Potential Nesting Site Analysis of Red-crowned Cranes in Kushiro Wetland using GIS

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Abstract: Red-crowned cranes (*Grus japonensis*), once considered extinct, have been increasing in number in eastern Hokkaido, a northern island of Japan. One of the recent concerns about the cranes has been that the habitats in eastern Hokkaido may not be large enough to accommodate the increasing number of cranes. This study focuses on the breeding areas, especially the nesting sites of the cranes to develop a simple nesting site selection model using GIS so that the model will be used to help find suitable nesting areas in other parts of the island. Geographic features in 1:25,000 scale maps and existing nest location points were digitized and a nesting site selection model developed for Kushiro Wetland with GIS. Potential nesting areas analyzed by applying this model are small and exist only along the edge of the wetland. The result is consistent with the understanding of experts on the cranes whose breeding environment is becoming undesirable. It is expected that GIS will be also useful for the subsequent analyses required to find suitable nesting areas other than eastern Hokkaido.

Keywords: GIS, rule-based GIS, crane, potential habitat analysis.

1. INTRODUCTION

Red-crowned cranes (*Grus japonensis*), or Tancho in Japanese, inhabit Hokkaido, a northern island of Japan. They were once considered extinct about 80 years ago, because of overhunting and loss of habitats (Masatomi, 1993). However, in the 1920s, a few cranes were found in Kushiro Wetland, the largest wetland in eastern Hokkaido (Saito, 1926). Since then they have been well protected, designated as a special national natural monument by the Japanese Government, and increasing in number. The number of cranes has been counted in winter through annual crane census since 1952. In 1993, more than 600 cranes were identified in eastern Hokkaido. Recognizing the steady increase in the number of the cranes and continuing development pressure on their habitats, however, it is realistic to assume that the current breeding

areas in eastern Hokkaido will be someday oversaturated for the cranes. Masatomi (1993) pointed out that the nesting sites are increasing in peripheral zones of the Kushiro Wetland where the accessibility to predators such as minks and foxes are high. High vulnerability of chicks and juveniles to such predators creates great concern about the future population of the cranes. Experts on the red-crowned cranes agree that the current number, about 600, is not enough to maintain the species against diseases and natural disasters and at least over 1,000 cranes are necessary. In that case, new habitat areas other than eastern Hokkaido may need to be found for the cranes.

The goal of this research is to find suitable nesting areas for red-crowned cranes in Hokkaido other than eastern part using GIS. To attain this goal, the research was divided into three stages: (1) spatial analysis of existing nesting sites in the Kushiro Wetland to develop a simple model on the nesting conditions; (2) same analysis as (1) for whole eastern Hokkaido in which there exist a

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variety of natural environments from ordinary wetlands to coastal areas including open marshes; and (3) potential nesting area analysis for the other parts of Hokkaido using the model developed during the first and second stages. This paper summarizes the result of stage (1) (Murakami and Hirata, 1996).

2. STUDY AREA AND AVAILABLE DATA SETS

The study area of the first stage encompasses ten 1:25,000 scale topographic map sheets covering most part of the Kushiro Wetland (Fig. 1). These topographic maps were revised in 1992 and 1993. In addition to the annual crane census conducted in winter, nests are annually identified from aircraft and their locations manually plotted on 1:50,000 scale topographic maps. The positional accuracy of the nest location data is not accurately known, but it is roughly estimated not to exceed 100 m on the ground (Masatomi, H., personal communication, 1996). The distribution of the original nest location maps is very limited to protect the habitats from human disturbances. This project employs nest location data of 1994 re-plotted on 1:200,000 scale maps and made available to a limited number of researchers by the Environment Agency.

These maps were digitized into vector format to make a GIS database for this project. The features digitized from the 1:25,000 topographic maps include road and river networks, buildings and wetland areas. We digitized 1:25,000 topographic maps instead of smaller scale ones with comparable accuracy to the nest location maps, because the digitized data is also planned to be used for other projects.

3. MODEL DEVELOPMENT

Since no perfect model for nesting site selection has been developed and is difficult to develop, we developed a simple model based on a rule of thumb. Wetland areas and rivers are considered favorable

for nesting while roads and buildings should be unfavorable due to possible human interference and intrusion of predators. Each nest must also be spatially separated from each other to establish the home range during the breeding season. Each road and river segment and each building were assumed to have equal influence on cranes and/or nesting conditions. Large fluctuation of the surrounding vegetation composite ratios between existing nests (Masatomi et al., 1990) suggests that nest locations should not largely depend on vegetation conditions, even though different vegetation types such as reed, sedge, alder and sphagnum are present in the Wetland. Consequently, the wetland area was assumed uniform in terms of vegetation in this analysis. The location data set of 39 existing nests found in 1994 was then used to measure the distance between the ground features and nesting sites, and between adjacent nests. In order to avoid unusual or exceptional cases of nesting sites, 10 % of the nests with extreme locations were ignored for each ground feature.

The results of the measurement are shown in Figs. 2 through 5. Figure 6 shows the relationship between the Wetland and existing nests. The model thus developed has the following conditions (Ando et al., 1996):

- (1) Distance from the nearest river network must be less than 265 m;
- (2) Distance from the nearest road network and the nearest building must be larger than 104 m and 364 m, respectively;
- (3) Distance from the existing nests must be larger than 2640 m; and
- (4) Nests must be located within the wetland area.

4. RESULTS

The developed model is then applied to the GIS database to find potential nesting sites in the Kushiro Wetland. The result is shown in Fig. 7,

which indicates the following characteristics:

- (1) Compared to the area of the Kushiro Wetland shown in Fig. 6, potential nesting areas in Fig. 7 are small, scattered and separated from each other and occupy only about 5 % of the whole Wetland; and
- (2) Most potential nesting areas are located along the edge of the wetland which is outside the protected areas and where accessibility to predators is high.

An exception is found in a circled area of the lower left part of Fig. 7. Although this area is part of the Kushiro Wetland, the natural conditions are considered different from the rest of the Wetland because the road constructed north of it has changed the water flow pattern and, as the result, made the area inappropriate for nesting sites (Masatomi, H., personal communication, 1996). This difference is clearly shown in Fig. 8 in which the locations of all identified nests from 1979 to 1994 except 1981-1984 and 1986-1989 are plotted. No nest has been identified in these years in the same circled area shown in Fig. 8. The model developed in this study was not able to distinguish this area from the rest of the wetland. The land cover data set of the Wetland derived from satellite images by Masatomi et al. (1990) does not show any difference associated with the conditions, either.

5. DISCUSSIONS

Since a perfect model for crane nesting site selection is unknown and will be difficult to develop as pointed out by Herr and Queen (1993), the model employed in this study is based on a simple set of rules using available data of geographic features. And there is no other data to evaluate the model and result of this study. However, even though the maximum crane population of the Kushiro Wetland is unknown, experts on the cranes believe that many cranes appear to build their nests in less than ideal locations (Masatomi, 1993). In the other parts

of eastern Hokkaido, the extent of breeding areas has also been gradually expanding recently, and due to the reduction of breeding areas caused by wetland development, there have been an increasing number of new nesting sites built under undesirable conditions (Masatomi et al., 1994, 1995). This tendency can be explained by the small potential nesting areas scattered along the edge of the Kushiro Wetland as shown in Fig. 7.

The significance of small potential nesting areas in Fig. 7 needs to be assessed with the accuracy of the original map and existing nest location data sets. The horizontal accuracy of ground features digitized from 1:25,000 topographic maps is less than 18.5 m RMSE (Murakami, 1995). The accuracy of the existing nest location data is estimated at no larger than 100 m. If this value covers 95 % (2s) of the error, the RMSE can be estimated at 50 m. In addition, when the nest locations were re-plotted to 1:200,000 scale topographic maps, from which we digitized the data, their spatial accuracy must have been degraded with the spatial accuracy of the maps, which is within 1.2 mm on the maps according to the map compilation rules adopted for the map scales not larger than 1:50,000 (Geographical Survey Institute, 1989). Based on the same discussion as above, the RMSE of the 1:200,000 scale topographic maps is 0.6 mm on the maps, i.e., 120 m on the ground. The combined RMSE of the nest location is then 130 m on the ground. This error of nest location is not small enough compared to the buffer size derived in this study. Since there are a number of potential nesting areas smaller than 130 m in size, such small potential nesting areas should not be considered significant.

6. CONCLUSIONS

GIS technology was applied to analyze nesting sites of red-crowned cranes in the Kushiro Wetland in Hokkaido, Japan. A simple model for crane

nesting site selection was developed using existing nest location and geographic feature data sets. Potential nesting areas located by applying this model to these data sets were small and existed only along the edge of the wetland. The result was consistent with the understanding of experts on the cranes that their breeding environment is becoming undesirable.

The GIS approach was proved to be useful for helping objectively visualize the current circumstances of the Kushiro Wetland as crane breeding areas, which have been mentioned in subjective manners by crane experts.

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Fig.1 Location of study area

Fig. 3 Distribution of existing nests and road networks with 104 m buffer in Kushiro Wetland

Fig. 2 Distribution of existing nests and river networks with 265 m buffer in Kushiro Wetland

Fig. 4 Distribution of existing nests and buildings with 364 m buffer in Kushiro Wetland

Fig. 5 Distribution of existing nests with 1320 m buffer in Kushiro Wetland

Fig. 7 Distribution of potential nesting areas extracted in Kushiro Wetland using GIS

Fig. 6 Distribution of existing nests and the Kushiro Wetland area

Fig. 8 Distribution of existing nests from 1979 to 1994 except 1981-1984 and 1986-1989 in Kushiro Wetland