Crowdsourced Wildlife Observations Uncover Ecotourism Assets—Sites and Species

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Abstract

1. Ecotourism is key to both conserving ecosystems and vitalising rural economies. Sustaining such recreation requires strategies that effectively balance ecosystem conservation with tourism promotion. A crucial component of this balance involves understanding which landscapes and species attract visitors. However, identifying these “charismatic” sites and species has traditionally relied on costly and spatially limited questionnaire surveys.
2. In this study, we propose a simple and scalable method to infer nature-based recreation sites and species that appeal to visitors using crowdsourced biodiversity observation data. Focusing on Inabe City, a rural Japanese municipality with high recreational visitation, we analysed 12,764 observations from iNaturalist and Biome platforms, alongside 238,625 observations from other areas in Japan. We developed an index to estimate observer residency based on the proportion of observation days within the city, which was validated through questionnaire data.
3. Spatial analyses revealed clear differences between presumed residents and visitors: while both groups used recreational facilities, residents were more active in lowland forests, and visitors were attracted to wetlands and mountain habitats.
4. Visitors also disproportionately recorded dragonflies and understory endangered plants compared to observations made outside the city, suggesting that these species contribute strongly to the area’s recreational appeal. While the popularity of green infrastructure and rare or endemic species was expected, several unexpected parks and aquatic insects also emerged as key attractions. These insights highlight the importance of conserving highland forests and wetlands to support biodiversity and tourism.

5. This study shows how community-based biodiversity platforms can be used to understand human-nature interactions and inform regional planning. By integrating ecological and social perspectives, such approaches can support sustainable tourism and contribute to rural revitalisation.

Keywords: Cultural ecosystem services; Conservation culturomics; Community Science; Citizen Science; Green infrastructure; Nature's Contributions to People (NCP)

Introduction

Nature recreation is a fundamental cultural ecosystem service that enhances human well-being and contributes to community development (Millennium Ecosystem Assessment, 2005). People often travel across cities, regions, and countries to seek opportunities for nature experiences, bringing substantial economic benefits to areas with unique or high-conditioned ecosystems (Echeverri et al., 2022; Naidoo et al., 2016). Nature recreation can be motivated by landscapes and outdoor activities associated with specific places, as well as by the desire to observe particular species or ecosystems. Certain species—often called "charismatic species"—disproportionately attract public attention and tourism interest (Albert et al., 2018; Lorimer, 2007; Veríssimo et al., 2009). While ecotourism can offer economic opportunities, it also carries risks of environmental degradation, illegal collection of wildlife, and negative impacts on local communities through overtourism (Buckley, 2004; Buckley et al., 2016). Thus, regions aiming to revitalise their economies through nature-based tourism must balance tourism promotion with protecting their natural assets, including landscapes and species (Capocchi et al., 2019; Chun et al., 2020; Shannon et al., 2017).

Many nature-rich regions, however, often suffer from limited human and financial resources for conservation efforts due to smaller human populations. Understanding tourists' demand for specific locations and species is crucial for designing effective conservation measures and sustainable tourism plans (Arbieu et al., 2017; Winkler et al., 2021). Spatial management strategies may include restricting access to fragile areas (e.g., requiring guided tours), enhancing infrastructure at popular sites to mitigate overtourism impacts, and promoting alternative locations to disperse visitor pressure. For species conservation, measures such as installing protective barriers for vulnerable habitats near popular trails or constructing boardwalks across wetlands can both protect habitats and enhance visitor experiences.

Nevertheless, identifying tourists' specific interests, particularly in terms of species, remains challenging. Traditional surveys, such as questionnaires, are costly and resource-intensive, limiting their widespread application (Albert et al., 2018; Colléony et al., 2017). Consequently, the lack of demand-driven data hinders the development of strategies that simultaneously support conservation and sustainable tourism (Beall et al., 2021; Perkins & Grace, 2009).

Recently, crowdsourced data and social media have gained increasing attention as cost-effective means to collect large-scale information on human-nature interactions. Photograph-based platforms such as Flickr have been widely used to identify tourism hotspots by utilising geotagged photographs (Chun et al., 2020; Costadone & Balzan, 2023; Ghermandi & Sinclair, 2019). In terms of species preferences, indicators like Wikipedia page views or social media mentions have been used to gauge species popularity (Mittermeier et al., 2021). However, such metrics often reflect global interest and may not accurately capture the preferences of actual visitors to a specific region or the species that are truly present there. For effective integration of conservation and tourism planning, it is essential to understand which places and species are most attractive to the visitors who actually experience the local environment.

Biodiversity observation platforms such as iNaturalist and Biome offer valuable opportunities to understand these relationships (Silk et al., 2021; Stanford et al., 2024). These applications collect geotagged wildlife observation data, providing insights into users' interests in particular species or ecosystems. They also lower the barrier to participation by using artificial intelligence and community support for species identification (Atsumi et al., 2024; Silvertown, 2009) while incorporating gamification elements that make observations more enjoyable (Koide et al., 2023). As a result, these platforms attract a wide range of users, from dedicated conservationists to casual nature enthusiasts (Fujiki & Tatsuno, 2021; Tiago et al., 2024). Consequently, wildlife

observation data collected through these platforms can cost-effectively reveal the interests of a broad community of nature lovers in specific places and species.

In this study, we develop a simple and scalable approach to identify species that are particularly appealing to visitors in a given area, using crowdsourced wildlife observation data. Our method consists of two key steps. First, we estimate the residency status of each observer by comparing the number of days they recorded wildlife within the region to their activity outside the region—assuming that users who frequently record observations outside the region are likely non-residents, whereas those who record more often within the region may be residents (see Resident Index in Methods). Second, we identify species that are disproportionately recorded by visitors inside the area, compared to their records elsewhere. To do this, we calculate a “local charisma index” for each species, which reflects the difference between its relative frequency in visitors’ observations inside the area and the expected frequency based on overall observation effort. This index ranges from –1 to 1, with positive values indicating species that are locally prominent and potentially attractive for visitors (see Methods).

We applied this approach to 251,389 observations from iNaturalist and Biome platforms in Japan, to uncover ecotourism assets of Inabe City, Japan. Inabe is located on the outskirts of the Nagoya metropolitan area and is actively promoting ecotourism and green infrastructure initiatives. The city is known for its unique limestone-based mountain ecosystems as well as its green infrastructure and OECM (Other Effective Area-Based Conservation Measures) sites (Fig. 1), which attract significant visitor interest. After validating our method for estimating users' residency status against questionnaire data, we compared the spatial patterns of observations made by residents and visitors, examined the environmental factors associated with these patterns, and identified specific species that disproportionately attract visitor attention. These insights enhance our understanding of human–nature interactions and offer practical guidance for regional conservation efforts and the planning of nature-based tourism initiatives.

Methods

Study area

This study was conducted in Inabe City, located in the northern part of Mie Prefecture, Japan (136.52°E, 35.16°N, Figure 1). The city spans 219.83 km², extending from the Suzuka Mountains in the west to the Yoro Mountains in the east. The central region comprises lowlands characterised by a mosaic of residential and agricultural land use. Mt. Fujiwaradake (1,144 m; Figure 1), a prominent peak in the Suzuka range, features limestone-based vegetation and remnant natural grasslands—an increasingly rare habitat type in Japan (Koyanagi and Furukawa 2013). While the Suzuka Mountains are a popular destination for hikers and campers, the Yoro Mountains are primarily dominated by forestry. As of the 2020 census, Inabe City had a population of 44,973. Benefiting from its proximity to the metropolitan area of Nagoya, the city is widely recognised for its outdoor recreational opportunities, such as camping, attracting approximately 700,000 visitors annually.

Inabe City has actively integrated green infrastructure into its tourism development. For example, Nigiwai-no-Mori, located near the city hall, was transformed from an abandoned forest—previously at risk of damage from wildlife and landslides—into a green-rich commercial complex that now attracts both visitors and residents. Yane-no-nai-gakko is a green infrastructure that restored natural wetlands to enhance biodiversity while mitigating flood risks (Green et al., 2021; Nakamura, 2022). Furusato-no-Mori conservation site—which is affiliated with Mt. Fujiwaradake Natural Science Museum—preserves a variety of plants native to Inabe and is designated as a Nationally Certified Sustainably Managed Natural Site, a classification

closely aligned with the concept of OECM. Through repeated workshops, various municipal departments, research institutions and companies have built strong collaborations, creating an environment well-suited for developing data-driven ecotourism strategies.

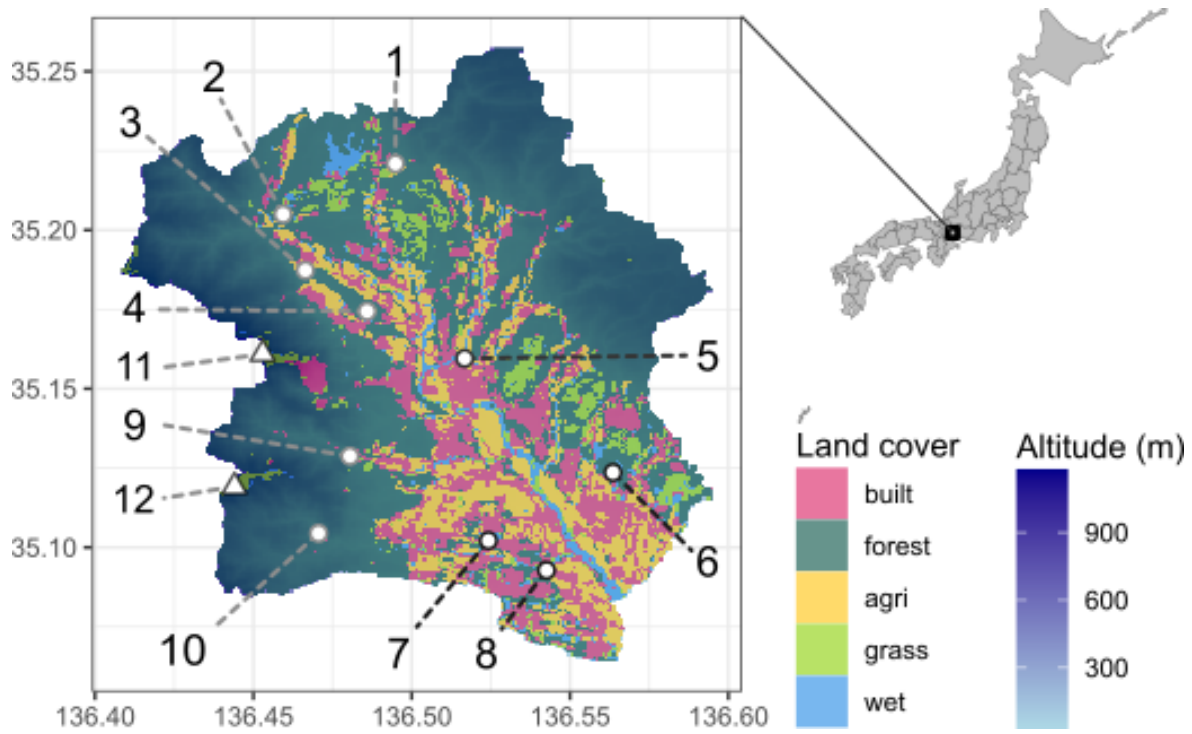

Figure 1. The map illustrates the land cover and topography of Inabe City, located in central Japan, and highlights key nature recreation sites. Numbered locations correspond to major parks, including (1) Inabe Agricultural Park, (2) Tatsuta Park, (3) Yane-no-nai-Gakko (a green infrastructure project for flood mitigation), (4) Furusato-no-Mori (an OECM site), (5) Nigiwai-no-Mori (a green-rich commercial complex), (6) Inabe Park, (7) Ryogaike Park, and (8) Nature Aquarium. It also shows campgrounds such as (9) Aogawakyo Camping Park and (10) Nordisk Hygge Circles UGAKEI, as well as prominent peaks, (11) Mt. Fujiwaradake and (12) Mt. Ryugatake.

Crowdsourced wildlife observation data

Observation data was collected from Biome and iNaturalist on 9 May 2025. To ensure geocoordinate accuracy, iNaturalist data was filtered to include only records with coordinate uncertainty below 200m. Biome data was restricted to records with geotagged photos (i.e. geocoordinates were obtained through the devices' GPS). For Biome data, all records from users who had made records in Inabe City were also analysed to compare their recording characteristics within and beyond the city.

To analyse the spatial patterns of wildlife observations, we calculated the number of unique users for Biome and iNaturalist within each grid cell. The grid cell size was set to 300 meters, reflecting the typical size of nature recreation facilities, such as parks and camping sites, which generally range from 200 to 500 meters in Inabe City. While it is possible that some individuals used both Biome and iNaturalist, potentially leading to a double count of unique users, this issue is likely negligible given that Biome users far outnumber iNaturalist users (see Results). All analyses were conducted on R version 4.4.1 (R Core Team, 2024).

Resident index

To differentiate between residents and visitors among wildlife observers, we constructed a "resident index," defined as the ratio of the number of days an individual recorded observations within Inabe City to their total number of observation days across all locations. Higher values indicate that the observer predominantly records in Inabe, suggesting local residency, while lower values imply occasional visits. Due to limitations in data availability, the resident index was calculated only for users of the Biome platform, encompassing 250,263 records across Japan. To ensure reliable classification, analyses were restricted to 387 users who had recorded observations on more than nine separate days.

To validate the resident index, questionnaire data from Biome app users were employed. Between 18 May and 30 November 2024, the app hosted an online campaign titled *"Inabe Nature Positive Inacchu Quest"* to promote wildlife observations in Inabe City. Biome users who posted observations from Inabe City were invited to join the quest, and the quest can be completed by recording ≥3 species. Upon completion, users were asked to voluntarily respond to an online survey indicating whether they were residents of Inabe City. The survey maintained user anonymity and did not collect personal information such as names or detailed addresses. This research was carried out with the approval of the research ethics committee of Kyoto Sangyo University.

Among the 78 questionnaire respondents, 44 had more than 9 days of observation. Logistic regression analysis suggested a positive association between the resident index (Figure 2: β=10.60±6.70SE, P=0.114). To distinguish between residents and visitors, we calculated the Youden Index using the `coords` function from the *pROC* package (Robin et al., 2011), yielding a threshold value of 0.66. For a more conservative classification, observers with a resident index greater than 0.7 were classified as residents, while those with a resident index below 0.2 were classified as visitors. This approach provided a balanced accuracy of 0.93 in predicting resident status. While the classification accurately identified visitors (all visitors were correctly classified), it showed some false positives for residents, with 4 out of 24 predicted residents actually being visitors (Figure 2).

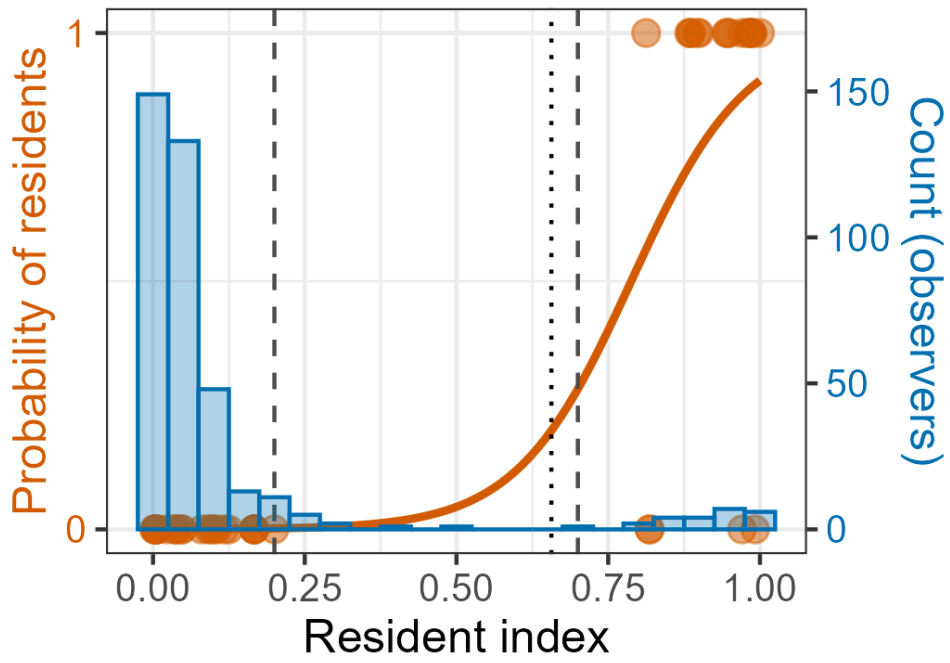

Figure 2. The distribution of the resident index is represented as a blue histogram, with actual residency status (0: visitor; 1: resident) indicated by orange dots. A logistic regression model, fitted to predict actual residency status based on the resident index, is displayed as an orange line. The dotted vertical line indicates the optimal threshold to classify residency status. The dashed vertical lines denote the thresholds used in this study: values above 0.7 are classified as residents, while values below 0.2 are classified as visitors.

Spatial Patterns of Resident and Visitor Observations

We analysed the environmental factors (elevation and land cover, see Figure 1) associated with the observation patterns of residents and visitors. The highest elevation for each grid cell was extracted from the ALOS World 3D dataset provided by JAXA (Takaku et al., 2021), and standardised before statistical analyses. Land cover data in 2022 was obtained from the High-Resolution Land-Use and Land-Cover Map of Japan Version 23.12, also provided by JAXA (Hirayama et al., 2022). Land cover classifications were aggregated into five categories: (1)

built, inherited from original classifications; (2) grass, inherited from original classifications; (3) forest, merging deciduous, evergreen, broadleaf and needleleaf forests, and bamboo; (4) agri, merging crop and rice categories; (5) wet, merging freshwater and wetland categories.

We employed zero-inflated models to separately examine the number of resident and visitor observers in each grid cell, using `zeroinfl` function from `pscl package` (Zeileis et al., 2008). To eliminate the influence of inaccessible locations, we focused the analysis on 513 grid cells where at least one observer had recorded wildlife.

Taxonomic patterns of observations

To quantify the disproportionality of observations for a given species in Inabe City, we calculated a "Local Charisma Index." The Index for species *s* is calculated as:

$$Local\ Charisma\ Index_s = \frac{Obs_{s,\,inside}}{Obs_{s,Total}} - \frac{Obs_{inside}}{Obs_{Total}}$$

where $Obs_{s,\,inside}$ is the number of observations of species *s* inside the area (in this study, Inabe City), $Obs_{s,Total}$ is the total number of observations of species *s* across all regions, Obs_{inside} is the total number of observations for all species inside the area, and Obs_{Total} is the total number of observations for all species across all regions. The first term indicates whether the species is predominantly observed in this region. The second term represents the overall proportion of species observations conducted in Inabe City relative to all areas. By subtracting the second term from the first, the index captures the degree to which species *s* is disproportionately observed in Inabe City, beyond what would be expected given the general observation effort. A positive value suggests that species *s* is particularly prominent in Inabe City, potentially reflecting its appeal as a target of recreational interest or its endemicity.

Results

Biome and iNaturalist contained 11,638 and 1,126 wildlife observation records from 623 and 22 users, respectively, within Inabe City. Observation locations were broadly distributed across the city, except in the forested eastern region (Figure 3A). Outdoor recreation facilities, such as "Nigiwai-no-mori," "Furusato-no-mori," "Yane-no-nai-gakko," and "Aogawakyo camping park," saw significant wildlife observation activity (see also Figure 1 for recreational facilities). The highlands of the Suzuka mountains, including the trail path to Mt. Fujiwaradake, also attracted many observers.

Based on the resident index, 24 observers were classified as residents and 348 as visitors. Spatial patterns of observations by residents and visitors were negatively correlated (number of observers in each grid cell: Spearman's ρ=-0.15, P<0.001), suggesting distinct preferences for observation locations between the two groups. Residents predominantly observed wildlife in the southern parts of the city, which are characterised by residential areas, croplands and industrial zones. They also frequented recreation facilities such as "Furusato-no-mori" and "Yane-no-Nai-Gakko" but not in mountain areas (Fig. 3B). In contrast, visitors avoided residential areas and focused their observations on recreation facilities such as "Nigiwai-no-mori," "Furusato-no-mori", camping sites, and Suzuka mountains (Fig. 3C).

Zero-inflated models revealed distinct associations between environmental conditions and wildlife observations by residents and visitors. More residents observed wildlife in lowlands (count model: elevation, $\beta = -0.76 \pm 0.17$, $P < 0.001$) and forested areas ($\beta = 1.45 \pm 0.57$, $P < 0.05$). Resident observers also tended to increase in built-up areas ($\beta = 1.12 \pm 0.60$, $P = 0.06$) and wetlands ($\beta = 1.20 \pm 0.74$, $P = 0.10$), though these were marginally significant. In the

zero-inflation component, residents were likely to make observations in built-up areas (binomial model: $\beta = 24.09 \pm 11.87$, $P < 0.05$). In contrast, more visitors made observations in highlands (count model: elevation, $\beta = 0.12 \pm 0.04$, $P < 0.01$). Among the landcover variables, wetlands had strongest effect in increasing visitors ($\beta = 2.69 \pm 0.66$, $P < 0.001$), then grasslands ($\beta = 1.97 \pm 0.70$, $P < 0.01$), forests ($\beta = 1.64 \pm 0.54$, $P < 0.01$) and built-up areas ($\beta = 1.50 \pm 0.56$, $P < 0.01$). However, visitors were less likely to make observations in forests (binomial model: $\beta = -3.08 \pm 1.52$, $P < 0.05$), agricultural areas ($\beta = -3.02 \pm 1.47$, $P < 0.05$) and highlands ($\beta = -1.01 \pm 0.38$, $P < 0.01$).

By analysing visitors' observations within Inabe City and comparing them to observations across all areas, we found that visitors disproportionately recorded aquatic insects and endangered or endemic plants during their visits to the city. To mitigate the influence of uncertainties inherent in citizen observations and to reduce the impact of specific individuals focusing on certain species, we ranked species observed by more than three individuals using the Local Charisma Index (Table 1). The top 20 species—all with positive index values, indicating they were observed more frequently in Inabe than expected based on their overall observation frequency—were predominantly plants and insects. Among these species, five were aquatic insects, including dragonflies (order Odonata, three species), casemaker caddisfly (*Perissoneura paradoxa*) and locally threatened water strider (*Aquarius elongatus*, Near Threatened on the Mie prefectural red list). Notably, the third and fourth-ranked species were endangered plants (*Amana erythronioides* and *Fritillaria japonica*: listed as Vulnerable on Japan's national red list), naturally found in the Suzuka Mountains and are also ex-situ conserved in Furusato-no-mori. The top 20 species also included mountain-dwelling plants (e.g. *Coptis japonica var. japonica* and *Veratrum oxysepalum var. oxysepalum*), as well as plants endemic to Central Japan (*Cirsium suzukaense*).

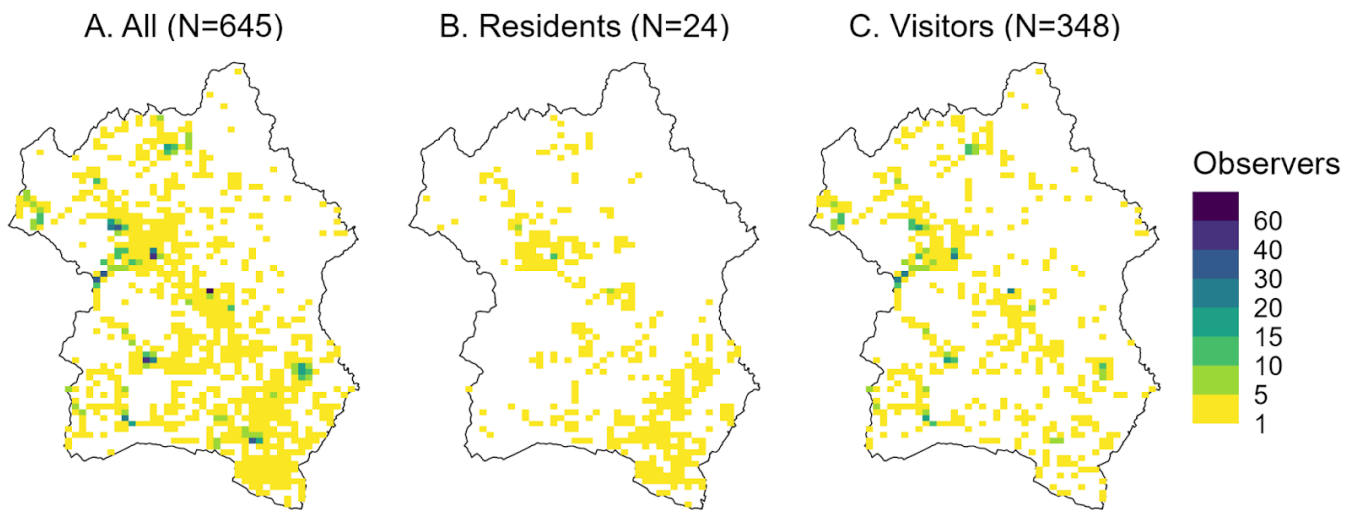

Figure 3. Spatial distribution of observers in Inabe City, displayed on a 300m resolution grid. Note that data for all observers were sourced from both iNaturalist and Biome, whereas residents and visitors were exclusively classified from Biome users based on their estimated residency status (resident index).

Group	Order	Scientific name	Japanese name	Records (*N*)	Obser-vers (*N*)	Local charisma index	National red list	Prefec-tural red list
insect	Odonata	*Trigomphus citimus subsp. tabei*	Tanabe-sanae	7	2	0.62	NT	VU
insect	Odonata	*Sympetrum speciosum subsp. speciosum*	Neki-tonbo	25	3	0.61		

insect	Odonata	*Aeshna crenata*	Oo-ruriboshi-yanma	31	2	0.59		
plant	Liliales	*Fritillaria japonica*	Mino-kobaimo	11	9	0.48	VU	CR+EN
insect	Odonata	*Boyeria maclachlani*	Koshiboso-yanma	13	2	0.47		
plant	Liliales	*Amana erythronioides*	Hiroha-no-amana	7	7	0.45	VU	CR+EN
insect	Odonata	*Davidius nanus*	Davido-sanae	19	4	0.44		
insect	Trichoptera	*Perissoneura paradoxa*	Yotsume-tobikera	5	3	0.37		
insect	Odonata	*Sympetrum risi subsp. risi*	Risu-akane	14	2	0.34		
plant	Asterales	*Cirsium suzukaense*	Suzuka-azami	5	4	0.34		
plant	Lamiales	*Veronica polita var. lilacina*	Inu-no-fuguri	5	1	0.34	VU	VU
plant	Liliales	*Veratrum oxysepalum var. oxysepalum*	Baikei-sou	13	11	0.34		
insect	Lepido-ptera	*Thermozephyrus ataxus*	Kirishima-midori-	12	8	0.32		NT

			shijimi					
insect	Odonata	*Somatochlora uchidai*	Takane-tonbo	9	2	0.31		
plant	Buxales	*Buxus microphylla var. japonica*	Tsuge	7	3	0.3		VU
plant	Malvales	*Daphne pseudomezereum*	Oni-shibari	6	4	0.3		
insect	Odonata	*Sympetrum eroticum subsp. eroticum*	Mayutate-akane	53	9	0.28		
plant	Chloran-thales	*Chloranthus quadrifolius*	Hitori-shizuka	14	14	0.26		
plant	Piperales	*Asarum rigescens var. brachypodion*	Suzuka-kannaoi	5	3	0.25		

Table 1. Top 20 species ranked by the Local Charisma Index, excluding those recorded by fewer than three individuals in Inabe City. Species group classifications follow Atsumi et al. (2024). “Records” and “Observers” refer to the number of records and the number of individuals who recorded the species within the city, respectively. “National red list” and “prefectural red list” indicate the species’ conservation status on the Japan national and Mie Prefecture Red Lists. For the complete species list, see Table S1.

Discussion

Using observation data from inside and outside the region, the resident index indicated that most observers in Inabe City were visitors rather than residents. While the prediction accuracy for residents was lower—requiring caution due to false positives where some predicted residents were actually visitors—the accuracy for visitor predictions was notably high. Combined with the larger sample size of visitors, analyses of visitor data provide more reliable insights. Residents and visitors showed different spatial observation patterns: residents primarily observed species in forests in lowlands, while visitors concentrated on freshwater areas and high mountain regions. Notably, visitors disproportionately observed aquatic insects and mountain flora—including rare or endemic species—compared to overall observations across all areas, suggesting those species' role as key attractions for tourists (Table 1).

Newly Developed Indices

The correspondence between the resident index and actual residency is encouraging, as it enables the identification of presumed residents and visitors without relying on survey data, making the approach highly scalable. This method holds potential for application across various spatial scales—from villages and prefectures to states and even countries. However, its success in this study may partly reflect the characteristics of Inabe City, which attracts many nature-oriented tourists who visit only occasionally. In urban contexts, the index might misclassify individuals commuting for work or school as *residents*, rather than true inhabitants. Nevertheless, even in such cases, the resident index is likely to remain effective in

distinguishing individuals who regularly engage with a given ecosystem from those whose interactions are limited to occasional visits.

Since we aimed to design the Local Charisma Index to be simple and intuitive for a wide range of local stakeholders, it is based solely on the number of records, not the number of observers. This design allows the index to better capture how readily a species can be observed within the region. However, it also introduces a limitation: the index may become inflated if a small number of observers record the same species repeatedly within the target area. Conversely, if the index were based only on the number of observers, it would fail to reflect differences between species, as many species—while they can be rare outside the region—can still be readily observed once present. Therefore, while the current index provides a useful and interpretable metric, it is important to also consider the number of observers, as shown in Table 1, for a more balanced understanding. We have already used Table S1 as a discussion tool with local stakeholders, and thanks to the simplicity of the index, both its purpose and limitations were well understood during these dialogues.

Insights for Ecotourism

Species observations were much fewer in the Yoro Mountains than in the Suzuka Mountains (Figure 3), likely due to the limited hiking infrastructure in this forestry-dominated area. Species distribution models (Biome Inc., unpublished data) indicate habitat suitability for popular plant species is lower in the Yoro Mountains, reinforcing its primary role as a forestry zone rather than a tourism destination. OECM site (Furusato-no-Mori) and green infrastructure mitigating flood risk (Yane-no-nai-gakko) received observations from both residents and visitors, highlighting their potential to foster interactions between these groups. Residents recorded observations in the city's southern areas with more intense land use, showing that nature recreation can persist

even within industrial zones. Lastly, Tatsuta Park emerged as an unexpected nature observation hotspot for visitors, suggesting the need for management plans to enhance tourism.

Visitors show a notable interest in aquatic insects and forest-associated plants. While it remains unclear whether these species are the primary motivation for visiting Inabe or merely incidental observations during recreational activities such as hiking, occasional interviews with visitors suggest that at least some come specifically to see certain plants or dragonflies. This indicates that, at least in part, particular species attract visitors. Species distribution models for these organisms may uncover “hidden gem sites” for tourism development (Kass et al., 2023). However, leveraging these natural assets must be accompanied by appropriate conservation strategies to mitigate risks such as overtourism and habitat degradation (Capocchi et al., 2019; Chun et al., 2020; Shannon et al., 2017). Even if specific species are not the primary draw for visitors, their association with tourism activities highlights key ecological features that contribute to Inabe’s appeal. This underscores the importance of wetland conservation and forest management to sustain and enhance the city’s potential as an ecotourism destination. In warm regions of Japan like Inabe, wetlands are especially vulnerable to rapid ecological succession, requiring active human intervention to maintain ecosystems (Tomita, 2014). Several wetlands in Inabe remain largely inaccessible and unmanaged: improving both their management and accessibility could further enhance their value as ecotourism resources. Collaborations with destination management organisations (e.g., Green Creative Inabe) and local environmental agencies (e.g. Mt. Fujiwaradake Natural Science Museum) could play a vital role in developing new opportunities for ecotourism and regenerative tourism in the region (Wondirad et al., 2020).

Possible Roles of Digital Platforms

Digital platforms such as Biome and iNaturalist contribute not only to biodiversity data collection but also present new opportunities for regional revitalisation. In Inabe, most biodiversity

observations were submitted by visitors, with relatively few contributions from residents. This trend reflects the city's demographic context—despite having a population of around 45,000, Inabe attracts approximately 700,000 visitors annually. By making biodiversity data more visible and accessible through digital platforms, the city can further enhance its attractiveness as an ecotourism destination. Improved access to such information may foster people's stronger emotional connections with nature, encouraging financial support, repeat visits and deeper involvement (Prévot et al., 2018; Tien et al., 2024). Meantime, active participation by residents is essential—not only to deepen the understanding of local ecosystems but also to strengthen resilient community networks and civic pride (Fariss et al., 2023; Hamatani, 2019). Incorporating biodiversity monitoring into school education could also help prevent the "extinction of experience" (Soga et al., 2020; Soga & Gaston, 2020), fostering early and lasting connections to nature in younger generations.

Conclusions

By treating biodiversity records accumulated on digital platforms as data reflecting human–nature interactions, this study developed a cost-effective and scalable approach to identify species attractive for visitors and nature observation hotspots. Leveraging crowdsourced biodiversity observations, we inferred which locations and species in Inabe City attract attention from both residents and visitors. While the popularity of green infrastructure facilities and rare or endemic plant species was anticipated, the unexpectedly high interest in certain parks and aquatic insects highlights overlooked assets with ecotourism potential. These findings offer valuable insights to support collaboration among stakeholders, enabling more

strategic and sustainable planning of ecotourism initiatives. In turn, such efforts can contribute to regional revitalisation by linking biodiversity conservation with local economic development.

Authors' Contributions

Keisuke Atsumi conceived the ideas, designed the methodology, conducted data analyses, and led the writing of the manuscript. Tatsuki Tsujino conducted the interviews. Mao Nakaseko, Shougo Ogasawara, and Takaaki Nishida provided essential input and logistical support throughout the project. Takaaki Nishida also secured funding for the study. All authors contributed to the writing and approved the final version of the manuscript.

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Conflict of Interest

Keisuke Atsumi and Hiroki Taga are employed by BIome Inc.; Shougo Ogasawara is employed by Pacific Consultants. The other authors have no conflicts of interest to disclose. None of the authors receive direct financial benefit from this study.

Data availability statement

All code used in this study will be made publicly available on GitHub. A derived dataset, with detailed location data masked, will be shared via the Open Science Framework (https://osf.io/dashboard). To protect observer privacy and ensure wildlife conservation, we will not publish raw geolocated records from the observation platforms. This is particularly important as some Biome posts include photographs taken on private property, and revealing precise locations of threatened species may increase the risk of illegal collection.

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