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Did the Population Really Change?

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Estimation of population trend, the temporal change of population size (*N*), provide quantitative baselines essential for status classification [1-4] and assessment on extinction risk through Population Viability Analysis (PVA) [3-6]. According to the Criterion A of the *IUCN Red List Categories and Criteria Version 3.1* [1], the population trend is the change of *N* in past only (Criterion A2), future only (Criterion A3) or from past to future (Criterion A4) [1,7]. To predict the probabilities and time of extinction within the future 100 years (Criterion E: [1]) demographic approach using PVA techniques can be used [4,5,7,8]. To understand the percentage of population decline in a given time in past (Criterion A2: [1]), on the other hand, two successive censuses, at least, over a temporal alignment are needed.

Though theoretically the population change can be solved by the difference between two successive *N* estimates, the variation in current census techniques and miss-interpretation of census results make the real application of the two-N technique more complicate. Direct use of difference between two successive *N* estimates to measure the population change, however, should be cautious of 'false-positive' answer (Figure 1).

Rather than a static and stable status, the population abundance which most transects investigation actually surveys dynamically changes with immigration and emigration of individuals, particularly related to the regionally seasonal movements. When the activity range of population size is actually wider than the study area, which frequently happens in most cetacean censuses, the number of *N* estimates between two successive censuses can change significantly when the immigration/emigration pattern has seasonal tendency [9]. The population 'change' in a short temporal interval should be viewed from a behavioral/ecological perspective rather than a demographic 'trend'.

The resolution of traditional census techniques, especially the transect methods, to measure the population trend is related to the size of population surveyed [10]. To the abundance between 250 – 1000 animals the expected CV of abundance estimate ranges between 38.7% (N = 250) and 20.9% (N = 1000), applying the strictly designed line-transect surveys [10]. Differences between two successive N estimates can merely result from the variation in survey technique rather than demographic change of population size if the surveys have wide variation while the rate of population change is low (Figure 1). Program TREND 3.0 (Marine Mammal and Turtle Division, SWFSC, NOAA) can be used to solve the question: What is the probability to detect a 'trend' between two successive censuses?

In the Capture-Mark-Recapture (CMR) exercise a careless interpretation of census results can have a false-positive trend. In cetaceans photo-ID technique is frequently applied to CMR exercise to estimate the population size [11-13], demographic rates [2,12,14], reproductive interval [15,16] and social dynamics [15,17,18]. When starting photo-ID survey on a novel population, the number of identified (marked) animals gradually increases with survey efforts (Figure 2). The rate (how fast) of accumulation of marked animals depends on how frequent the photo-ID surveys are conducted. In an annual or seasonal survey frequency the accumulation stage in the sighting curve (Figure 2) would take several years. Careless interpretation of population

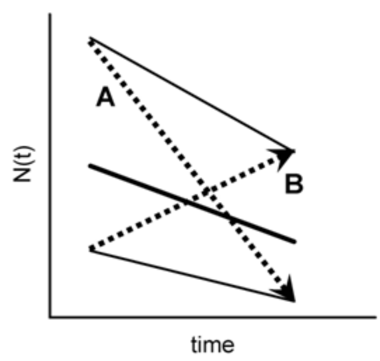

Figure 1: Likely bias of trend estimation based on the census surveys on a slowly declining population. This hypothetic population is declining by 30% abundance every 10 years (the thickened solid line), meeting the standard to classify *VU* (Vulnerable) under Criterion A2b of the *IUCN Red List Categories and Criteria Version 3.1* [1]. The area enclosed by the 95% confidence interval of N estimate (the two thin solid lines) represents the likely range of population 'trend' between two successive censuses: from the most pessimistic (arrow A) to the most optimistic (arrow B) estimates. The most optimistic estimate can have catastrophic consequences on the conservation of threatened population.

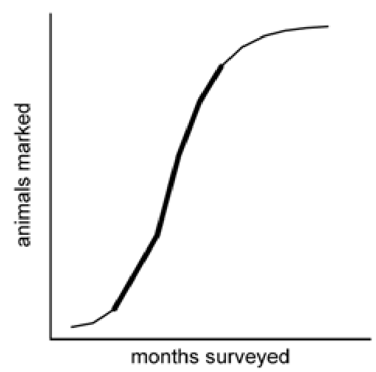

Figure 2: The curve of accumulation of animals marked (identified and assigned) in photo-ID exercise of cetaceans. Careless use of *N* estimate during the accumulating stage (the thickened line) when resighting rate is still low can have unrealistic and unreasonable optimistic population trend.

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'change' at this stage when the resighting rate is still low can have a unrealistic and unreasonable 'happy' conclusion: The population trend were 'behind increasing' [19].

Even though papers have reported it is unrealistic to estimate population trend for the cetacean populations by 2-N technique [2,7,8,20-22], practices of census-based trend estimation are still frequently called particularly in Asian countries. Many of which were conducted in inappropriate ways such as short inter-survey interval (like monthly 'trends'), inappropriate regression curve-fitting (like polynomial or sinusoidal), erroneous use of CMR modeling (like assuming the number of sighted animals equal to the number of identifiable animals in population) and/or inconsistent design of censuses.

Unbiased trend estimation of cetacean populations often awaits decadal, or longer, census efforts [7,8,21-23]; however, population loss can be substantial at the time the population decline becomes detectable [8,22,24]. Precautionary managements are needed before the change of population size is informed. Estimation of population trend is still important in order to provide quantitative baselines for the sound status and risk assessments [1]. Careful design of census surveys, including season, frequency and methods of used, realistic interpretation of temporal change of abundance between successive censuses and, particularly, reasonable use of adequate model to measure population trend [7,8] are important perspectives to be considered before applying traditional census techniques to understand the demographic change of a population.

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