

Przewalski's Horse (*Equus ferus ssp. przewalskii*)

Population growth rate of the Mongolian Przewalski's horse population

A population growth rate analysis of the Great Gobi B SPA and Hustai NP populations was conducted based on data from release to 2012. Abundances in the Khomiin Tal and Chinese populations were too small to usefully analyze population growth. Because of high foal and yearling mortality, and for consistency with previous assessments, the analysis was restricted to mature individuals (five years old or older). Captive-born individuals that were released younger than five years were considered to be released into the mature population when they reached age five.

The classic definition of population growth rate, based simply on the total abundance of mature horses is:

$$r_c(t) = \log[N(t+1)/N(t)], \quad (1)$$

where $N(t)$ is the number of mature individuals at the beginning of year t .

Note that this can also be calculated from the demographic transitions in the population:

$$r_c(t) = \log \left[1 + \frac{R(t) + B(t) - D(t)}{N(t)} \right], \quad (2)$$

Where $R(t)$ is the number of released individuals in year t , $B(t)$ is the number of wild-born horses that reached maturity (five years of age) in year t , and $D(t)$ is the number of mature horses that died in year t .

If the classic growth rate is positive, on average, then the population size has been increasing over time. However, neither the population trend nor the classic growth rate allows determination of the extent to which the observed population growth depends on ongoing releases of captive-born individuals; the goal is to determine whether the population would be growing even in the absence of releases. Modifying equation (1) to only count wild-born individuals is not an appropriate solution, since captive-born individuals contribute to subsequent growth through producing wild-born offspring. Instead, a “wild” population growth rate is created by removing the releases from equation (2):

$$r_w(t) = \log \left[1 + \frac{B(t) - D(t)}{N(t)} \right]. \quad (3)$$

Thus, released horses are not considered a contribution to population growth in the year of their release, but they are counted as part of the population in subsequent years.

Each growth rate was calculated for each year, and means calculated over the entire period since the population's reintroduction and over the last ten years. Demographic stochasticity causes population growth rates to be more variable when populations are small, so weighted means were calculated, weighting by the square root of initial abundance each year.

In Great Gobi B SPA, both measures of population growth rate have fluctuated dramatically through time (Figure 1), with only the “classic” growth rate being positive prior to 2007, when the first wild-born individuals reached mature status. When the 2009/2010 dzud is included, only the classic growth rate has a positive mean (although with a confidence interval that includes large negative values); however, over the past decade excluding the dzud year, the average annual “wild” growth rate is estimated to be about 5% (Table 1).

In contrast, both growth rate measures for the Hustai NP population have been consistently positive, and not highly variable, since 2000 (Figure 1); the estimated mean growth rates are all convincingly positive, exhibiting growth of about 11% per year (Table 2).

The growth rate analysis of the Hustai population is indicative of a population that is steadily and consistently growing. The convergence of growth rates in recent years reflects the fact that releases of captive-bred individuals have ceased, and recent population dynamics reflect reproduction by and survival of wild-born and well-established captive-born individuals.

The results for the Gobi population suggest that the population is more dependent on continued releases for the near future (contrast the “wild” and “classic” growth rates). However, during the 2009/2010 dzud, mature captive-born individuals had a much higher death rate (30/31) than did mature wild-born individuals (14/23). If the 2009/2010 dzud is thought to be “unusual” and unlikely to reoccur then we can be fairly confident that the population will grow, albeit with greater annual variability than in the Hustai population.

A more nuanced analysis that might help understand the role of released individuals in the Gobi population would investigate the rate at which survival and reproduction of captive-born individuals converges on that of wild-born

individuals as a function of time since release, as well as examining which individuals are most susceptible to environmental fluctuations such as drought. A full demographic analysis that incorporates age and sex structure will also provide insight into the trends and patterns of population growth.

Figure 1. Annual growth rates of two reintroduced Przewalski's horse populations. The red curve shows the annual growth in total abundance of mature individuals (equation 1); the green curve removes from this the increment associated with releases of captive individuals (equation 3).

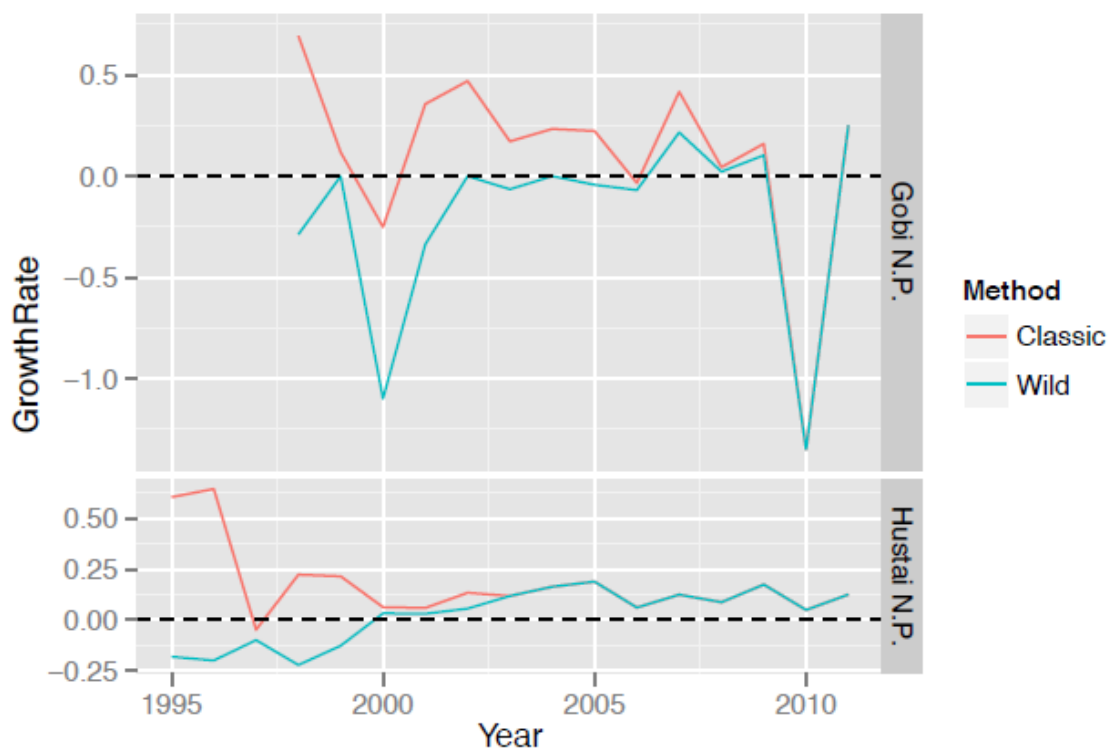


Table 1. Weighted means of the three growth rates in Great Gobi B SPA, averaging across the entire history of the introduction, the most recent 10 years of data, and the most recent 10 years with the drought year removed. Bootstrap 95% confidence intervals in parentheses. Weighting is by the square root of abundance at the beginning of each year.

	All years	2002-2011	2002-2009, 2011
Classic	0.010 (-0.535, 0.222)	-0.024 (-0.677, 0.231)	0.195 (0.102, 0.297)
Wild	-0.202 (-0.692, 0.002)	-0.151 (-0.723, 0.073)	0.048 (-0.016, 0.131)

Table 2. Weighted means of the three growth rates in Hustai NP, averaging across the entire history of the introduction and the most recent 10 years of data. Bootstrap 95% confidence intervals in parentheses. Weighting is by the square root of abundance at the beginning of each year.

	All years	2002-2011
Classic	0.141 (0.102, 0.202)	0.120 (0.089, 0.146)
Wild	0.057 (-0.001, 0.101)	0.114 (0.085, 0.144)