DEVELOPING ECOLOGICAL NETWORKS BETWEEN URBAN WOODLANDS IN AN INDUSTRIAL AREA: A CASE STUDY IN THE OSAKA METROPOLITAN AREA OF JAPAN

Tomohiro Ichinose[1] and Wakako Miyata[2]

[1]*Institute of Natural Environmental Sciences, University of Hyogo*

[2] *Sekisui Exterior Co, Ltd.*

ABSTRACT

We proposed an ecological network plan for part of the Osaka metropolitan area based on an analysis of satellite image data using a geographical information system. Vegetation cover was identified using the normalized difference vegetation index for SPOT4 data captured in June 2003. Large woodlands and many smaller woodlots were located in a mountainous area (the Rokko Mountains) in the northwestern part of the study area, but there was little vegetation cover elsewhere. Small woodlots (0.2 ha or larger) were selected and 500-m buffer zones around them were created to identify locations where it was necessary to connect the Rokko Mountains and the project area along the Mukogawa River, with the goal of helping forest birds to move into the area. However, a large gap in the northern part of the project area should be remedied; we propose a planting plan for a small factory in the area.

Keywords: ecological network, satellite image data, industrial area, afforestation, forest birds

INTRODUCTION

Urban growth has fragmented and isolated wildlife habitat, especially woodlands. As a result, growth has decreased biodiversity in urban areas. On the other hand, many industrial areas were abandoned at the beginning of the 1990s in advanced countries as a result of the decline of heavy industries. Many woodlands have been restored or created in these areas in the past decade (Kowarik and Körner 2005).

However, many of these new woodlands are isolated from other woodland habitats and should be connected by ecological networks to permit travel between habitats by wildlife and to conserve biodiversity in urban and industrial areas. In Japan, the population has been decreasing since 2004 and the number of abandoned areas have increased in urban and industrial areas. Many large sites have been abandoned, especially on reclaimed waterfronts, when heavy industries moved to other Asian countries or reduced the size of heir plants. These sites were often formerly sandy beaches or tidal flats, but it may be so difficult to restore former habitats on these sites that we must sometimes choose other options.

Currently, a large project has been initiated to establish large semi-natural woodlands in part of the Osaka metropolitan area in Japan. The project area is isolated from surrounding natural woodlands, thus it is necessary to develop ecological networks to conserve biodiversity in the area. In this paper, we describe a proposed ecological network plan for the area based on the analysis of satellite image data using geographical information system software, and a greenery plan for a small abandoned factory.

We selected birds as the indicator species for the plan because we can find many bird species even in urban and industrial areas, they can fly between habitats, and they are one of the most popular taxa among citizens.

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MATERIALS AND METHODS

STUDY AREA

The project area (about 1000 ha) is located in Amagasaki City, in the Osaka Bay Area of Hyogo Prefecture (Figure 1). The area has been used by heavy industry since the 1960s on reclaimed lands. Presently, there are many abandoned industrial areas.
The government of Hyogo Prefecture has begun a project called the "Amagasaki Forest Plan for the 21st Century" that aims to increase the vegetation cover from 4% to 30% over the next 100 years. The first part of the project will start in 2006 at a 29-ha site abandoned by the iron and steel industry. Because the area is located in the Osaka metropolitan area, the area is surrounded by dense residential and commercial areas and there are few woodland areas and open spaces around the site.

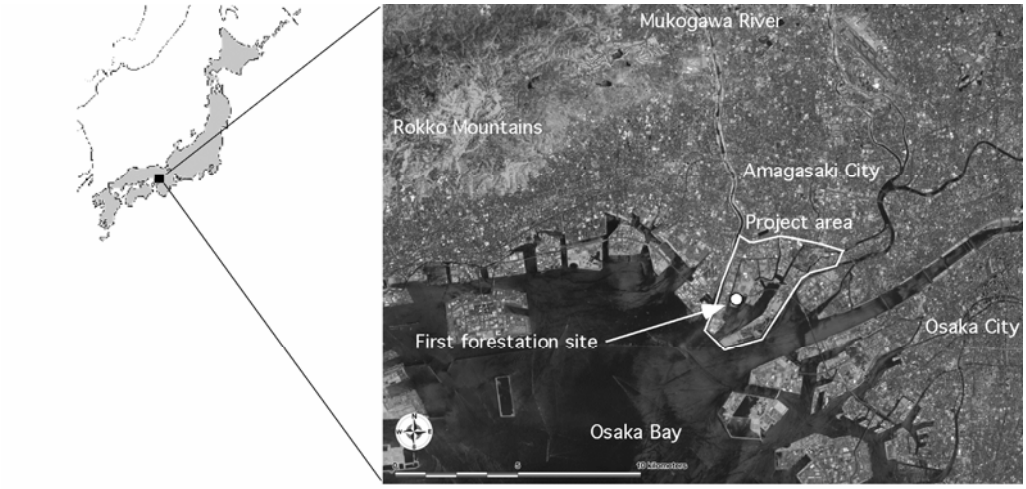

Figure 1. Location of the project area and first afforestation site.

ANALYSIS OF SATELLITE IMAGE DATA

Vegetation cover in the project area was identified using the normalized difference vegetation index (NDVI) for SPOT4 data captured on 3 June 2003:

$$NDVI = (Near\ IR - R)/(Near\ IR + R), \quad (1)$$

where *Near IR* represents the value in the near-infrared band and *R* represents the value in the red band. We conducted ground-truthing in the winter and summer of 2005 to correlate the NDVI values with the presence of vegetation. Large woodlots (≥ 2 ha) were identified and 200-m buffer zones were created around their boundaries in the software. Ichinose and Katoh (1998) indicated that a woodlot at least 2 ha in size is necessary for breeding of passerine species that prefer woodland habitats. Hashimoto and Natuhara (2002) showed that at least 32% of the area within a 200-m radius of existing woodlots also had to support woodland to achieve a probability of occurrence of the great tit (*Parus major*) equal to 0.5 or better.
Small woodlots (≥ 0.2 ha) were also identified, and 500-m buffer zones around these woodlots were created in the software. Ichinose (2002) reported that woodlots at least 0.2 ha in size are necessary to provide habitat for overwintering species that prefer woodland. In addition, the proportion of woodland within a 500-m radius of these small woodlots is an important environmental factor for overwintering birds (Ichinose and Katoh 1998). Gaps in ecological

networks between large woodlands and small forested sites were identified based on our analysis of the gaps between these buffer zones.

PROPOSAL FOR PLANTING AT A FACTORY

We focused on a large gap in the ecological network in the northern part of the project area, where many small factories are concentrated. An environmental conservation bylaw of Amagasaki City states that an owner must reserve 10% of an industrial area for planting if the factory covers 1 ha or more. Smaller factories are not governed by the bylaw. As a result, there is no vegetation cover in the parts of the project area occupied by small factories.
To fill the gaps in the ecological network, we proposed a planting plan for a small factory. Our goal was to illustrate how planning could be done for one small area, then use this as a case study to guide future planting at other small factories. The goal would be to create "stepping stones" (i.e., ecological corridors) for overwintering birds.

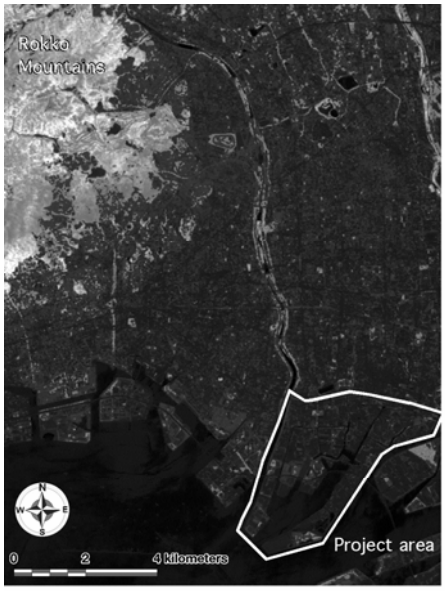

Figure 2: Results of the NDVI calculations.

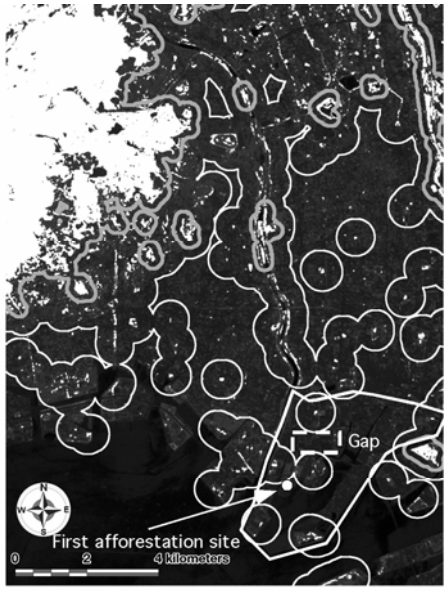

Figure 3: Results of the buffer zone analysis. Thick grey lines represent the 200-m buffer zones around woodlot areas larger than 2 ha; areas surrounded by thin white lines represent the 500-m buffer zones around woodlot areas larger than 0.2 ha.

RESULTS

CALCULATION OF NDVI AND EXTRACTION OF VEGETATION COVER

We calculated an NDVI value for each grid cell (Figure 2) and found that the NDVI values ranged from –1 to 1. The result of our ground-truthing showed that grid cells with an NDVI value of 0.1 or more were covered by vegetation.
The results revealed that large woodlands and many of the small woodlots were located in a mountainous area called the Rokko Mountains, in the northwestern part of the study area, and that there was little vegetation cover in the project area. Figure 3 shows that there is no 200-m buffer zone from over 2 ha woodland near from the project area, therefore it might be difficult for forest birds to reach the first site scheduled for planting under the forest plan for the 21st century during the breeding season. However, 500-m buffer zones connect the Rokko

Mountains and the project area along the Mukogawa River, thus forest birds can probably move into this area. However, a large gap was found in the northern part of the project area (Figure 3), and this gap must be bridged to complete this ecological corridor.

PLANTING PLAN FOR A SMALL FACTORY

There was no large contiguous space available for planting at the small factory. We thus selected four small areas for planting (Figure 4).
Our planting concept was to use native species whose seeds can be collected from the Mukogawa River watershed, with an emphasis on tree species that produce berries and nuts that can serve as foods for birds during the winter season. In addition, we selected deciduous trees for the entrance (Area 1) and evergreen trees for the northern end of the factory (Areas 3 and 4). An illustration of the proposed planting for Area 2, which is beside a parking lot, is shown in Figure 5.
There are many volunteer groups interested in planting trees in Amagasaki City. Some have been growing large numbers of seedlings of native species for afforestation of the project site. Thus, we are confident that we can secure enough native seedlings and volunteers to successfully establish forest vegetation at the factory site.

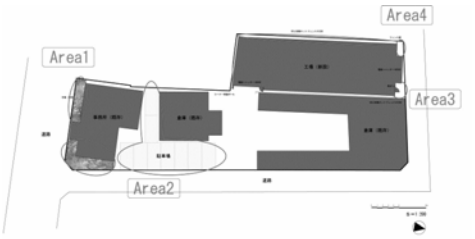

Figure 4: Map of the small factory, and locations of the four proposed planting sites.

Figure 5: Illustration of the proposed planting in Area 2.

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