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Climate Change and Biosecurity Risks: Korean Water Deer - A Threatened Species Not a Pest

Sihyun Park[1] and Eric Ahn[#]

[1]Chadwick International School, Republic of Korea
[#]Advisor

ABSTRACT

The International Union for the Conservation of Nature (IUCN) Red List has led efforts to monitor and conserve populations of animals, plants, and fungi since 1964. However, recent research suggests the list is not effectively accounting for the consequences of rapid man-made climate change. The Korean Water Deer (*Hydropotes inermis argyropus*) is classified as vulnerable internationally, but in South Korea it is widely considered a pest, with the government offering bounties to cull what are considered high numbers. Both the IUCN's classification and the Korean government's approach to Korean Water Deer fail to consider the possibility of a rapid decline in numbers due to rapidly spreading biosecurity threats facilitated by rapid climate change. This paper describes the current status of Korean Water Deer, the biosecurity threats the population faces, and potential solutions to protect the population. This case study of Korean Water Deer will also add to evidence that the IUCN's classification system is failing to accurately describe the potential for rapid collapse of mammal populations due to biosecurity threats facilitated by climate change.

Introduction

The Korean Water Deer (*Hydropotes inermis argyropus*) is one of two subspecies of Water Deer (*Hydropotes inermis*) in Northeast Asia, with the other being the Chinese Water Deer (*Hydropotes inermis inermis*). Estimates for the current number of Korean Water Deer in South Korea range from 100,000 to 1,000,000, but a geographic information systems model in 2016 estimated the population to be 0.078 per hectare, or around 780,000 (Jung et al., 2016). However, the collapse of the Chinese Water Deer population in China – with an estimated population of 10,000 or less, and one estimate of only 3500 in the wild – foreshadows the potential collapse of the Korean Water Deer population (Shi, W. et al., 2014).

The Korean Water Deer is a relatively small species of deer that normally weighs between 9-14 kg and grows to 45-55cm in height and 75-100cm in length, with an average lifespan of 12 years (Water Deer, 2024). It is described as an "edge species" as it thrives in the borderlands between wetlands and forests, and it mainly feeds on graminoids: grasses, rushes, and sedges (Baldwin, 2021). The deer play a significant ecological role in the distribution of graminoid seeds and their presence affects "plant populations and communities" (Lee et al., 2020).

Currently, the Water Deer (*Hydropotes inermis*), including both the Korean and Chinese sub-species is on the IUCN Red List and classified as "vulnerable" (Harris et al., 2015). Under the justification for the listing, the IUCN explains that "due to lack of updated information it is not possible to assess the worldwide status of this species" but a "serious decline is nevertheless evident" as "the species is not particularly adaptable and appears to be rather sensitive to environmental changes" (Harris et al., 2015). Despite its lack of adaptability, the IUCN describes how the Korean Water Deer appears to be able to live in rice paddies between "unmodified waterways and patches of fallow habitat" in the southern regions of South Korea (Jung et al., 2016).

Despite the described vulnerability of Korean Water Deer in South Korea and the example of the total collapse of Chinese Water Deer populations in China, the Korean government currently classifies the Korean Water Deer

as “harmful wildlife” that poses a threat to agriculture and human populations (Park et al., 2021). Research has focused on control of the Korean Water Deer population to limit what are perceived as the threats caused by the species. For example, research has been conducted on what type and height of fencing is most effective at preventing “wild-life vehicle collisions, wildlife disease spread, and crop damage” and “eliminating possible resting areas outside fences” to reduce “the number of successful jump attempts” (Park et al., 2021).

Despite the significant ecological role played by Korean Water Deer and its status as a subspecies of an internationally vulnerable species, the perception of it as a pest in South Korea means that research on biosecurity threats caused by rapid man-made climate change has been limited. The lack of awareness may partly be caused by the ineffectiveness of the current IUCN Red List classifications.

As already described, the IUCN justification for the “vulnerable” classification of Water Deer internationally includes the proviso that there is a lack of data relating to Water Deer populations, but the species’ sensitivity to environmental change means further rapid decline in remaining populations is likely and expected. Furthermore, recent research suggests that IUCN Red List fails to fully incorporate rapid global environmental change associated with climate change, such as increased biosecurity risks for native species like the Korean Water Deer, and when this change is taken into account, the IUCN appears to “underestimate the extinction risks” and in one study more than 50% of new species identified as threatened under updated criteria lack any form of protection (Peng et al., 2023). Given the current status of Korean Water Deer on the Red List and its limited ability to adapt to environmental change, it is highly likely that the subspecies’ population is threatened to a much greater extent than is currently understood.

Background

Climate change related biosecurity threats to native species like the Korean Water Deer can be organized into three major categories: the spread of invasive species, the spread of disease, and changes in habitat. Across these three categories, the environmental policy and management has been described as “slow to respond to this challenge” (Bradley et al., 2023).

Rapid man-made climate change is forcing species to find suitable habitats or evolve. For native species in warming environments, the choice is either to find a new habitable range or compete with “invasive” species. Species that succeed as “invaders” have been found to have “high levels of additive genetic variation”, so the success rate of a species in any habitat is dependent on “the genetic makeup of a species” (Finch et al., 2021). However, native species are not only threatened by the invasion of their habitats by direct competitors for resources or predators. In many cases, the first invasion to threaten a species is a plant invasion. As the climate of a region changes, plants that could not previously survive in the previously climactic colder conditions can now thrive. The plants that arrive compete with the existing species, possibly replacing a plant species that was an important food source for animals higher up the food chain (Gianoli, 2021).

Warmer climates also facilitate the spread of diseases that would previously have not spread through colder habitats. The connection between “rising global temperatures, rates and incidence of species decline, and emergence infectious diseases” has been described as an “unprecedented planetary crisis” that is defined by “escalating climate and biodiversity crises” (Pfenning-butterworth et al., 2024). With warmer and wetter conditions, it is expected that “a wider distribution of known vectors and the recruitment of new strains to the vector pool could result in infections spreading to more and potentially new species of hosts” (Caceres, 2012).

Of the three most significant climate change related threats to a species’ survival, rapidly changing habits pose possibly the most significant threat. Research suggests that the realization of “mid-range” climate warnings for 2050 would lead to extinction for “15-37% of species” (Thomas, 2004). The changes in habitat associated with a warming climate have been modeled extensively, and “the majority of models indicate alarming consequences for biodiversity, with the worst-case scenarios leading to extinction rates that would qualify as the sixth mass extinction event in the history of the earth” (Bellard, 2012).

Methodology

The biosecurity threats to biodiversity associated with rapid man-made climate change have been described. The specific biosecurity threats to the Korean Water Deer population will be explored with the aim of highlighting the weakness of the current IUCN Red List classification and the general perception and policy making related to Korean Water Deer in South Korea. These threats will include the introduction of invasive species, the spread of disease, and changes in habitat.

Once the threats to the population have been established, solutions that could be applied to the South Korean context and specifically Korean Water Deer conservation will be described.

Results and Discussion

As the South Korean climate warms, various plant species can extend their presence through the peninsula. Although these plants do not compete directly with Korean Water Deer, some can outcompete the graminoids that it feeds on, reducing the overall supply of nutrition in the wild for the species. As agricultural land expands into the traditional habitat of the Korean Water Deer, the pressure on the graminoids from invasive plant species make it more likely that the deer will search for food in the agricultural fields. Common ragweed (*Ambrosia artemisiifolia*) is one species of plant that is currently considered an invasive species in South Korea and is outcompeting the graminoids that the deer rely on (Kil et al., 2004).

Disease spread by ticks, bacterial infections, and viral infections also pose an increasingly significant threat. *Anaplasma capra* is a pathogen spread by ticks and although the effect on the health of Korean Water Deer is not well understood, a recent study found that 17.8% of Korean Water Deer tested for the disease were found to be positive (Amer, 2019). Another disease spread by ticks, *Theileria* is again not well understood in how it affects the health of Korean Water Deer, but it was found in populations in South Korea and is described as becoming more widespread due to climate change (Seong et al., 2015).

The bacteria *Brucella abortus, which* can cause reproductive issues and debilitation, was found in 59% of Korean Water Deer tested between 2010-2012 (Kim et al., 2014). Some evidence suggests that this bacteria spreads more successfully in warmer climates, but data is limited for Korean Water Deer populations (Faramarzi et al., 2019). Bovine Viral Diarrhoea Virus (BVDV) has also been found in Korean Water Deer populations (Kim et al., 2014). The virus can lead to reproductive issues and even death in young deer. Stressors, such as environmental change have been linked to higher levels of transmission of BVDV (Tinsley et al., 2012).

Although the spread of invasive species and disease pose significant threats to Korean Water Deer, the most immediate and dangerous threat is disruption to the deer's habitat. Droughts and floods have been shown to fragment the populations of various species, including Korean Water Deer, and South Korea is experiencing more regular and intense periods of drought and flooding as its climate changes (Choi et al., 2021). The fragmentation of deer populations has been shown to lead to isolated genetic pools, creating vulnerabilities to disease (Queiros et al., 2013). This would be happening at the same time climate change facilitates the more rapid and widespread spread of diseases as described above.

Climate change in South Korea is also rapidly affecting ecosystems, changing the patterns of growth and ranges of plants (Choi et al., 2021). All herbivores, including Korean Water Deer, will face increasing difficulties finding reliable sources of nutrition, but as described above, Korean Water Deer do not adapt well to environmental changes and will likely struggle more than other species.

Finally, the impacts of climate change on the health, habitat, and food sources of Korean Water Deer will align with increasing human expansion into the traditional habitats of the deer. Some research suggests that the Korean Water Deer population has increased in recent years, but the changes in climate and reduced habitat would suggest that the deer population is probably falling. The unreliability of population estimates creates an opportunity for the

interpretation of evidence in a way that suits economic interests. There may be incentives for researchers to argue that the population is thriving because of the economic damage that has been reported by the deer eating and damaging crops and spreading disease (Jung, 2016). Reporting that the population is thriving creates the conditions for widespread culls and the general treatment of Korean Water Deer as a pest, with the Korean government even offering bounties for the culling of the deer (Jang, 2024).

Securing a Future for Korean Water Deer

The biggest obstacle to effectively managing and conserving the population of Korean Water Deer is the lack of accurate information. As described above, estimates vary widely and rely on statistical modelling using geographic information systems. To secure the long-term future of Korean Water Deer, the most urgent task is to accurately measure and monitor the stability of the population.

Once the size of the population has been accurately established, policy makers can make informed decisions on how urgent resource allocation is for the conservation of the species. Subsequent stages would include assessments of the fragmentation of the deer's habitat and whether human encroachment into the deer's habitat is exacerbating the economic damage caused by crop destruction and the spread of disease associated with the deer.

Furthermore, to reduce the deer's suspected role as a reservoir of disease that can be transmitted to livestock, other wild animals, and in some cases humans, research on the prevalence of disease in the species and how such disease are transmitted is required. Further research on how diseases like those described in this paper interact with a warming climate and stress caused by habitat change is also required.

Finally, regardless of the outcome of research on the accurate population size of Korean Water Deer, the general public perception of the species as a pest needs to change. The total collapse of the Chinese Water Deer population shows that the species is highly sensitive to changes in its habitat. The rapid change in habitat and climate caused by global warming in South Korea means the deer faces an uncertain future regardless of the current size of its population. The Korean Water Deer's distinctive fang like teeth make it an ideal species for raising awareness of general habitat collapse as it is certain to attract attention. The Korean Peninsula is also the only place in the world with an apparently sustainable population. This should be a source of pride for South Koreans and could be utilized as a means of raising awareness not only about the threats posed by rapid climate change to Korean Water Deer but also to other species of flora and fauna.

Conclusion

The almost total collapse of the Chinese Water Deer population in China should act as a warning regarding South Korea's current perception and treatment of Korean Water Deer. The situation is not helped by the IUNC's Red List most likely underestimating the impact of rapid climate change on the health and population of Korean Water Deer. As described above, current estimates of the Korean Water Deer population range from 100,000 to 1,000,000 in the wild. There is no accurate monitoring and recording of information on the size of the population or the health of the individuals within the population. Looking at the Water Deer population as a whole, across Northeast Asia, the Korean Water Deer population is the only population of any significance. The Chinese Water Deer has almost disappeared. The IUNC's Red List classifies the species as vulnerable, but as this paper shows, the classification does not reflect an accurate or up to date understanding of the Korean Water Deer Population. Exacerbating the problem, the destruction of the deer's natural habitat has led to the deer relying on agricultural land for sources of food. The economic interest of farmers has created the perception of Korean Water Deer as a pest, and overreporting of the deer's population is incentivized by associated such as culls with bounties.

Given the Korean Water Deer's vital role in dispersing seeds for broader ecological health, research that will establish an accurate population figure for the deer is urgently needed. Furthermore, the pathogens found in the deer

population suggest it faces significant threats that could dramatically reduce the population number over a short period of time. With the persistent fragmentation of its habitat by agricultural and urban development, the increasing likelihood of a pathogen spreading in the warmer climate poses a threat to the species that is not well-understood. Finally, the case study of Korean Water Deer adds to recent research which suggests the IUNC's Red List is failing to effectively incorporate rapid habitat and climate change caused by global warming. The increasing threats to Korean Water Deer due to rapid climate change, including the spread of invasive species, diseases, and habitat change require urgent research to avoid pushing the deer to the edge of extinction, as seen in China with the Chinese Korean Water.

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