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Changes in the size of the Sable Island Horse Herd between 1960 and 1980 and an examination of aspects of winter weather as possible causes of population crashes

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The horses on Sable Island are most likely descendants of animals introduced in the second quarter of the eighteenth century by Andrew LeMercier and of numerous other animals sent to the Island since that time to "improve" the breed (Christie 1980). Human residence on the Sable Island has been continuous since 1803 and from that time up to the middle of the twentieth century the horses have served as riding and draught animals and as a profitable export. The diaries of the superintendents of the Island's Humane Establishment in the Public Archives of Nova Scotia contain numerous references to the size of the herd in historic times and most are between 200 and 400 animals. But these population estimates are few and of varying accuracy, and it is not possible to determine from these limited data to what extent the fluctuations in numbers were natural or as a result of periodic exports of horses.

Since 1960 fairly frequent and more reliable estimates of horse numbers have been made by A.W. Mansfield (1967), D.A. Welch (1975) and since 1976 by the Canadian Wildlife Service. Lock (1981) collected these counts and these are the horse population estimates used in Figures 1 and 2. The open circle in these figures signifying a May 1965 population on these figures is an estimate, not an actual count. In May of that year a team of geologists from Dalhousie University was on the Island and they reported encountering more than 70 dead horses in the course of their travels (F. Androschuck, pers. comm.). They are unlikely to have found all the horses that died; therefore, if one assumes, as a conservative estimate, that about 80 of the 218 horses counted by Mansfield in February 1965 died that spring, approximately 140 would have survived the crash. Thus, in the two decades under consideraton, during which time the herd has been undisturbed, its size has varied between 140 and 359 horses.

The pattern of population change has been one of slow growth and occasional major mortalities or population crashes. These occurred in 1965, 1972 and 1980 and Mansfield's censuses from 1961 to 1966 show that a smaller, but still substantial die-off occurred in 1963.

The biological literature contains several reports of crashes in populations of introduced large herbivores. Reindeer introduced to St. Paul and St. George Islands in the Pribiloffs (Scheffer, 1951) and St. Matthew Island in the Behring Sea (Klein, 1968) underwent rapid population growth and catastrophic crashes from which the populations didn't recover. But these were animals which subsisted primarily on extremely slow-growing lichens and once browse was exhausted the death of a majority of the herd was inevitable. The Sable Island horse herd subsists on vegetation that annually dies and is renewed; a catastrophic crash of the type experienced by insular arctic reindeer populations is averted.

Within the short period 1961 to 1980, for which we have accurate horse population data, there have been three major crashes: in 1965, 1972 and 1980, suggesting a regularity of population growth and crash with a period of seven or eight years. This apparent regularity further suggests a density dependent interaction of horses with their forage, but an assumption that this is the cause of the observed crashes can only be made if one is able to demonstrate the absence of an extrinsic factor influencing the population.

With the hope of identifying such a controlling factor, I examined weather records for Sable Island from 1960 to 1980 and extracted those measures which could be used as an assessment of the severity of a winter. It was not, at first, expected that examination of values of weather phenomena averaged over a whole winter would show any strong correlation with the population crashes. It seemed likely that the crashes might be precipitated by a few consecutive days of bad weather which would not show up in whole-winter averages. However, Figures 1 and 2 show that there is an interesting correspondence between the population crashes and some aspects of winter weather.

Welch (1975) suggested that "the final cause of death is probably heat loss (hypothermia) in most horses." He noted that the horses were on a negative energy budget in winter and that any excessive heat loss, particularly in late spring when their energy reserves are least, can result in death. He suggested that rain followed by freezing temperatures caused greatest mortality.

The correlation of mass mortalities with freezing precipitation is not particularly good (Figure 1). The amount of freezing precipitation recorded on Sable Island in the winters of 1962 and 1964 were greater than in 1965, and higher in the years 1973, 1974 and 1975 than in 1972 when there was a crash. There was no freezing precipitation recorded in the winter of the large 1980 crash. Welch, of course, was only looking at the 1965 and 1972 crashes and from this limited perspective there does appear to be the possibility of freezing precipitation having a role in precipitating population crashes.

It is instructive to examine the other factors contributing to heat loss - wind speed and mean temperature. Wind speeds averaged higher in 1964 than in 1965; higher in 1970 than in 1972; and higher in 1978 than in 1980. High wind speed alone obviously did not cause the crash. The case is similar with mean winter temperature: the mean values for the crash years are slightly below normal, but the mean winter temperature in 1975, a winter of no exceptional horse mortality, was lower than in the winter of 1980 during which over 200 horses died. Taken together, the greater than average wind speeds and the cooler temperatures of the crash years 1965, 1972 and 1980 result in winters of slightly greater than average thermal stress. However, the combinations of high wind speeds and low temperatures in the winters of 1970 and 1978 appear to have been about as bad as in the winters of the crash years, yet in 1970 and 1978 there was no population crash. That thermal stress alone is not responsible for precipitating these crashes is demonstrated by the fact that they occur in late March and April - after the period of highest winds and lowest temperatures. These horses are obviously quite able to withstand the rigours of life outdoors in as relatively mild a climate as Sable Island's.

When snowfall records are examined (Figure 2), correlations with population crashes are immediately apparent. Three measures of snowfall were used: the numbers of days on which snowfall exceeded 10 cm, total snowfall from December to May, and late-winter snowfall from March to May.

Welch (1975) has pointed out that the horses are on a negative energy budget over winter after achieving maximal heat levels by December. Maintaining body temperature against the high rate of heat loss in winter demands an expenditure of energy greater than that which can be obtained grazing in the short winter days on the poor quality forage available at that time of year. If a heavy snowfall reduces a horse's ability to graze efficiently, its rate of energy assimilation is reduced still further and its energy reserves may become exhausted before spring when grazing on new plant growth allows the resumption of a positive energy budget and replenishment of energy reserves.

The correlation of population crashes with snowfall is not, however, as direct as it first appears on examination of Figure 2. In 1971 the winter's snowfall was similar to that in 1980, but a crash was precipitated in 1980 and not in 1971. The mean winter wind speeds and temperatures were similar in both years and less freezing precipitation was recorded in the crash year - 1980. The important difference between these years was the size of the horse population. At the beginning of winter 1971 there were 267 horses; in 1980 there were 359.

It has been calculated (Welch 1975) that a herd of 300 horses would consume only 13% of Sable Island's forage production. This doesn't mean that the Island could support almost eight times as many horses. If production could be harvested with 100% efficiency and if the forage did not deteriorate after the growing season, then 2,400 horses could just about be maintained. However, the food value of forage drops drastically after the growing season and the amount available for grazing is greatly reduced by trampling. Such trampled forage cannot be cropped as effectively as standing grass. The amount of trampling increases as population increases and as the season progresses the damage is greatest just before the new grass appears in April. At that time, when horses' energy reserves are lowest, food becomes most difficult to gather. The importance of population size is shown by the fact that in the three crashes since 1961 the proportion of the herd which dies increases as the population size increases.

I had expected that snowfall in March and April would be most damaging, but Figure 2 shows that a large late-winter snowfall is not necessary to produce a population crash. A large snowfall in January and February can so deplete energy reserves that animals are unable to survive on the remaining low-quality forage until spring.

Thus, for practical or predictive purposes it appears that population size and total snowfall are the most important determinants of winter mortality. If the population is relatively low, an above average snowfall may not cause a crash (1971), but at higher population levels the amount of snowfall needed to produce substantial mortality is reduced (1980). An examination of records for the period 1961-1980 shows that as a rule of thumb a crash is likely in any winter if the sum of the number of horses and twice the winter snowfall in centimetres exceeds 600. The horse population will be approximately 300 going into the winter of 1984-85 and if past experience is valid, we might expect a population crash in March or April 1985 if the winter's snowfall is around 150 cm. The average annual snowfall on Sable Island is 139 cm.

Mansfield's (1967) censuses in the early 1960's show that a large number of horses died in the spring of 1963, yet not so many that we can think of the event as a population crash. In that winter there were only 226 horses on the island and the total snowfall was 111 cm. But 93 of the 111 cm fell from March to May that year and one can only presume that this exceptional late winter stress prevented the less fit and fat animals from grazing effectively for a long enough time that their already reduced energy reserves were totally depleted and they succumbed.

The population crashes have given rise to much humanitarian concern and to discussion of the possibility of managing the herd to prevent an uncontrolled increase in numbers and periodic mass mortality in bad winters. Any living population can be managed in two basic ways: by controlling birth or by controlling death. If, as has been done with the wild horse herds in the southwestern United States, birth were to be controlled by drug-induced reduction of the fertility of herd stallions and the growth of the population were limited to 200-250 horses, there would be a low winter mortality at first. However, the proportion of old and sick horses in the herd would increase and in a hard winter a larger number of animals would die. Such a delayed population crash would likely reduce the population to less than 100.

If, as a management procedure, it was decided to allow unlimited reproduction, the consequence is the necessity of controlling mortality. This could be done humanely by assessing the condition of animals in early winter and culling the old and sick, those which are likely to die in a hard winter. There are the animals which would be removed by predators in a normal free-ranging large herbivore population. If thus managed the population were maintained at 200-250 animals, very few would suffer the ignoble death by starvation and exposure which is the lot of older horses and many pregnant mares in an unmanaged population.

We have three choices:

1. leave the herd unmanaged

2. control fertility

3. control mortality

The disadvantage of the first is that humanitarian concerns are not answered and the population fluctuates widely and at its highest levels the pressures of winter grazing and trampling cause significant damage to the horses' habitat: the fragile, vegetated terrain of Sable Island.

The second choice avoids the difficult necessity of culling the old and diseased horses but in a herd with limited range, like the Sable Island horse herd, the likelihood of a reduction of the population to a very low level is increased. There is a limited genetic variability in the Sable Island herd and if periodic fluctuations allow numbers to crash to very low numbers, this will be further and damagingly decreased. Only the periodic introduction of new stock could avert this, but such introductions would destroy the genetic uniqueness of the herd.

The third choice, difficult in that it involves careful monitoring of the condition of individual horses and difficult in that it involves culling the vulnerable ones, has the overwhelming advantage that it will reduce death by starvation in bad winters and thus answer humanitarian concerns. Furthermore, by ensuring that wide population fluctuations will be eliminated, it preserves both the integrity of the horses' habitat and the genetic identity and variability of the herd.

Figure 1. The size of the Sable Island Horse herd between 1960 and 1980 and four measures of winter severity in these years.

a. The number of days between January and April in which the mean temperature was below 0°C.

b. The number of days of freezing precipitation between January and April.

c. The mean wind speed from January to April.

d. The mean temperature from January to April.

The vertical stripes indicate those years in which there was a horse population crash. The open circle indicates an estimate of the number of horses surviving the 1965 crash.

Figure 2. The size of the Sable Island Horse herd from 1960 to 1980 and three measures of snowfall in those years.

a. The number of days from January to May on which snowfall exceeded 10 cm.

b. Total winter snowfall, measured from December the previous year to May.

c. Late winter snowfall: from March to May.

The vertical stripes indicate years in which there was a horse population crash. The open circle indicates an estimate of the number of horses surviving the 1965 crash.