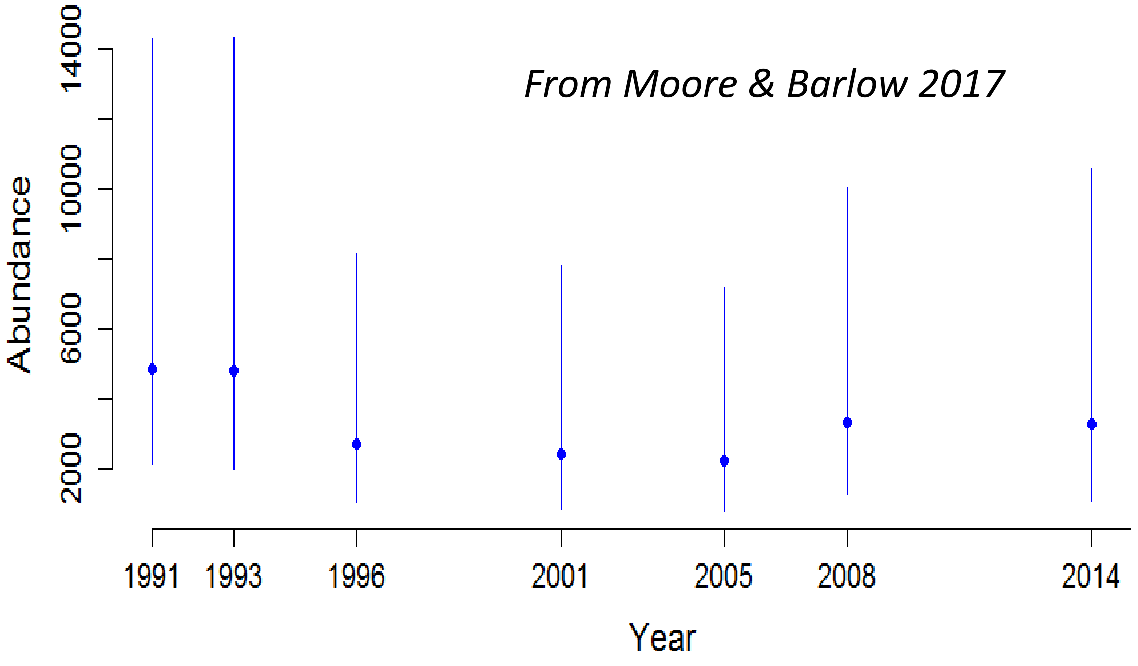
Perennial challenge of estimating beaked whale abundance from visual line-transect data

- Cryptic behavior = Low sample sizes, error-prone species identification, and unknown but low g(0)
- Therefore, probable biases and high CVs

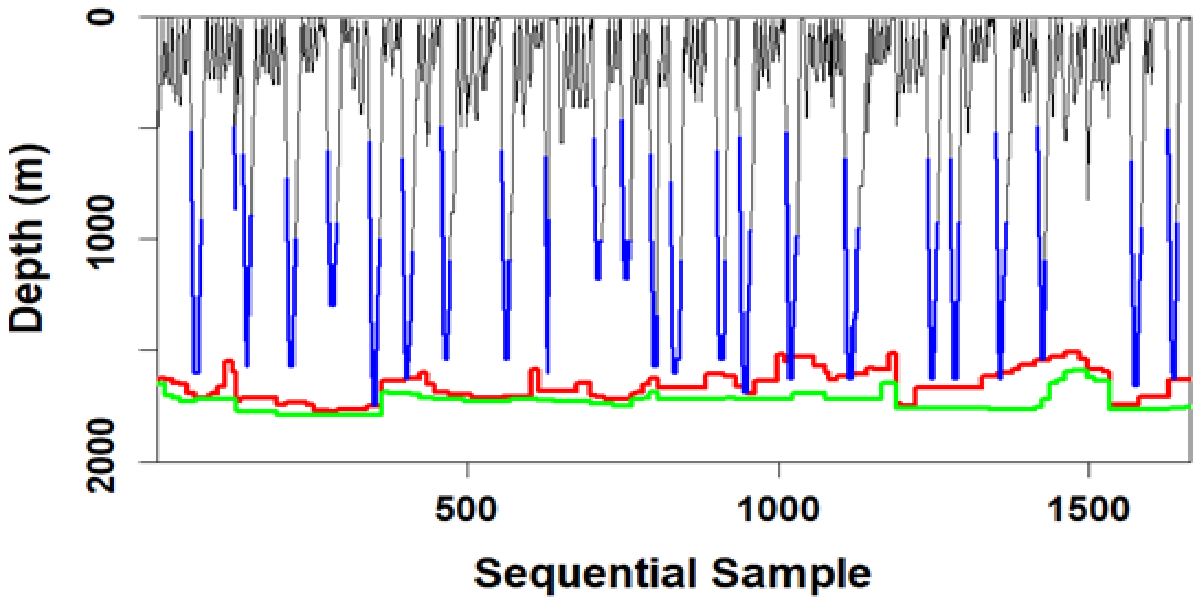


n = 3 to 18 per year (63 total)

Visual CV = 0.59-0.67

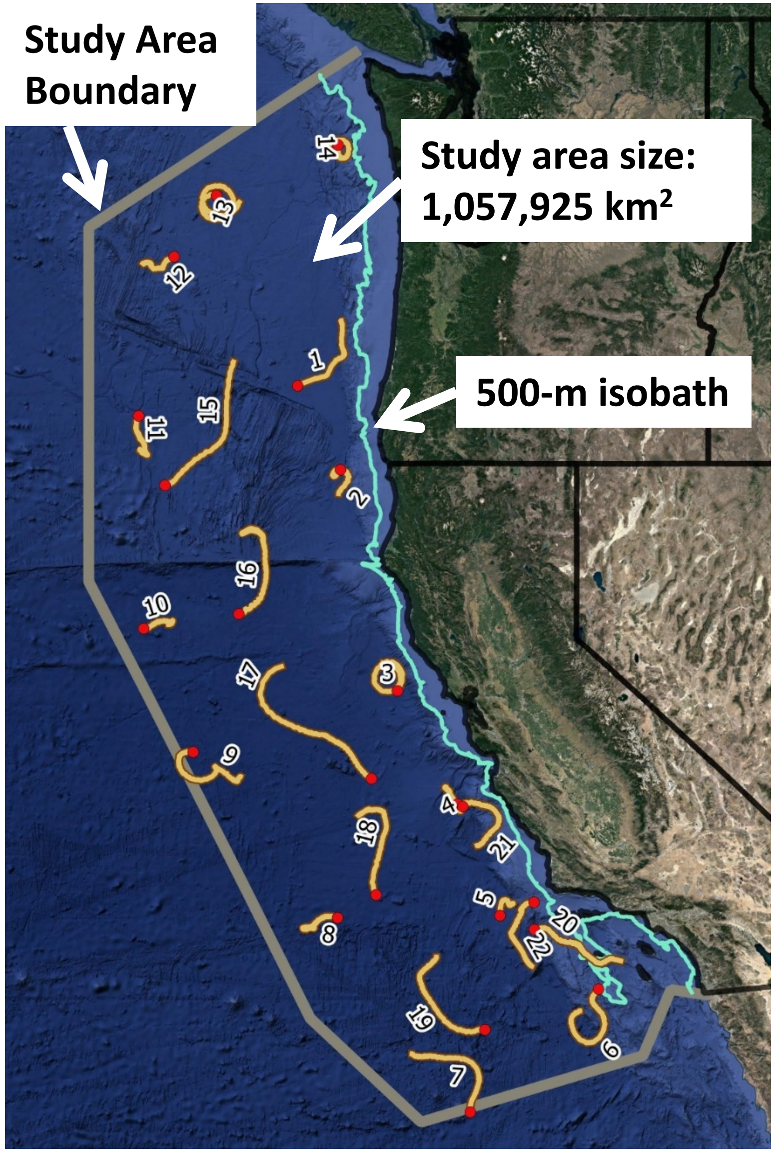
Can we do better with passive acoustics?

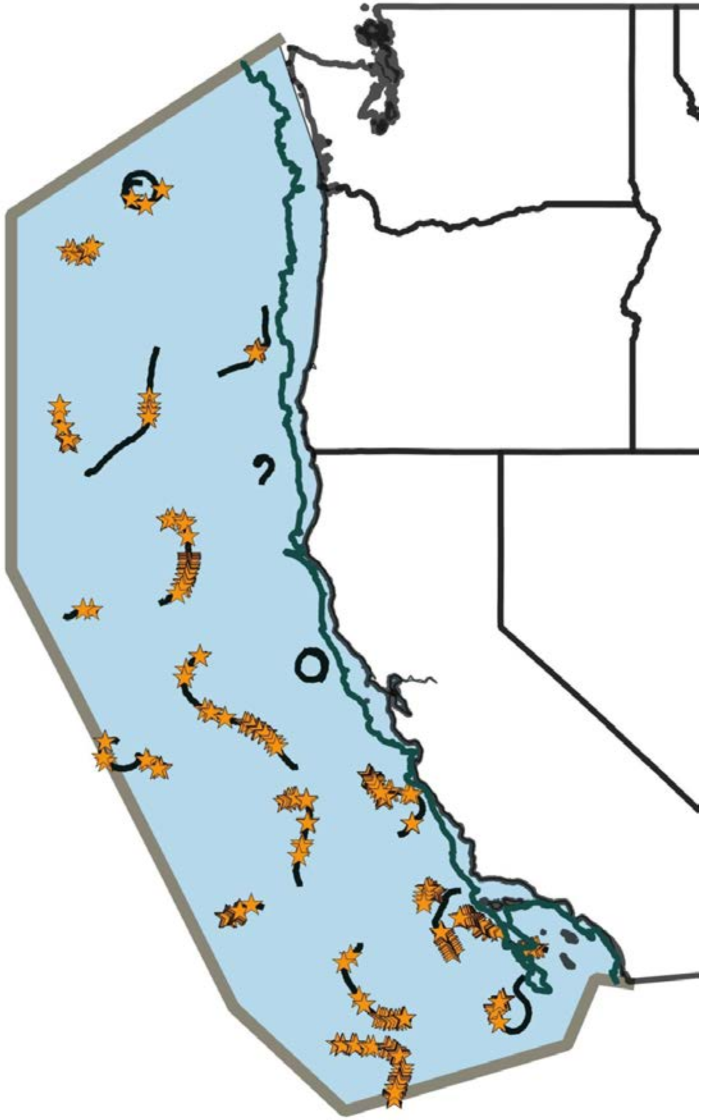
- Beaked whales are at depth often and exhibit stereotypic acoustic behavior → Better sample sizes?



Schorr and Falcone, unpubl. data

PASCAL 2016 (Passive Acoustic Survey for Cetacean Abundance Levels)





Ziphius detected in 870 out of 111K (0.8%) 2-min intervals

Point distance sampling framework (Bayesian)

$$N = \frac{\sum_{j=1}^{J} D_j}{J} * A$$

Population size (N) = average density (mean D across the J DASBRs) * size of study area (A)

For each DASBR j (random effect)…

$$n_j \sim Poisson(E[n_j])$$

Number of 2-min intervals with Ziphius detections (n_j) is a Poisson random variable, with an expectation $E[n_j]$…

$$E[n_j] = \frac{D_j}{s} * k_j * 2\pi r^2 * g(0)$$

Expected number of detections = Group density (animal density / group size s) * number of 2-min intervals sampled (k) * effective detection area (where r is effective detection radius) * detection probability at distance = 0

Data sources

Sampling effort from PASCAL data

Effective detection range from PASCAL data and dive depth data by Schorr and Falcone (Barlow et al., in prep)

Parameter to estimate

$$E[n_j] = \frac{D_j}{s} * k_j * 2\pi r^2 * g(0)$$

Group size from visual line-transect data (SWFSC, Moore and Barlow)

Calculated from:

- Time at surface (Barlow et al. 2013)
- Mean foraging dive-time (Schorr et al. 2014)
- PASCAL encounter-history data

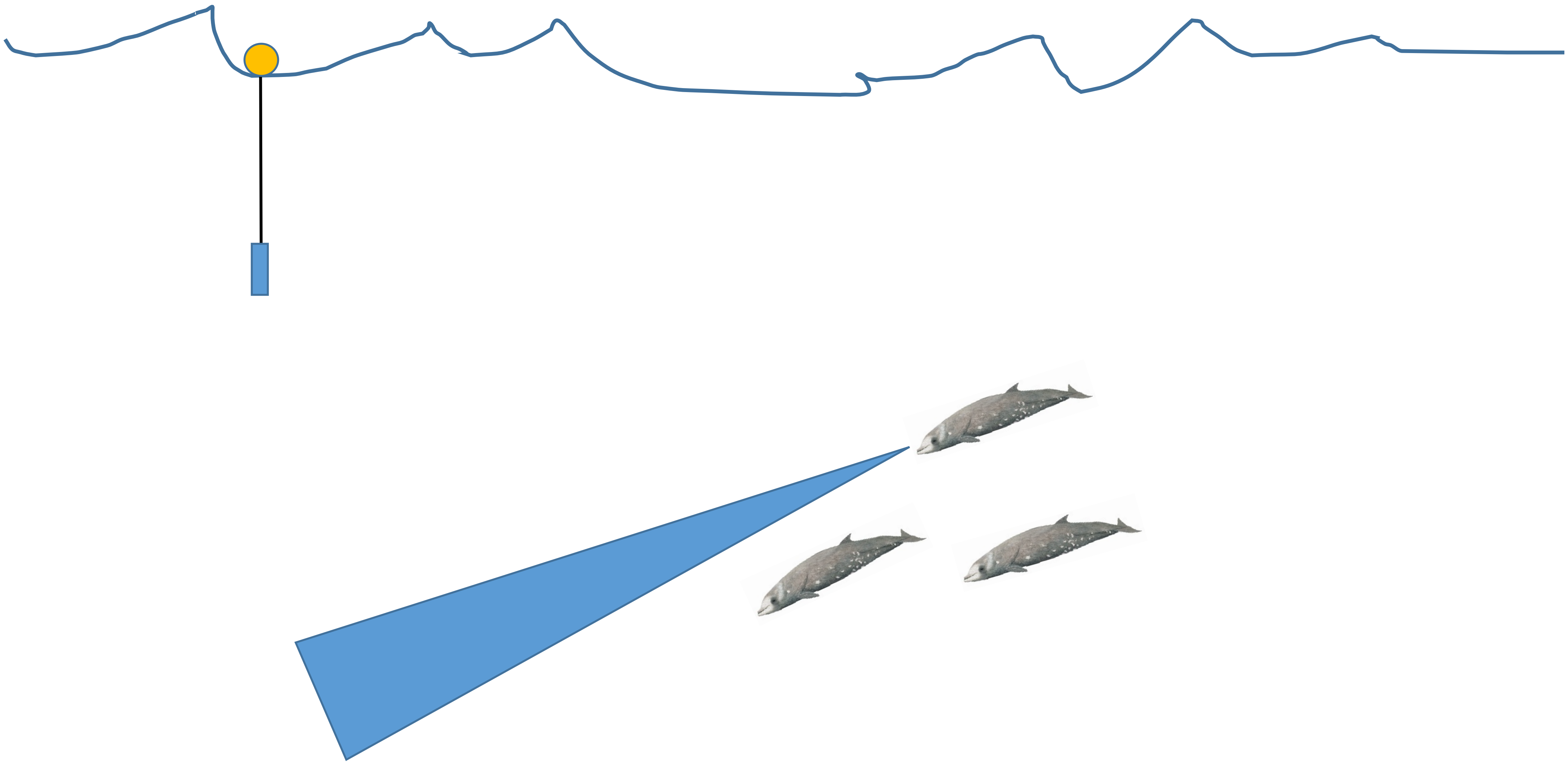
A closer look at g(0)

- g(0) represents the probability that a beaked whale group within the detection area is actually ‘available’ to detection during a 2-min interval
- g(0) = p1 * p2

  p1 = probability than an animal will be clicking (i.e., on a deep forage dive)

  p2 = probability that an animal is behaviorally available to detection given that it’s clicking

A closer look at g(0)



A closer look at g(0)

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40 minutes

Animals click for 40+ minutes but time between first and last detection is typically much shorter than this…

… irrespective of detection distance (out to about 2km)

A closer look at g(0)

p1 = probability than an animal will be clicking = 0.295 (CV = 0.09)

- This is the proportion of time throughout the day that animals are clicking on foraging dives (Barlow et al. 2013)

p2 = probability that an animal is behaviorally available to detection given that it's clicking

- The proportion of time animals on foraging dives are facing the hydrophone
- p2 = minutes available to detection / minutes clicking during a foraging dive = 0.370

15.7 min (SE = 1.4)

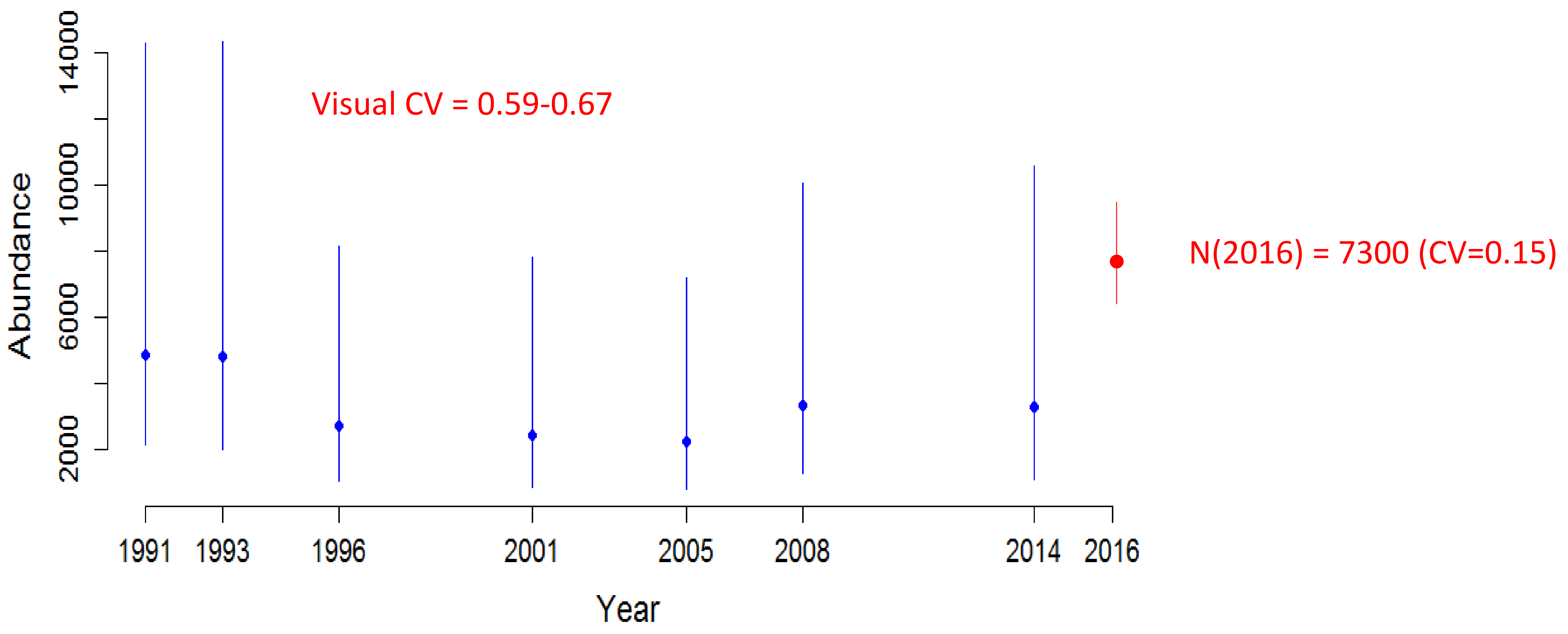
From encounter history data

41.9 min (SE = 6.9 min)

From Schorr et al. 2014

- g(0) = p1 * p2 = 0.295 * 0.370 = 0.11

Preliminary new abundance estimate



Inferences

- More Ziphius than we thought! (Current estimates of visual g0 likely too high)
- Can obtain more precise estimates of Ziphius with acoustics than visual methods

Issues (we’re not done yet)

- The behavioral availability question is more complex than I showed you…
- We are still working out some challenges on estimating the random DASBR effects
- We are currently ignoring some autocorrelation in the data
- Final estimates will likely be less precise than I am currently reporting

Thank you…

- Jen Keating and Emily Griffiths (PASCAL fieldwork and data processing)
- Greg Schorr and Erin Falcone (dive data)
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