Research in Marine Sciences
Volume 10-Issue 2-2025
Pages 761-768

Evidence of sika deer visiting coastal area on Tanegashima Island

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Received: 2025-04-15 *Accepted: 2025-05-22*

Abstract

The use of seawater by terrestrial mammals is often overlooked, despite its ecological and habitat management significance. This study investigated whether sika deer *Cervus nippon*, which are capable of drinking highly concentrated saltwater, utilize seawater in coastal areas. Multiple deer tracks were found on a beach, indicating that at least three individuals had come from the forest edge to the tide pool. Although, this study did not provide conclusive evidence that the deer drank seawater, it did show that they use the beach, suggesting that they may be drinking seawater from the tide pools. This is an important finding, indicating that terrestrial mammals beyond Bovidae may also drink seawater.

Keywords: Large herbivore; Mineral lick; Sodium; Terrestrial mammal; Ungulate.

1. Introduction

Numerous studies have demonstrated that marine environments serve as critical habitats for marine mammals (Schipper *et al.*, 2008; Pompa *et al.*, 2011). However, the potential benefits of these environments to terrestrial mammals have often been overlooked. Seawater is notably rich in sodium, a mineral essential for maintaining physiological functions in terrestrial mammals (Michell, 1989). In contrast, many terrestrial plants contain only trace amounts of

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sodium, making it difficult for herbivorous mammals to obtain sufficient quantities through their diet alone (Borer *et al*., 2019). These facts suggest that seawater could potentially serve as a supplementary sodium source for certain terrestrial mammals.

Historically, however, it has been assumed that, aside from the sea otter *Enhydra lutris* (Castellini and Mellish, 2023), no mammals that both marine and terrestrial environments are capable of drinking seawater. This assumption is based on the high salinity of seawater, which poses physiological challenges. Chronic ingestion of saltwater can have detrimental health effects in mammals. For instance, in sheep, prolonged intake of high-salinity water leads to reduced appetite and subsequent weight loss (Masters *et al.*, 2005). Similarly, in Boer goats *Capra aegagrus hircus*, regular consumption of 1.5% saline water results in a decline in body condition (Runa *et al.*, 2019).

In recent years, Alsaid *et al*. (2024) reported that the tahr *Arabitragus jayakari*, a terrestrial ungulate, is capable of drinking seawater. This discovery implies that coastal marine environments may play a significant role in the ecology of certain terrestrial mammals, and that maintaining connectivity between inland habitats (e.g., mountains and grasslands) and coastal areas could be vital for habitat use and conservation of such mammals.

Despite the ecological implications, there is still limited knowledge about terrestrial mammals that regularly consume seawater, with the tahr being the only confirmed example to date. There is currently no established method for identifying other such species. However, the sika deer *Cervus nippon* may represent another candidate. Previous observations have documented sika deer consuming highly concentrated saline solutions over extended periods. In our prior experiments, sika deer consistently drank a salt solution (prepared by dissolving 900 g of salt in two liters of water) that was placed in a forested area throughout the year (Suzuki *et al.*, 2024; Suzuki *et al.*, 2023). Notably, females, cannot obtain sufficient amounts of sodium from plants (Mori *et al.*, 2023), exhibited a marked preference for saltwater during the reproductive season (Suzuki *et al.*, 2024).

If sika deer are found to use seawater directly, this would support the hypothesis that certain terrestrial mammals utilize marine environments to meet nutritional needs, particularly sodium. Furthermore, providing artificial salt sources in inland habitats may be a practical method for identifying other terrestrial mammals with similar ecological behaviours. In this study, we aim to investigate whether sika deer use coastal areas, with the broader goal of enhancing our understanding of the interactions between terrestrial mammals and the marine environment.

2. Data and methods

Sika deer has a large population throughout Japan, except in certain regions (Suzuki *et al*., 2022a; Iijima *et al*., 2023), to the extent that it causes significant damage to forests in many

regions (Suzuki *et al.*, 2021; Ohashi *et al.*, 2014). In addition, this species is not only distributed in Japan but also across East Asia and Russia. It has also been introduced as an invasive species in several countries, including those in Europe (Bartoš, 2009), the United Kingdom (Swanson and Putman, 2009), New Zealand (Banwell, 2009) and North America (Feldhamer and Demarais, 2009).

The surveys were conducted in Tanegashima Island, located to the southwest of Japan from 25 to 27 February 2025. Tanegashima Island covers an area of 444.3 km², and due to the fact that the mountainous areas where deer inhabit reach up to the coast providing access to the beaches. In Japan, other ungulates such as the Japanese serow *Capriconis crispus* and wild boar *Sus scrofa* are present, but only deer inhabit this island.

Firstly, five types of sika deer signs—deer tracks, deer trails, fecal pellets, browsing marks, and bark stripping—were surveyed at 22 sites in the mountainous areas surrounding the coast to determine deer distribution in the Island. The signs were recorded based on the Deer Impact Score (DISco), that was outlined in our previous paper (Yamagawa *et al*., 2023). DISco is adjusted based on the quality and quantity of the traces, and it ranges from 0 to 13. A higher score indicates stronger deer influence and is associated with a higher population. For further details on DISco, please refer to our previous publication (Yamagawa *et al*., 2023). Furthermore, DISco map of Tanegashima Island was generated through spatial interpolation of the surveyed DISco values. The interpolation was executed using the Inverse Distance Weighting (IDW) tool in QGIS, encompassing an area within a 4 km radius from the DISco survey points. The distance coefficient for the IDW interpolation was maintained at the default value of 2.0.

Next, to determine whether sika deer visit the coast, tracks were surveyed at six beaches on the island (Figure1). At each site, an area approximately 150 meters in length was examined along the transitional zone between mountainous terrain and the beach. When tide pools were present, the surrounding areas were also inspected for tracks. While a single survey was generally conducted at each beach, additional surveys were performed on subsequent days in cases where tracks were initially detected, in order to assess any increase in track occurrence.

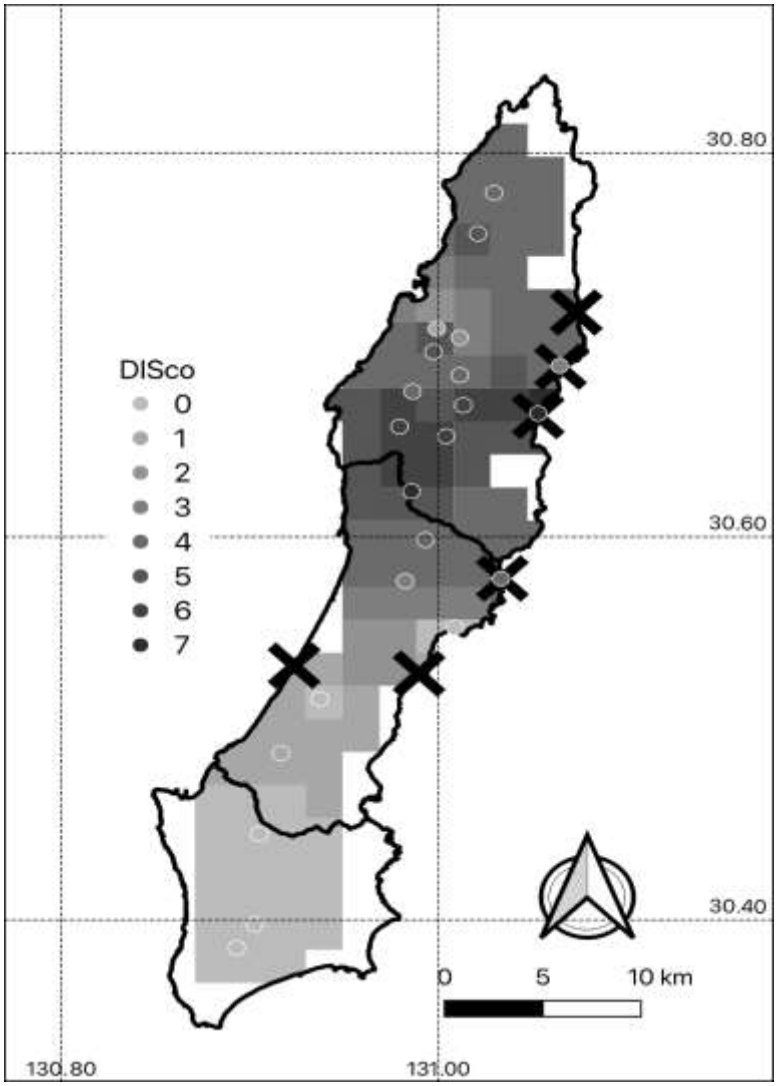

Figure 1. Deer Impact Score (DISco) map of Tanegashima Island, Japan. Circles (○), squares (□), and cross marks (×) indicate DISco survey sites, interpolated DISco, and coasts where deer tracks were surveyed, respectively.

3. Results

Of 22 sites, deer signs were recorded at 14 sites, and were primarily concentrated in the northern part of the island (Figure 1). Although signs were sparse in the southern region, their presence indicates that all of the beaches surveyed for deer tracks were located within the sika deer's distributional range.

Deer tracks were found on one (30.663 °N, 131.053 °E) of the six beaches on February 25, 2025. At that time, the tracks were only found around a tidal pool (Figure 2A). Since this beach is frequented by many surfers, it seemed that the tracks from the forest edge to the tidal pool

had disappeared. A follow-up survey conducted on February 26 revealed no change in track distribution. However, by February 27, new tracks had appeared, extending from the forest edge (Figure 2B) to the tidal pool, and the number of tracks around the tidal pool had also increased. At least three parallel track lines were identified (Figure 2C), suggesting that three individual deer had approached the tidal pools.

Figure 2. Pictures of deer tracks. A) The tracks around the tidal pool; B) The tracks extended from the forest edge; C) Three lines of the tracks heading for the tidal pool

4. Discussion

In this study, it is clarified that multiple deer have been visited coastal area. This survey did not determine whether the deer that came to the tidal pools drank seawater. While it would have been ideal to observe drinking behaviour using a motion-triggered camera, it was unable

to set up such a camera at the beach where the tracks were found. This was because the beach is frequented by many surfers, and there was a risk of capturing their privacy on the camera.

Although, definitive proof that the deer drank seawater was not obtained, there is a high likelihood that the deer drank seawater based on several reasons. The first reason is that the tracks were concentrated around the tidal pool. If there was no need to drink seawater, the tracks would not have been concentrated in that area. The second reason is that the tracks were in three lines, heading toward the tidal pool. This suggest that the deer that appeared on the beach were in a group. Since sika deer typically form groups with females and their young, this implies that the deer that left these tracks likely included females. Female deer are more prone to sodium deficiency compared to males (Mori *et al*., 2023). Therefore, in our previous experiments, it was primarily females that came to drink the saltwater in the forested area (Suzuki *et al*., 2023; Suzuki *et al*., 2024). The females likely came to drink seawater in order to obtain sodium.

In the future, it would be best to choose study sites with high population densities when investigating seawater consumption by sika deer. As mentioned earlier, it is likely that females are the ones drinking seawater. Moreover, females tend to be more abundant in the central areas of the distribution, where population density is higher, rather than at the forefront of their range (Suzuki *et al*., 2022b). In fact, the only beach where tracks were found in this survey is, according to DISco, one of the areas with the highest population density on the island (Figure1).

Conclusion

This study suggests that sika deer may visit coastal areas to ingest seawater. Owing to their large population size and broad geographic distribution, sika deer represent a highly accessible species for ecological investigation. Examining seawater ingestion behavior in this species may offer valuable insights into the largely understudied field of how terrestrial mammals interact with and utilize marine environments.

Acknowledgement

This study is funded by research grant #202205 of the Forestry and Forest Products Research Institute.

Conflicts of interest

The authors declare no conflicts of interest.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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