Analysis of the Purpose of Visiting Wetlands Using Pictures Posted on Social Media

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ABSTRACT

In this study, 4,136 pictures posted on a social media platform were analyzed to discover wetlands that are worth visiting to experience our cultural values. Pictures from 300 of the 2,499 listed wetlands have been posted in South Korea. Proximity of a wetland was the most important criterion, regardless of the type of wetlands that were visited. People visited wetlands at the time and season when they were good for recreational activities. Most of the subjects in the pictures were the visitors and natural scenery of a wetland. There was no correlation observed between the wetland conditions and the number of pictures taken by the visitors. Sightseeing and leisure activities are a significant part of various ecosystem services offered by wetlands, but most of the visitors seem to be unaware that the place they have visited is a wetland. Therefore, wetland awareness programs are needed, even for wetlands close to the residential areas that many people have already visited in this study.

Keywords: Image contents, Public awareness, Wetland awareness program, Wetland visitation

Introduction

Wetlands are an important component of landscape with high productivity and biodiversity, which is due to their heterogeneous terrestrial matrix. The main reason behind the loss of wetlands is human activity, but recently, people have started to become aware of the importance of wetlands (Wang et al., 2008). Particularly, the recreational activities in wetlands provide an opportunity for people to experience the importance and value of wetlands. Although some famous wetlands are known only as tourist destinations, more people visiting wetlands is part of an effort to perceive the value of wetlands (Pu-

eyo-Ros et al., 2019). For this reason, inclination towards the cultural services has recently enhanced among various ecosystem services of wetlands (Xu et al., 2020).

Cultural services include non-material benefits, such as recreation, esthetic enjoyment, physical and mental health benefits, and spiritual experiences. Cultural services are co-produced and co-created outcomes of people's interactions with the ecosystems (Chan et al., 2011). Therefore, emphasizing on cultural services in wetlands may assist in obtaining voluntary consent from people for wetland conservation. Encouraging as many people to visit wetlands as possible and experience the cultural values of wetlands in person is an important aspect for understanding the importance of wetlands, but it is practically impossible (Daniel et al., 2012). Nevertheless, it is still necessary to quantitatively analyze the cultural value of wetlands and provide appropriate information to the stakeholders (Small et al., 2017).

An evident method to analyze the cultural value of wetlands is through examining the wetland images. This

analysis is particularly useful for determining the esthetic and recreational values among the cultural values of wetlands (Do & Kim, 2020; Lee *et al*., 2020). The preference of visitors was assessed through surveying the pictures of certain locations and landscapes within wetlands (Dobbie, 2013; Zhu *et al*., 2021). Recently, the esthetic and recreational values of wetlands have been analyzed using pictures shared on several social media platforms (Ghermandi, 2018; Oteros-Rozas *et al*., 2018). The metadata of pictures shared on social media, such as a geotag describing the latitude and longitude, and timestamps describing the date and time, are generally considered a suitable proxy for estimating the visitation intensity of different locations and times (Kaiser *et al*., 2021; Sinclair *et al*., 2020). For this analysis, we assumed that the site where many pictures were taken is an attractive location for the visitors, and the season or time when many pictures are taken is suitable for the visitors to conduct recreational activities (Barros *et al*., 2019; Yoshimura & Hiura, 2017). Furthermore, the image content, that is, the characteristics visible in the pictures, is essential for analyzing the specific activities and attractive landscape components and facilities within the analyzed wetlands (Do & Kim, 2020). Technically, it is possible to automatically analyze the picture contents of large-scale images using the artificial intelligence tools (Lee *et al*., 2019).

In this study, pictures posted on various social media platforms were analyzed to discover wetlands that can be visited to experience our cultural values, especially the esthetic and recreational values of wetlands in South Korea. We analyzed the metadata such as geotags, timestamps, and picture contents of the large-scale pictures taken in all wetlands surveyed in South Korea. In this study, we aimed to (1) select wetlands preferred by people, and (2) analyses the characteristics of wetlands that are frequently visited by many people.

Materials and Methods

Wetland distribution analysis

We used the national inventory of inland wetlands prepared by the Ministry of Environment of Korea, the National Institute of Environmental Research, and the National Institute of Ecology. The wetland inventory covers 2,499 inland wetlands, including brackish wetlands at the national boundary of South Korea. We extracted the data on wetland types, polygon data of wetland delineation, geographical coordinates, and wetland conditions (e.g., ranking of each wetland) from the wetland database for our analysis. Rank "I" represents the wetlands in a well-conserved condition, which exhibited the highest score for more than half of the evaluation criteria. Rank "II" includes wetlands, which fulfilled the requirement for an "I" ranking wetland, but exhibited temporal degrada-

tion. Rank "III" includes wetlands that require moderate enhancement for recovery to a healthy condition. Rank "IV" includes severely modified wetlands, and thus, active restoration practices are required for recovery to their previous status. Detailed methods used for the assessment of wetland conditions have been described previously by Im *et al*. (2020). Wetland types were divided as follows: human-made, lake mountain, and riverine wetlands, based on their topography (Table 1). The wetland datasets are available at the EcoBank portal of the National Institute of Ecology of South Korea (http://www.nie-ecobank.kr/opn/file/list.do?svcId=103). We estimated the wetland size and central point using the wetland delineation polygon data. The boundary of wetlands was set based on the distribution of water and vegetation, which is considerably different from the range of visitors' activities. Therefore, a 100 m buffer of wetland boundaries was defined as the range to allow visitors for taking pictures and engaging in recreational activities. Wetland distribution analysis and visualization were performed using the QGIS 3.10.8 program.

Picture retrieval and image content analysis

Flickr images were downloaded using the Flickr geotagged photo metadata downloader plugin compatible for QGIS program. Pictures taken from 2007-2019 were selected and geographically cropped to the boundary of South Korea. Among the selected pictures, duplicates and those that could not be analyzed due to resolution issues (lower than 80 pixels) were excluded from the analysis.

Table 1. Wetland types of South Korea

Wetland sub-types	Wetland types
Estuarine/deltas/salt marsh	Riverine
Rivers/streams/creeks	
Floodplain	
Lagoon	Lake
Reclaimed lake	
Freshwater lake	
Oxbow/dune slack	
Bog	Mountain
Fen	
Marsh	
Shrub dominant swamp /abandoned paddy field in high elevation area	
Artificial dam/reservoir	Human-made
Rice paddy	
Irrigation channel/fishing pond	
Retention pond/urban parks	

We used Amazon Rekognition to identify the subjects and scenes in the pictures. Amazon Rekognition is a deep learning image analysis service that can help detect the subjects, people, text, scenes, and activities. The subjects and scenes in the pictures were assigned a confidence score from 0 to 100, which indicated the probability that a given prediction is correct. We selected the subjects and scenes with the highest confidence scores. The analysis was performed using the Facepaws package in the R software.

Statistical analysis

The correlation between the wetland size and number of pictures taken in each wetland was confirmed using the Pearson correlation analysis. Differences in the number of pictures depending on the wetland type and grade conditions were assessed using one-way ANOVA with Tukey's post-hoc tests. Statistical tests were performed using the GraphPad Prism software (version 8.00; GraphPad Software, San Diego, CA, USA).

Results

Preference of visitation in wetlands

Of the 2,499 wetlands included in the national wetland inventory of South Korea, 4,136 pictures were posted from 300 wetlands (12% of the total number of wetlands, Fig. 1A). An average of 13.7 pictures per wetland was posted (Fig. 1B).

A monthly analysis of the pictures taken at wetlands revealed that April and May are the most popular months to visit wetlands. People frequently visited wetlands in October and November (Fig. 2A). Also, people visited wetlands early in the morning, but the time when the pictures were taken was between 1 p.m. to 5 p.m. (Fig. 2B). Many pictures were uploaded at 24 p.m., which seems to be different from the actual time when the picture was taken. The pictures were mostly taken during the day, but the metadata recorded them as taken at midnight.

Preferred wetland size, type, and condition and their contents

A total of 308 subjects were identified in the pictures, with a confidence score of over 80%. Regardless of the wetland types and conditions, the visitors captured the natural scenery, people, water, and wetland plants (Fig. 3) in their pictures. There were no differences in the subjects depending on the wetland types and conditions.

Wetland with the highest number of pictures (452) is Ilsan Lake Park Wetland located in the capital area of South Korea. Wetlands where many pictures were taken include the Nakdong River Estuary (247 photos), Jangahm Wetland (Sangju, 189 photos), Cheongcho Lake (164 photos), and Yeouido Saetgang Eco Park Wetland (158 photos, Fig. 4A). The wetland size was found to be significantly correlated with the number of pictures taken at wetlands (Fig. 4B). More number of pictures were taken at large-sized wetlands than at small-sized wetlands (r=0.4, $P<0.05$). Among wetland types, the highest number of pictures were taken at riverine wetlands, but the average number of pictures per wetland type was not significantly different among different types of wetlands.
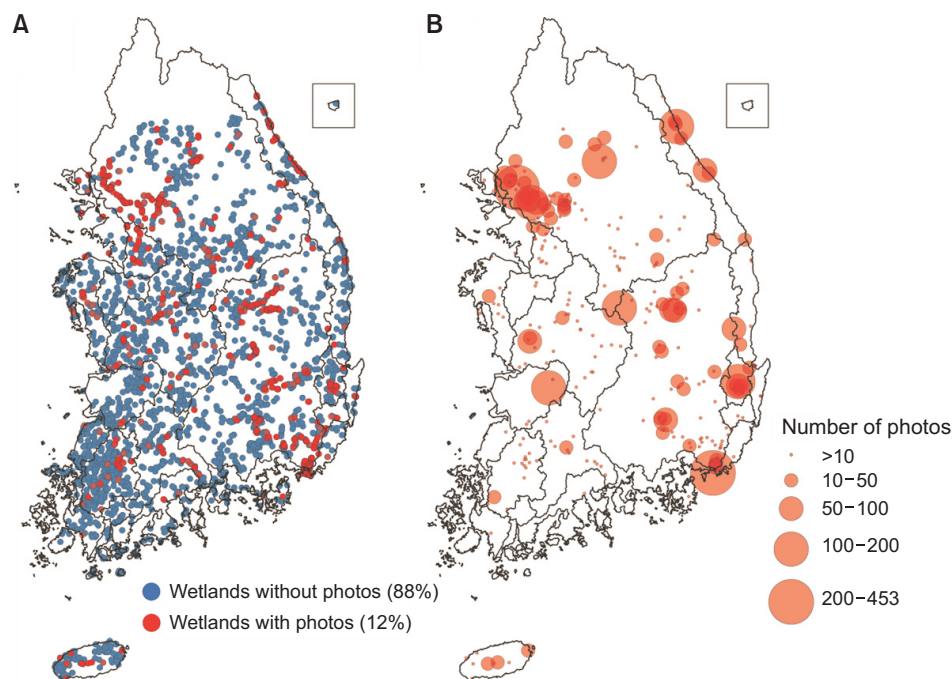

Fig. 1. The distribution of wetlands (A) and the number of photos taken in wetlands (B).
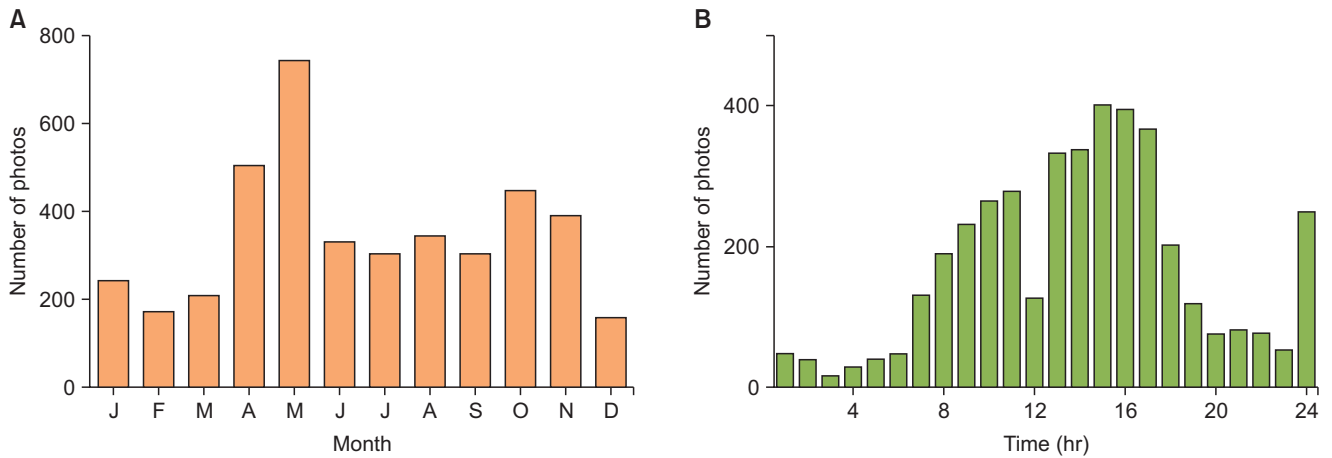
Fig. 2. Preferred month (A) and time (B) for taking photos in wetlands.
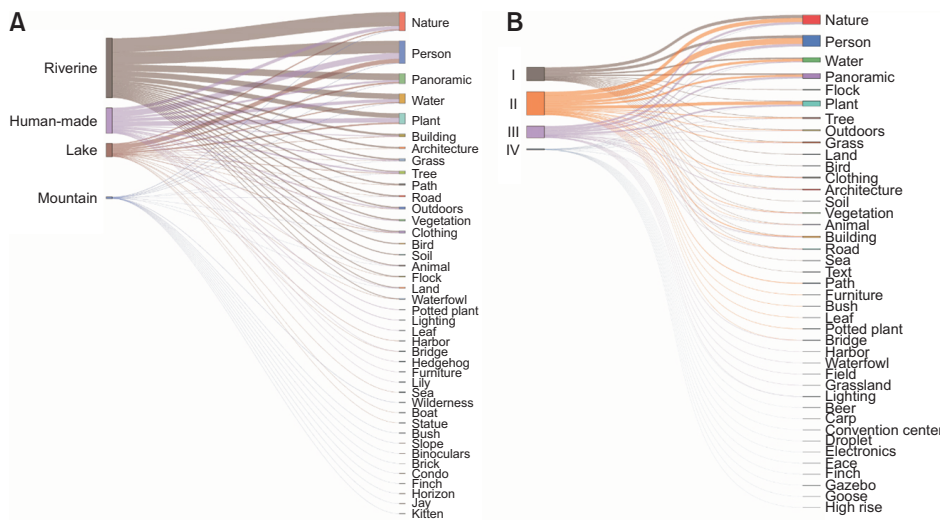

Fig. 3. Subjects of photos according to wetland types (A) and conditions (B). I–IV, wetland condition rankings.

Many pictures were taken at the Grade II wetlands, but there was no difference in the number of pictures based on the wetland conditions (Fig. 4C, D).

Discussion

The metadata of the pictures posted on the social media revealed the public preference for visiting the wetlands. Pictures were taken in 12% of the wetlands, but the wetlands where the pictures were taken were distributed evenly across the country. Considering that most wetlands in the wetland inventory are very small in size and located in areas that are difficult to find and non-accessible, people have still managed to visit a considerable number of wetlands. Many people visited wetlands close to their residential areas, although they may also be interested in visiting the wetlands with excellent scenery and high biodiversity, such as wetland reserves (Do et al.,

2015a). Proximity to the park and wetland was found to be the most important aspect, regardless of the type of parkland they were visiting (Wilkins et al., 2019). Residents of the local area are likely to revisit if they have visited the wetlands in the past (Park et al., 2017). Particularly, many people have visited artificial wetlands made from parks. Visitors could not recognize that the park they visited was a type of wetland, but they likely enjoyed a space mixed with water and land. Wetland parks have also been recognized as better places to take care of and enjoy the nature.

The geotag and timestamp of metadata provide information on the time and location of the wetlands preferred by people to visit (Ghermandi, 2018). Previous research has shown that the visitors of wetland reserves a high percentage of visits during certain period of times to appreciate and experience the unique scenery of the wetland (Do & Kim, 2020). However, when analyzing
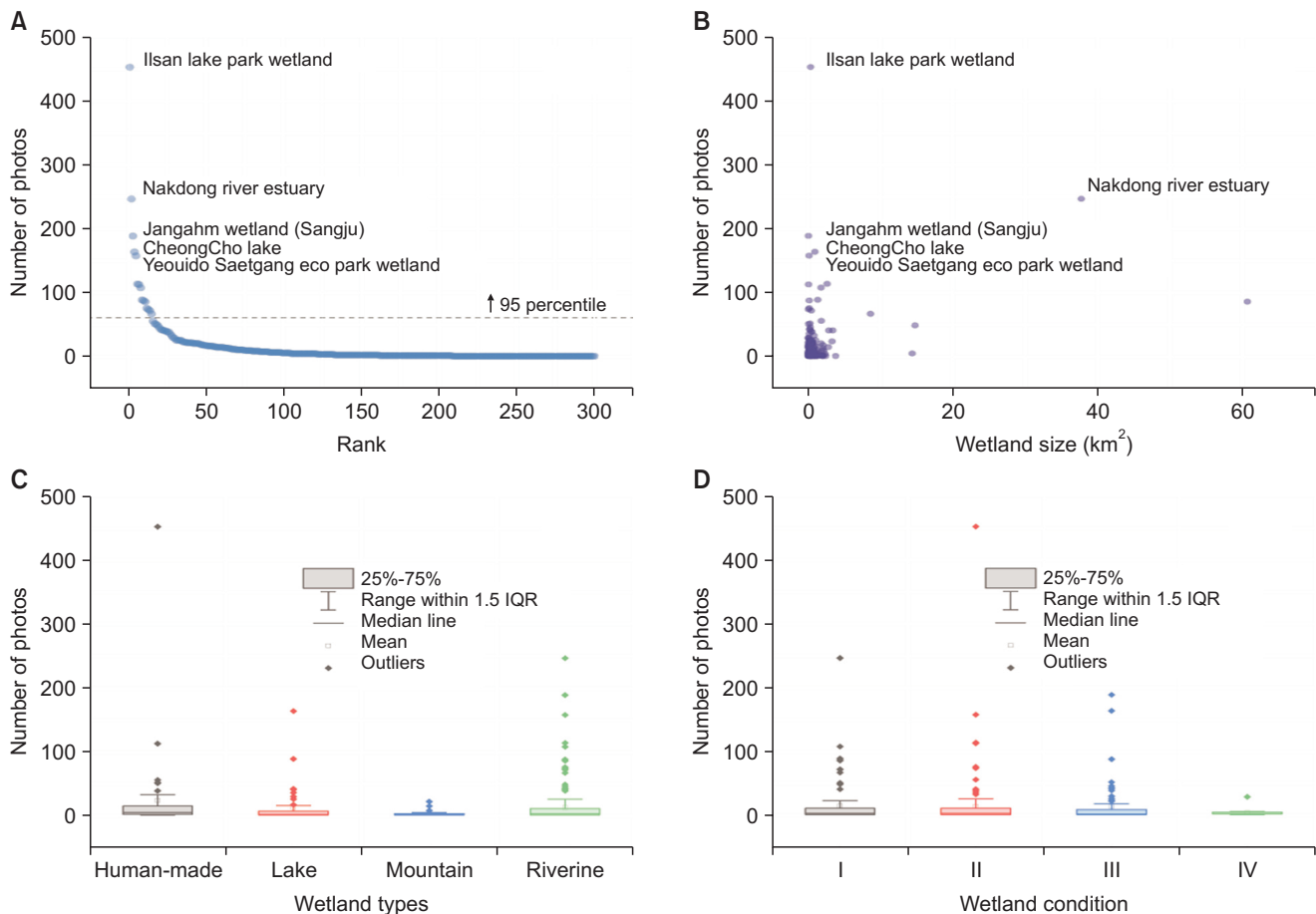
Fig. 4. Rank of wetlands with the most photos (A), number of photos according to wetland area (B), the difference number of photos among wetland types (C), and condition (D). IQR, interquartile range; I-IV, wetland condition rankings.

the visiting time of wetlands across the country, people visited wetlands at a time and season when they were good for recreational activities, because the time and destination of the visit to the wetlands depends on the purpose of the visit (Do *et al*., 2015b). If people visit the wetlands to relax rather than to observe the animals or plants, they visit the places that are easily accessible at all times and seasons. This is also relevant to the purpose of the aforementioned wetland visits. This is also supported by the analysis of the subjects in the pictures taken by people while visiting the wetlands. Most of the subjects in the pictures were passengers and natural scenery of the wetland. There was no correlation found between the wetland conditions and number of pictures taken by the visitors. The proximity and convenience of reaching the wetlands are important because people usually visit wetlands for recreational activities (Sonti *et al*., 2020). The conditions of wetlands may not affect the choice of wetlands to visit unless the hygienic condition is poor or the visit is not too dangerous.

In this study, we confirmed that many people are inter-

ested in visiting wetlands. However, visitors are assumed to visit wetlands for simple reasons, such as sightseeing and leisure activities. Certainly, sightseeing and leisure activities are an important part of the various ecosystem services offered at wetlands (Zhou *et al*., 2020). Particularly, wetlands near the residential areas possess high cultural ecosystem service values. Wetland areas contribute to the quality of life and well-being of the local population (Pedersen *et al*., 2019). Nevertheless, some management methods may provide better services to the visitors of wetlands. Managers should provide appropriate information to the visitors that the place they are visiting is a wetland. Wetlands with frequent visitors should have a wetland visitor guide program. Wetlands near the residential areas and frequently visited by many people can help promote the awareness regarding wetlands.

Conflict of Interest

The authors declare that they have no competing interests.

References

Barros, C., Moya-Gómez, B., and García-Palomares, J.C. (2019). Identifying temporal patterns of visitors to national parks through geotagged photographs. *Sustainability*, 11, 6983.

Chan, K.M., Goldstein, J., Satterfield, T., Hannahs, N., Kikiloi, K., Naidoo, R., *et al*. (2011). Cultural services and non-use values. In P. Kareiva, H. Tallis, T.H. Ricketts, G.C. Daily, and S., Polasky (Eds.), *Natural capital: theory and practice of mapping ecosystem services* (pp. 206-228). Oxford: Oxford University Press.

Daniel, T.C., Muhar, A., Arnberger, A., Aznar, O., Boyd, J.W., Chan, K.M., *et al*. (2012). Contributions of cultural services to the ecosystem services agenda. *Proceedings of the National Academy of Sciences of the United States of America*, 109, 8812-8819.

Do, Y., and Kim, J.Y. (2020). An assessment of the aesthetic value of protected wetlands based on a photo content and its metadata. *Ecological Engineering*, 150, 105816.

Do, Y., Kim, J.Y., Lineman, M., Kim, D.K., and Joo, G.J. (2015a). Using Internet search behavior to assess public awareness of protected wetlands. *Conservation Biology*, 29, 271-279.

Do, Y., Kim, S.B., Kim, J.Y., and Joo, G.J. (2015b). Wetland-based tourism in South Korea: who, when, and why. *Wetlands Ecology and Management*, 23, 779-787.

Dobbie, M.F. (2013). Public aesthetic preferences to inform sustainable wetland management in Victoria, Australia. *Landscape and Urban Planning*, 120, 178-189.

Ghermandi, A. (2018). Integrating social media analysis and revealed preference methods to value the recreation services of ecologically engineered wetlands. *Ecosystem Services*, 31, 351-357.

Im, R.Y., Kim, T., Baek, C.Y., Lee, C.S., Kim, S.H., Lee, J.H., *et al*. (2020). The influence of surrounding land cover on wetland habitat conditions: a case study of inland wetlands in South Korea. *PeerJ*, 8, e9101.

Kaiser, N.N., Ghermandi, A., Feld, C.K., Hershkovitz, Y., Palt, M., and Stoll, S. (2021). Societal benefits of river restoration - implications from social media analysis. *Ecosystem Services*, 50, 101317.

Lee, H., Seo, B., Koellner, T., and Lautenbach, S. (2019). Mapping cultural ecosystem services 2.0 - potential and shortcomings from unlabeled crowd sourced images. *Ecological Indicators*, 96, 505-515.

Lee, J.H., Park, H.J., Kim, I., and Kwon, H.S. (2020). Analysis of cultural ecosystem services using text mining of residents' opinions. *Ecological Indicators*, 115, 106368.

Oteros-Rozas, E., Martín-López, B., Fagerholm, N., Bieling, C., and Plieninger, T. (2018). Using social media photos to explore the relation between cultural ecosystem services and landscape features across five European sites. *Ecological Indicators*, 94, 74-86.

Park, E., Lee, S., and Peters, D.J. (2017). Iowa wetlands outdoor recreation visitors' decision-making process: an extended model of goal-directed behavior. *Journal of Outdoor Recreation and Tourism*, 17, 64-76.

Pedersen, E., Weisner, S., and Johansson, M. (2019). Wetland areas' direct contributions to residents' well-being entitle them to high cultural ecosystem values. *The Science of the Total Environment*, 646, 1315-1326.

Pueyo-Ros, J., Ribas, A., and Fraguell, R.M. (2019). A cultural approach to wetlands restoration to assess its public acceptance. *Restoration Ecology*, 27, 626-637.

Sinclair, M., Mayer, M., Woltering, M., and Ghermandi, A. (2020). Using social media to estimate visitor provenance and patterns of recreation in Germany's national parks. *Journal of Environmental Management*, 263, 110418.

Small, N., Munday, M., and Durance, I. (2017). The challenge of valuing ecosystem services that have no material benefits. *Global Environmental Change*, 44, 57-67.

Sonti, N.F., Campbell, L.K., Svendsen, E.S., Johnson, M.L., and Novem Auyeung, D.S. (2020). Fear and fascination: use and perceptions of New York City's forests, wetlands, and landscaped park areas. *Urban Forestry and Urban Greening*, 49, 126601.

Wang, Y., Yao, Y., and Ju, M. (2008). Wise use of wetlands: current state of protection and utilization of Chinese wetlands and recommendations for improvement. *Environmental Management*, 41, 793-808.

Wilkins, E.J., Sinclair, W., Miller, H.M., and Schuster, R.M. (2019). Does proximity to wetlands matter? A landscape-level analysis of the influence of local wetlands on the public's concern for ecosystem services and conservation involvement. *Wetlands*, 39, 1271-1280.

Xu, X., Chen, M., Yang, G., Jiang, B., and Zhang, J. (2020). Wetland ecosystem services research: a critical review. *Global Ecology and Conservation*, 22, e01027.

Yoshimura, N., and Hiura, T. (2017). Demand and supply of cultural ecosystem services: use of geotagged photos to map the aesthetic value of landscapes in Hokkaido. *Ecosystem Services*, 24, 68-78.

Zhou, L., Guan, D., Huang, X., Yuan, X., and Zhang, M. (2020). Evaluation of the cultural ecosystem services of wetland park. *Ecological Indicators*, 114, 106286.

Zhu, L., Davis, L.S., and Carr, A. (2021). Visualising natural attractions within national parks: preferences of tourists for photographs with different visual characteristics. *PloS One*, 16, e0252661.