

F-2.1.1 Investigation of Distribution and Environmental Conditions of Wetlands using Satellite Imagery

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Abstract Movements and habitat conditions of Red-crowned Cranes (*Grus japonensis*) and Oriental White Storks (*Ciconia boyciana*) were studied in East Asia using two kinds of satellite-based observation techniques, i.e., satellite tracking and remote sensing techniques. A satellite tracking system is used to automatically obtain bird location data, from which migration routes, local movements within habitat, and important places for breeding, stopover and wintering can be identified. Satellite remote sensing was used to investigate the distribution and environmental condition of wetlands. By combining these two techniques we analyzed the relationship between wetland ecosystems and bird habitation patterns. First, land-cover conditions and local movements of birds in their breeding sites of the Amur basin were analyzed. Then the migration routes and land-cover condition were studied in East Asia.

Key Words: Red-crowned Crane, Oriental White Stork, remote sensing, satellite tracking

1. Introduction

In this study we focus on two species of endangered migratory birds, i.e., Red-crowned Cranes (*Grus japonensis*) and Oriental White Storks (*Ciconia boyciana*), both of which inhabit wetlands in East Asia. They are threatened by human development activities and have greatly decreased in number during last several decades; according to existing reports, the present populations of Red-crowned Cranes and Oriental White Storks are estimated at about 2,000 and 3,000 respectively^{1), 2)}. Since these birds stand at the top of wetland food chains, protecting them from extinction requires conservation of whole wetland ecosystems. We may say their existence is an indicator of the state of conservation of natural wetlands.

In order to investigate bird movements and habitat conditions we employ two kinds of satellite-based observation techniques, i.e., satellite tracking and remote sensing techniques. A satellite tracking system is used to automatically obtain bird location data, from which migration routes, movements within local habitats, and important places for breeding, stopover and wintering can be identified. Satellite remote sensing techniques are used to study the distribution and environmental conditions of wetlands in East Asia. Satellite images are useful for observing ground surface conditions over large areas or in areas difficult to enter on the ground such as wetlands. By combining these two techniques we analyze the relationship between wetland ecosystems and bird habitation patterns. In this report we describe the results of our investigation conducted from 1998 to 2000.

2. Capturing birds and installing Argos terminals

In July 1998 to 2000 small transmitter terminals were deployed on Red-crowned Cranes (adult birds) and Oriental White Storks (chicks of fledging age) each year in wetland areas along the Amur River in the Russian Far East. Their migration routes from the breeding sites in the Amur basin to the wintering sites in China were tracked with the Argos system. Table 1

summarizes the ID numbers and capture sites of the successfully tracked birds. The IDs starting with a 'C' indicate Red-crowned Cranes, and those starting with an 'S' indicate Oriental White Storks.

3. Analysis of bird movements and land-cover conditions in the Amur basin

3.1 Spatial extent of bird movements

In order to analyze bird movements and land-cover conditions in the Amur

basin we used Landsat/TM images, whose ground resolution was 30 m. Bird location data were overlaid on the TM images and bird movement patterns were studied. It was found that in 1998 and 2000 each bird stayed within a concentrated area with a diameter of about 10 to 15 km. In 1999, on the other hand, all three birds locally changed their habitats within the Amur basin, and their location points were scattered over larger areas. This different bird behavior may be ascribed to the difference of food conditions caused by weather conditions.

3.2 Bird locations and land-cover conditions in the Amur basin

Using Landsat/TM images, the land-cover of the Amur basin was classified into 6 types, i.e., water, wetland 1, wetland 2, wetland 3, farmland/soil, and woods. Wetland 1 was the wettest part of wetlands with reed grasses and sedges as dominant vegetation. Wetland 2 was a moderately wet part of wetlands with sedges and lowland grasses. Wetland 3 was a relatively dry part of wetlands dominated by lowland grasses. The land-cover type 'woods' included both woods in wetland areas and forests in mountainous areas.

Bird location points were overlaid on the land-cover thematic images to study what kind of land-cover types the birds mainly inhabited. Table 2 summarizes average percentage of location data in each land-cover type for both species of birds. From Table 2 we see that the total percentages of bird locations in wetland areas (wetland 1 – 3) are 79.5 for Red-crowned Cranes and 80.1 for Oriental White Storks as an average of 1998 to 2000. This means that

Table 1. ID numbers and capture sites of successfully tracked birds.

Year	Red-crowned Crane		Oriental White Stork	
	ID	Capture site*	ID	Capture site*
1998	C20848	A	S9086	B
	C20850	B	S20846	B
	C20851	A	S20853	A
1999	C20819	A	S20818	K
	C21502	A	S20820	K
			S20821	A
			S20823	K
2000			S19033	A
			S19361	A
			S19460	K
			S19640	K

(*) A: Arkhara area, B: Blagoveshchensk area, K: Khabarovsk area.

Table 2. Average percentage of bird location data in each land-cover type in the Amur basin.

Land-cover type	Red-crowned Crane			Oriental White Stork			
	1998	1999	Total	1998	1999	2000	Total
Water	0.2	0.8	0.3	0.0	2.2	0.0	0.5
Wetland 1	31.0	24.0	29.8	22.3	21.7	56.5	26.1
Wetland 2	40.3	41.5	40.5	25.4	41.3	32.6	29.9
Wetland 3	9.2	9.3	9.2	30.4	17.4	2.2	24.1
Farmland	15.3	17.1	15.6	13.1	5.4	4.3	10.3
Woods	4.0	7.4	4.6	8.8	12.0	4.3	9.0

both species mostly stay within wetland areas in the Amur basin. We may think that since the natural conditions of wetlands are fairly well preserved on the Russian side of the Amur basin, the birds can find enough food within the wetland areas and tend to stay there.

4. Analysis of bird movements and land-cover conditions in East Asia

4.1 Migration routes and important habitats

In order to see bird migration routes and to identify important habitats in East Asia, bird location data were overlaid on NOAA/AVHRR satellite images, whose ground resolution was 1km. For both bird species, there were two main corridors in northeast China leading from the Amur basin breeding habitats to the Liaodong bay coast: one along the Nen River basin and the other along the Songhua River basin. From the Liaodong Bay coast both species traveled along the Bohai Bay coast to the Yellow River delta. From the Yellow River delta, Red-crowned Cranes flew to Yangchen Beach both years, while Oriental White Storks flew to the Wuhan Lakes in 1998 and Lake Poyang in 1999 and 2000.

Important habitats were identified and listed in Table 3. We note that Oriental White Storks have a higher number of important habitats than Red-crowned Cranes. This is due to the fact that Oriental White Storks take a longer time (103 days on average) to migrate to their wintering sites than Red-crowned Cranes (13 days on average).

Table 3. Important habitats of Red-crowned Cranes and Oriental White Storks in East Asia, where birds stayed more than 10 days.

Species	Site	Longitude (°)	Latitude (°)	Type	Usage
Red-crowned Crane	Amur River basin	127.6 - 130.4	49.0 - 50.1	inland	breeding
	Liao River delta	121.8	41.0	coastal	stopover
	Yancheng beach	119.9 - 120.8	33.0 - 34.4	coastal	wintering
	Han/Imjin estuary	126.6	37.6	coastal	wintering
Oriental White Stork	Amur River basin	127.6 - 135.5	47.8 - 50.9	inland	breeding
	Nen River basin	122.3 - 126.6	44.9 - 49.0	inland	stopover
	Songhua River basin	128.5 - 132.7	46.0 - 47.7	inland	stopover
	Ussuri River basin	134.1	47.3	inland	stopover
	Liao River basin	122.4	42.9	inland	stopover
	Bohai Bay coast	117.5 - 119.2	38.6 - 39.6	coastal	stopover
	Yellow River delta	117.8 - 118.9	37.7 - 38.2	coastal	stopover
	Shengjin Lake	116.4	30.0	inland	stopover
	Poyang Lake	116.1	29.1	inland	wintering
	Wuhan Lakes	113.8	30.3	inland	wintering

4.2 Bird locations and land-cover conditions in China

Land-cover map produced from NOAA/AVHRR images was used to investigate land-cover conditions of bird habitats in China. Bird location data were overlaid on this thematic map and the land-cover type of each location point was studied. Table 4 summarizes average percentages of location data in each land-cover type for Red-crowned Cranes and Oriental White Storks.

It was found that most of the birds were more frequently found in farmlands than in wetlands. The percentages of bird location data in wetlands were 19.7 for Red-crowned Cranes and 31.9 for Oriental White Storks as an average of 1998 to 2000. This result shows a notable contrast to the previously mentioned result from the Amur basin of the Russian Far East where both bird species spend most of their time in wetlands. Probably it is inevitable for the birds to visit farmlands to find their food, because considerable areas of wetlands have disappeared due to agricultural and industrial development in China. These frequent stays in farmlands might be causing problems, e.g., competition for food resources with local people, hunting and contamination with pesticides.

Table 4. Average percentage of bird location data in each land-cover type in China.

Land-cover type	Red-crowned Crane			Oriental White Stork			
	1998	1999	Total	1998	1999	2000	Total
Wetland	22.7	16.5	19.7	33.9	38.0	23.7	31.9
Farmland	44.3	26.4	35.6	39.1	46.4	43.0	42.1
Grass	25.8	49.5	37.2	22.2	9.3	26.5	20.2
Shrub	2.1	6.6	4.3	0.2	3.4	0.7	1.1
Forest	5.2	1.1	3.2	0.7	3.0	2.5	1.8
Harsh Desert	0.0	0.0	0.0	3.8	0.0	3.6	2.9

5. Conclusions

Movements and habitat conditions of Red-crowned Cranes and Oriental White Storks were studied by two kinds of satellite-based observation techniques, i.e., satellite tracking and remote sensing. Satellite tracking enables us to obtain automatically bird locations over a broad area. Remote sensing enables us to regularly observe environment at conditions of bird habitats. By combining these two techniques of habitats we could analyze the relationship between bird movements and environmental conditions. The following are major results of this study:

- (1) The spatial extent of bird movements in their breeding sites in the Amur basin was different from year to year; in 1998 and 2000, most birds stayed within a concentrated area with a diameter of about 10 to 15 km, but in 1999, bird location points were scattered over larger areas and some birds locally changed their habitats within the Amur basin. This difference in bird behavior may be due to different food conditions caused by weather conditions.
- (2) In the Amur basin both bird species stayed mostly within natural wetland areas. About 80 % of all location points of each kind of bird fell inside wetland areas.
- (3) Migration routes and important habitats of Red-crowned Cranes and Oriental White Storks were identified in East Asia. For both species, there were two main corridors in northeast China leading from the Amur basin breeding habitats to the Liaodong bay coast: one along the Nen River basin and the other along the Songua River basin. From the Liaodong Bay coast both species traveled along the Bohai Bay coast to the Yellow River delta. From the Yellow River delta, Red-crowned Cranes flew to Yangchen Beach in 1998 and 1999, while Oriental White Storks fled to the Wuhan lakes in 1998 and the Poyang Lake in 1999 and 2000. Important habitats where birds stayed more than 10 days are listed in Table 3.
- (4) In China, both Red-crowned cranes and Oriental White Storks were found more frequently in farmlands than in wetlands. Their frequent stays in farmlands might be causing problems for the existence of the birds, e.g., competition for food resources with local people, hunting and contamination by pesticides. Further research is needed to investigate the real situation regarding wetland reduction in China and its effects on the existence of the birds.

References

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