UNIVERSITI PUTRA MALAYSIA

HABITAT MODELING AND POTENTIAL DISTRIBUTION OF THE MALAYAN SUN BEAR (HELARCTOS MALAYANUS RAFFLES) USING GEOSPATIAL INFORMATION TECHNOLOGY

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HABITAT MODELING AND POTENTIAL DISTRIBUTION OF THE MALAYAN SUN BEAR (*HELARCTOS MALAYANUS RAFFLES*) USING GEOSPATIAL INFORMATION TECHNOLOGY

By

MONA NAZERI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirements for the Degree of Doctor of Philosophy

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To the soul of my beloved father

‘No amount of clever modeling or detailed
GIS habitat maps can circumvent our need
For this natural history information’

(Ruckelshanus et al., 1999)

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirements for the degree of Doctor of Philosophy

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Faculty: Forestry

While tropical rain forests are known as biological hotspot, few studies have been conducted to determine the potential distribution of species. Distribution modeling in tropical areas with high rate of deforestation and loosing connectivity is critically important for species management programs. Identifying the ecological requirements of the species and delineating the distribution of species throughout the entire habitat are fundamental in nature conservation. Simulations of spatially – explicit habitat enables conservation planners to identify key areas to protect, detection of wildlife corridors and preserve landscapes. This study assessed the application of Species Distribution Modeling (SDM) to Malayan Sun Bear habitat using the Maximum Entropy (MaxEnt) and Ecological Niche Factor Analysis (ENFA) with special emphasis on remote sensing and geographic information system (GIS) data. In order to test the models, two different spatial scales of Krau Wildlife Reserve (KWR) and Peninsular Malaysia were selected to model suitable habitat of Malayan Sun Bear. Results showed that both modeling outputs were acceptable in two different scales

even though, MaxEnt could discriminate marginal and high suitable habitats better when applied on larger scale. On the other hand, ENFA had better results when applying in smaller scale. These contrasts in suitability maps were admitted by Area Under the receiver operator characteristic Curve (AUC) plots as well. AUC values for models ranged from 0.87 in small scale of KWR and 0.97 for large scale of Peninsular Malaysia, suggesting strong and accurate predictable species-Ecogeographical matching. The environmental variables applied in methodology such as land cover, vegetation indexes and climatic variables had higher correlation with suitability map creation. Comparing the output of suitability maps of the models showed that in Peninsular Malaysia, MaxEnt separated high suitable area by covering 5% of the total 131598 km^2 and 13% of the total area to the marginal habitat. On the other hand, ENFA suitable habitat was doubled to 10% and for marginal habitat it was covering 24% of Peninsular Malaysia. Results of the best model revealed that the protected areas covered only 21.9% of the total marginal and suitable habitat. Extending the boundaries of protected areas and establishing new areas has the highest priority for any conservation action plans. This study plays an important role in increasing the limited knowledge of habitat preferences of the Malayan Sun Bear.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

PEMODELAN HABITAT DAN POTENSI PENYEBARAN BERUANG MATAHARI (*HELARCTOS MALAYANUS RAFFLES*) MENGGUNAKAN TEKNOLOGI MAKLUMAT GEOSPATIAL

Oleh

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Hutan tropika sering menjadi kawasan tumpuan biologi namun, tidak banyak kajian yang dijalankan untuk menentukan potensi penyebaran spesies. Pemodelan penyebaran spesies di kawasan tropika yang mempunyai pengkadaran tinggi dalam deforestasi dan pengasingan habitat adalah penting untuk program pengurusan spesies. Mengenal pasti keperluan ekologi dan melukiskan taburan spesies di serata habitat merupakan asas pemuliharaan alam. Simulasi dalam pengkhususan ruang membolehkan perancang konservasi mengenal pasti kawasan penting yang perlu dilindungi, pengesanan koridor hidupan liar, dan memeliharakan landskap. Penyelidikan ini menilai aplikasi pemodelan penyebaran spesies untuk habitat Beruang Matahari dengan menggunakan entropi maksimum (MaxEnt) dan faktor analisis dalam bidang ekologi (ENFA) yang khususnya menekankan penderiaan jauh dan data GIS. Demi menguji keberkesanan model, dua skala ruangan yang berbeza dipilih dari Rezab Hidupan Liar Krau (KWR) dan Semenanjung Malaysia untuk pemodelan habitat yang sesuai

untuk beruang Matahari. Walaupun keputusan kajian menunjukkan bahawa kedua-dua output pemodelan dapat diterima dalam dua skala yang berbeza, tetapi MaxEnt dapat mendiskriminasikan habitat yang kecil daripada habitat yang sesuai semasa ia digunakan dalam skala yang lebih besar. Selain itu, ENFA menunjukkan keputusan yang lebih memuaskan semasa ia digunakan dalam skala yang lebih kecil. Perlawanan yang didapati daripada keputusan kajian juga diterima oleh plot AUC (Area under the receiver operator characteristics Curve). AUC menilaikan model dari 0.87 (skala kecil di KWR) hingga 0.97(skala besar di Semenanjung Malaysia),dan ianya mencadangkan peramalan spesies-ekogeographikal yang kuat dan tepat. Sesetengah pembolehubah persekitaran seperti penutup lahan, indeks vegetasi dan pembolehubah cuaca yang digunakan dalam metodologi mempunyai korelasi yang tinggi demi reka bentuk peta kesesuaian habitat. MaxEnt mengasingkan ruang yang sesuai sebanyak 5% daripada 131598 km^2 di Semenanjung Malaysia dan 13% daripada jumlah luas di habitat kecil. ENFA menunjukkan habitat sesuai sekali ganda iaitu 10% untuk Semenanjung Malaysia dan 24% dalam habitat skala kecil. Model yang terbaik menunjukkan bahawa kawasan lindung tersebut hanya mengandungi 21.9% daripada jumlah habitat yang sesuai. Peluasan kawasan lindung dan mengenalkan kawasan lindung baru adalah langkah yang sangat penting di dalam mana-mana rancangan konservasi. Kajian ini memainkan peranan penting dalam menambahkan pengetahuan dalam keutamaan habitat dan kegunaan habitat Beruang Matahari.

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I certify that a Thesis Examination Committee has met on (23 June 2011**)** to conduct the final examination of (Mona Nazeri) or her thesis entitled " Habitat modeling and potential distribution of the Malayan Sun Bear (*Helarctos Malayanus*) Using Geospatial Information Technology " in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

MONA NAZERI

Date: 23 June 2011

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