An Approach to Identify a Linked Spatial Network for Large Mammal Conservation on Yellow Sea Coast

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Abstract

On the coastal region how to protect the natural ecosystems is an urgent issue. In this study, taking the Elaphurus Davidianus as a case, a framework has been proposed to identify an ecological spatial network for the conservation of large mammals, which could be finished in two steps: ecological naturalness assessments and human-induced ecological risks assessments. Through the naturalness assessments regions to be conserved is identified, which are regions that having high ecological value; and through the human-induced risks assessments, a spatial network that is linked by regions with low human induced ecological impacts is identified. The analysis shows that this approach is an efficient solution through which the ecological risks can be infiltrated and ranked, and the efficient ecological conservation could be realized by prioritizing the management efforts.

Keywords

Ecological security • Ecosystem management • Ecological naturalness assessment • Ecological risks assessment • Coastal region

1 Purpose

How to prioritize the ecosystem for conservation purpose at landscape scale on coastal region is the question we want to discuss in this study. Landscape scale is the most reasonable scale to realize the ecosystem management for human actions acted at this scale.

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2 An Approach to Identify a Spatial Network for Ecosystem Management

2.1 Ecosystem's Naturalness Assessment

Naturalness indicates the wildness, least human disturbed or pristine condition of an ecosystem. A high naturalness ecosystem generally is low human disturbed, providing more ecological welfare, and being the habitat of more wild species. This naturalness assessment is more to reflect the ecosystem's inherent character as much as possible.

The national nature conserve, the large area of native vegetations, forests, and other low human disturbed places, might be conserved first (Noss 1987).

2.2 Ecological Risks Assessment

From the ecological assessment, places with high naturalness and low risks should be prioritized to manage.

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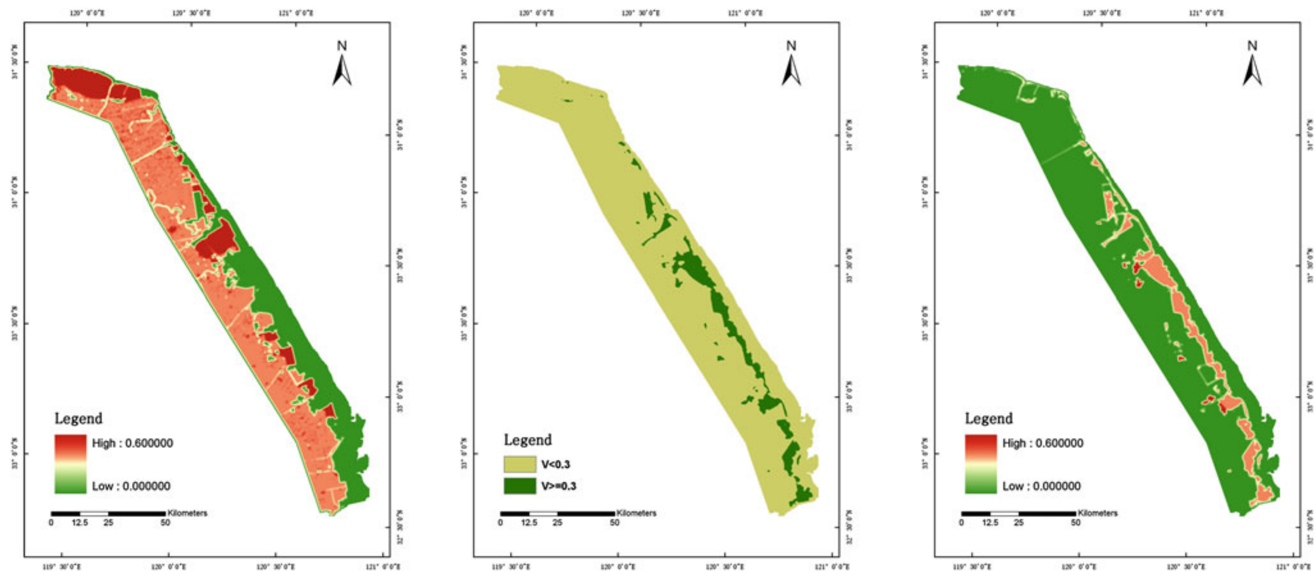

Fig. 1 **a** Ecological naturalness assessments. The suitable region, which is mainly located in the southeastern coast, has become more fragmented in recent time; **b** ecological risks assessments. The region with high R value has been enlarged in recent times, and the region has sprawled from the inland to the coast; **c** the areas with a value both $V > 0.3$ and $R < 0.3$ are computed. These regions are relatively more suitable for Milu population

The places with high naturalness could be called ecological hotspots. Ecological hotspot has been understood as "an anomaly, aberration, outbreak, elevated cluster, critical resource area and so on" (Patil et al. 2001). In this study we refer the ecological hotspots to the areas critical in affecting certain ecological process, such as areas important for birds' migration, areas as habitats of some endangered species such as Red-crowned Crane, Père David′s deer (Myers 1990; Myers et al. 2000).

2.3 Identification of the Ecological Conservation Spatial Network

The area with high ecological naturalness and low or moderate risks should be first conserved. For the same reason as the areas with moderate naturalness and risks, the areas with both high naturalness and risks are taken as mid-level security.

3 Identification of an Ecological Conservation Spatial Network on Chinese Coast

3.1 The Study Site

The wetlands on the Yancheng coast are an appropriate region to establish a wild Milu population (Ding 2005). Milu originated from middle and eastern China, inhabiting the plain and marshlands in the Huang River basin and the Yangtze River basin. Historically, because of the intensifying human pressures in the inner mainland, Milu migrated to the coastal region south of Huang River, from the west and north. They lived in this region until they became extinct in China.

3.2 Ecological Naturalness Assessment

According to Dafeng Milu's behavioral ecology research, we define a suitability index V to evaluate the potential habitat suitability for Milu. This index mainly reflects Milu's preferred habitat choice, where they can get food and shelter. According to the behavioral research in Dafeng, food, water and shelter are the most critical elements for a suitable Milu habitat (Ding 2005). Taken not only as food but also as shelter, the vegetation landuse is used to identify suitable habitat areas for Milu (Ding 2005). Within our landuse data, only the forests lands type and the high grasslands type could reflect the Milu's favorite habitat choice, so we choose the forest and the high cover grassland as the land cover type which we analyze as follows to get index values (Miller and Wardrop 2006). We define V as suitability index value, which was:

$$V = W_F P_F + W_G P_G$$

where W_F and W_G are the weights of landcover forest and high cover grassland, respectively, and PF and PG is the percentage of the forest and high cover grassland area, respectively, in each statistics cell. The cell is 1 km × 1 km, and in this size we do the spatial neighborhood analysis, after transferring the vector form landuse data into raster form. We analyze 3 year's S index spatial distribution, 1987, 1995, and 2000, using the available data (Fig. 1a). According to Dafeng Milu research report, forest land cover is more important to Milu than grassland in its life history. So in the analysis, according to the experts' opinion, we determine that WF is 0.6, and WG 0.4.

We could found that appreciate region suitable for Milu has been fragmented more and more in recent years. And the region mainly locates on the south-eastern Yancheng coastal region.

3.3 Ecological Risks Assessment

On the Yancheng coast, agriculture and other intensive human disturbance activities, including salt field development, aquaculture development, harbor building and industrial factory building are the main human activities causing negative impacts on the coastal environment. These activities always fragment the potential habitat and destroy the ecosystems' integrity. In this study we take the land cover types agriculture and building land as the data with which we do the risk assessment (Ding 2005). We define R as the risk index value, which was:

$$R = W_A P_A + W_B P_B$$

where W_A and W_B are the weights of landcover farm lands and building lands, respectively, and P_A and P_B are the percentage of farm land and building land areas, respectively, in each cell. In the same size of the cell as the index V, we also compute R in 1987, 1995, and 2000, in the same process as V computing (Fig. 1b). For the risk assessment, given that it is less harmful to Milu compared with other building activities such as industrial and aquiculture, W_A is determined as 0.4, and W_B 0.6, according to experts' opinion.

The region with high R index value is increased more and more, and sprawl from inland to the coast.

4 Discussions

Two questions could be answered in the Milu example study: how to assess the Chinese Yancheng coastal region, integrating the landscape assessment and the Milu population research, and what region should be conserved according our assessment. Our ultimate aim is to restore the Milu metapopulation on the Yancheng coast. This work is to highlight the urgency that some priority coastal region should be reserved for Milu reintroduction. The main management issue for Milu reintroduction is the trade-off between development and Milu protection. Two levels of security patterns (SP) give us some information how urgent it is to reserve lands for conservation. If high level ecological SP is the aim, the economy might develop slower. Scenario analysis, with the involvement of policy-makers, native farmers, scientists and investors should be an effective way to resolve this issue (Peterson et al. 2003). This should be done in the near future.

It should be pointed out that this study for Milu habitat choice is not enough. It is just a theoretical discussion on how to use the coarse landuse data to assess a region and determine a possible ecological SP. More research should continue, and proposing issues are: the accurate threshold level that makes the habitat unacceptable to the deer, which could be measurable by the indices we provide. If it could be realized we could give more accurate and plausible spatial strategy for Milu reintroduction; in this study, only the food and shelter needs for Milu are considered. In fact, Milu need different detailed habitats in their life history (Ding 2005). So if with the detailed landcover map through the high resolution image interpretation, information that what kinds of vegetation are selected as food at different time of the year could be gotten, the more accurate and convincingly results for Milu conservation could be realized. Research on the issue of Milu's habitat choosing process in its life history should continue (Ding 2005).

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