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Assessing the effects of survey planning on abundance estimates of breeding stock 'D' humpback whales (*Megaptera novaeangliae*) from North West Cape, Western Australia

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Southern Hemisphere Breeding Stock D humpback whale population estimates from North West Cape, Western Australia

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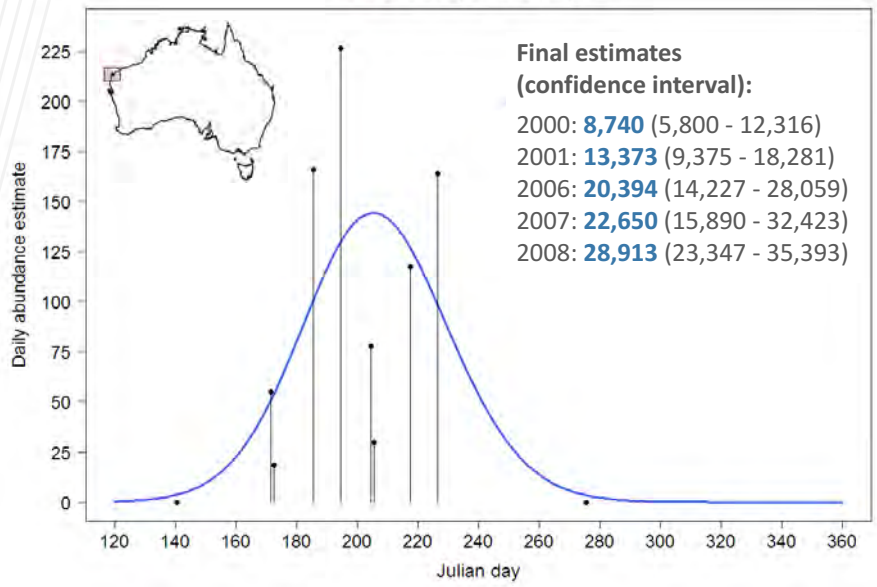
ABSTRACT

Estimates of the abundance of Breeding Stock D humpback whales (*Megaptera novaeangliae*) are key to the conservation and management of what is thought to be one of the largest populations of the species. Five years (2000, 2001, 2006, 2007 and 2008) of aerial surveys carried out over an eight-year period at North West Cape (Western Australia) using line transect methodology allowed trends in whale numbers to be investigated, and provided a base for comparison with estimates made approximately 400km south at Shark Bay (Western Australia). A total of 3,127 whale detections were made during 74 surveys of the 7,043km² study area west of NWC. Pod abundance for each flight was computed using a Horvitz-Thompson like estimator and converted to an absolute measure of abundance after corrections were made for estimated mean cluster size, unsurveyed time, swimming speed and animal availability. Resulting estimates from the migration model of best fit with the most credible assumptions were 7,276 (CI = 4,993–10,167) for 2000, 12,280 (CI = 6,830–49,434) for 2001, 18,692 (CI = 12,980–24,477) for 2006, 20,044 (CI = 13,815–31,646) for 2007, and 26,100 (CI = 20,152–33,272) for 2008. Based on these data, the trend model with the greatest r^2 was exponential with an annual increase rate of 13% (CI = 5.6%–18.1%). While this value is above the species' estimated maximum plausible growth rate of 11.8%, it is reasonably close to previous reports of between 10–12%. The coefficient of variation, however, was too large for a reliable trend estimate. Perception bias was also not accounted for in these calculations. Based on a crude appraisal which yielded an estimated $g(0)$ of 0.783 (from independent observer effort, CV = 0.973), the 2008 humpback population size may be as large as 33,300. In conclusion, the work here provides evidence of an increasing Breeding Stock D population, but further surveys are necessary to confirm whether the population is indeed increasing at its maximum rate.

KEYWORDS: ABUNDANCE ESTIMATE; SURVEY-AERIAL; MIGRATION; MODELLING; TRENDS

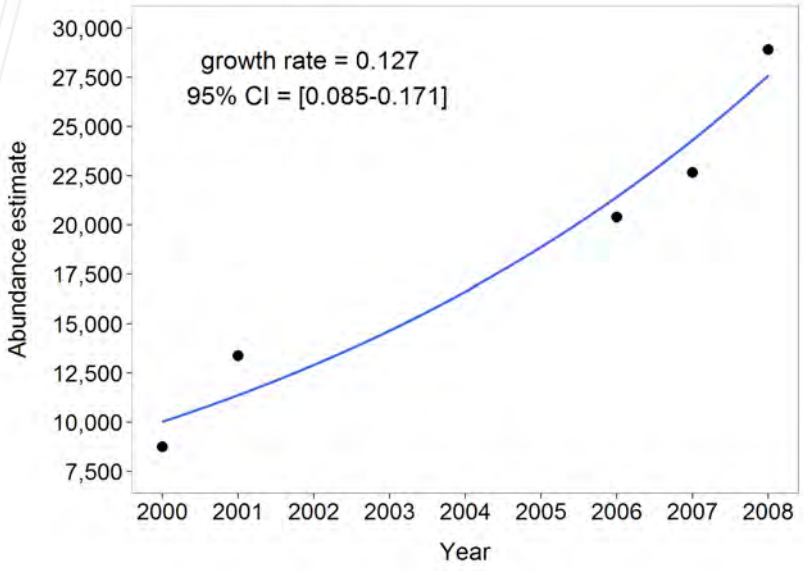
Modelling migration counts



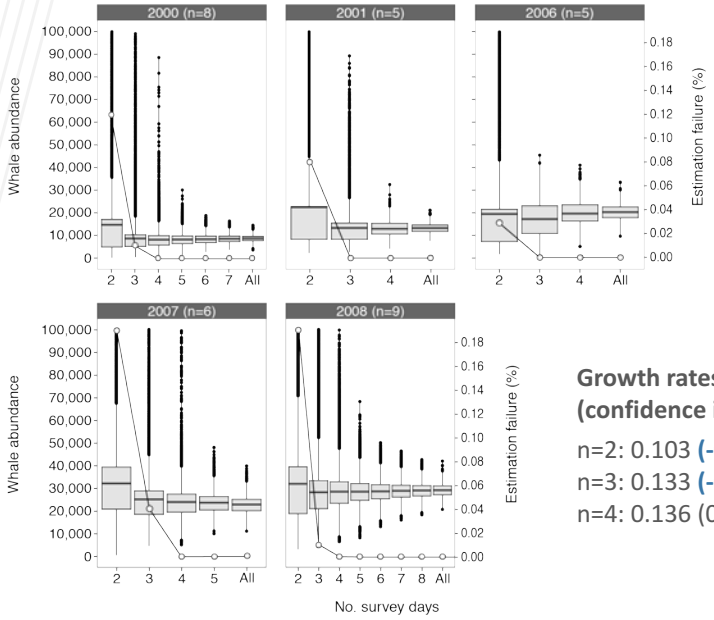
Final estimates (confidence interval):

2000: **8,740** (5,800 - 12,316)
2001: **13,373** (9,375 - 18,281)
2006: **20,394** (14,227 - 28,059)
2007: **22,650** (15,890 - 32,423)
2008: **28,913** (23,347 - 35,393)

Population growth



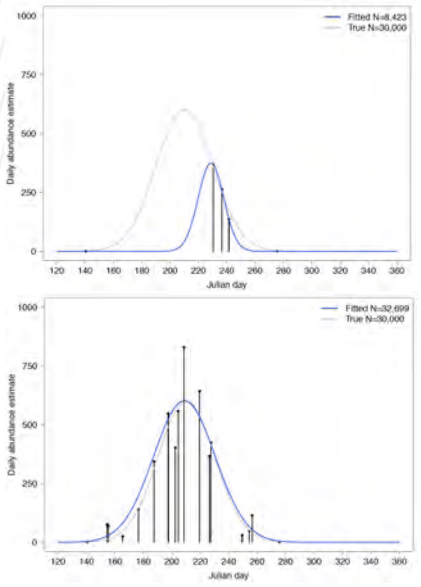
Empirical approach: doing worse



Growth rates (confidence interval):

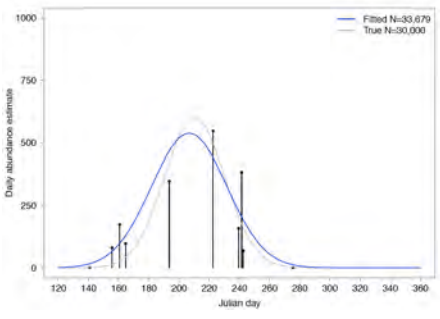
n=2: 0.103 **(-0.123, 0.298)**
n=3: 0.133 **(-0.005, 0.260)**
n=4: 0.136 (0.047, 0.229)

Simulation approach: doing better (?)

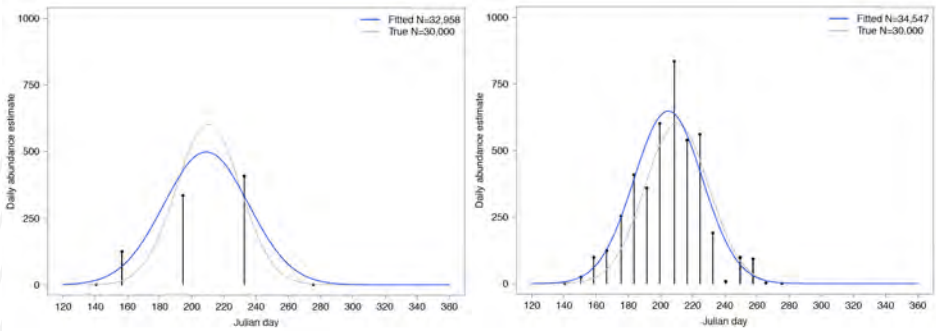


Random sampling:

n=4 to 30



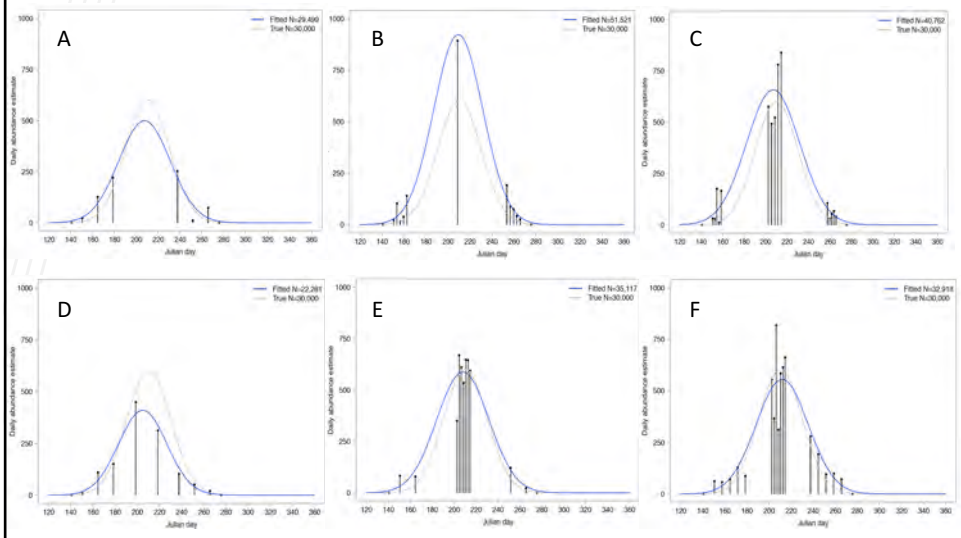
Simulation approach: doing better (?)



Systematic sampling:

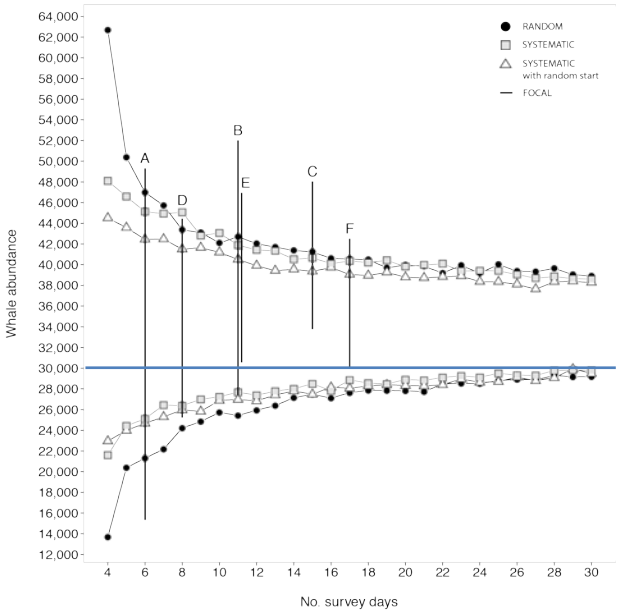
n=4 to 30 + random start (Yes/No)

Simulation approach: doing better (?)

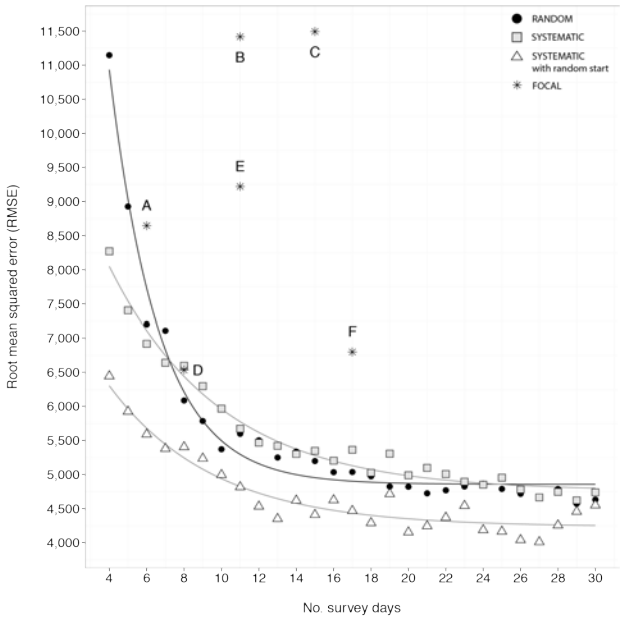


Focal sampling – scenarios A to F: n=6 to 15

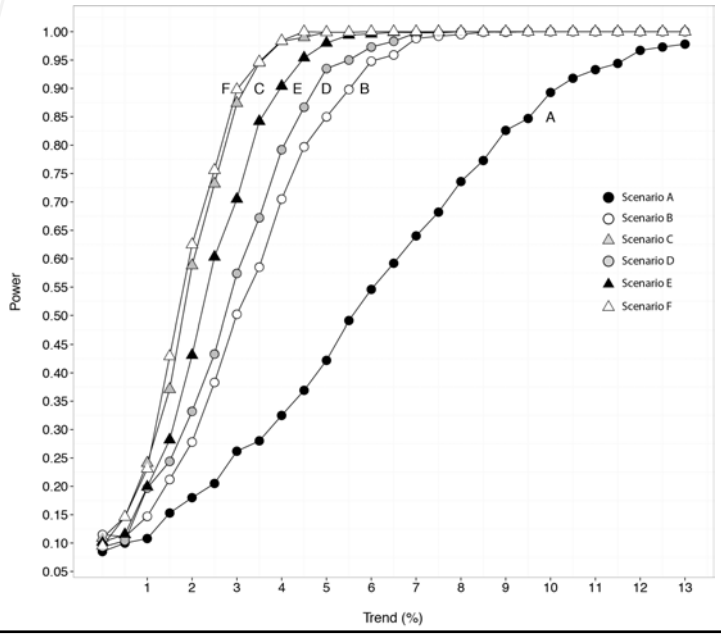
Simulation approach: doing better (?)



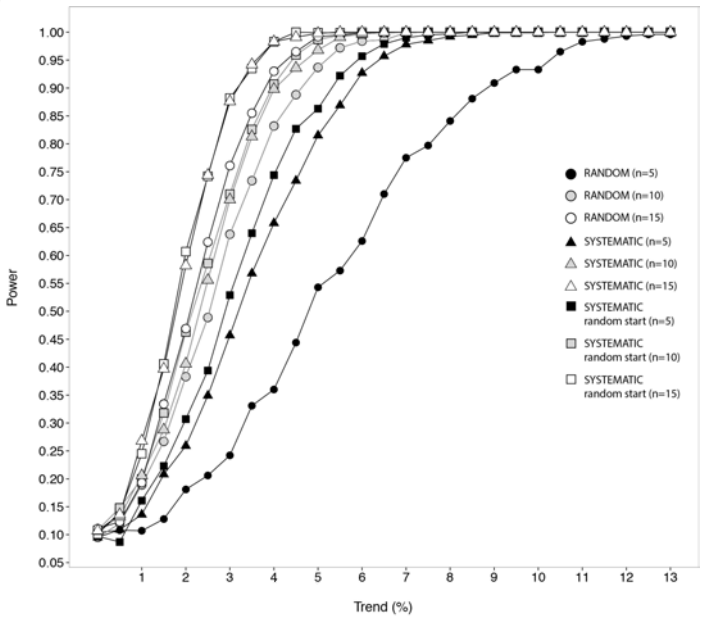
Simulation approach: doing better (?)



Detecting trends



Detecting trends



Conclusions and recommendations

(1) Minimum requirement of **5 surveys**

(2) Choice of design function of study goals

(3) Trend: the more usually the better

(4) Based on our original data, 6 and 9 years required to detect 10 and 5% trends

(5) Abundance: 10-12 surveys optimal

(6) F and D two best designs overall

(7) Survey planning exercises **are critical to maximising cost-effectiveness**

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