DEVELOPMENT OF PARAMETRIC MODEL FOR UNGROUPED AND GROUPED LINE TRANSECT DATA

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ABSTRAK

Pensampelan transek garis adalah kaedah pengamal statistik yang kerap (*frequentist*) digunakan dalam ekologi untuk menganggarkan jumlah penduduk atau kepadatan objek di kawasan kajian yang ingin dikaji. Tesis ini memberikan kaedah baru untuk menghasilkan fungsi pengesanan (*detection function*) yang baru berdasarkan garis transek teori persampelan. Ciri-ciri kaedah baru yang dibangunkan dapat menghasilkan model yang tidak meningkat secara monotonik yang fleksibel. Berdasarkan kaedah ini, model parametrik baru dapat dibangunkan dan dicadangkan untuk mengira kepadatan penduduk berdasarkan data transek garis. Kelebihan model yang dicadangkan adalah penurunan secara monoton dengan jarak tegak lurus dan memenuhi andaian keadaan bahu (*shoulder condition*). Beberapa sifat model statistik yang dihasilkan ditunjukkan dan kesimpulan mengenai penganggar $f(0)$ bagi model yang dicadangkan diperolehi dengan menggunakan kaedah perkiraan momen (MME), penganggar kebolehjadian maksimum (MLE) dan taburan asimtotik. Terdapat dua cara terutama untuk mengira anggaran kepadatan penduduk iaitu kaedah bersifat parametrik dan kaedah bukan parametrik. Tesis ini memberi tumpuan kepada penggunaan penganggar kebolehjadian maksimum (MLE) untuk menganggarkan parameter $f(0)$ sebagai kaedah anggaran berparametrik. Untuk kaedah anggaran bukan parametrik, anggaran kernel digunakan untuk menghasilkan penganggar bukan parametrik untuk $f(0)$. Penggunaan penganggar kernel bersama dengan model yang dicadangkan dapat menghasilkan parameter kelicinan kernel (*smoothing kernel*). Prestasi penganggar yang dihasilkan bagi kedua-dua kaedah penggaran untuk model yang dicadangkan ini dinilai melalui kajian simulasi dan kemudian dibandingkan dengan model yang sediaada didalam literatur. Prestasi ini diukur dengan menggunakan kaedah Ralat Relatif Min (RME) dan Pincangan Relatif (RB). Keputusan kajian simulasi bagi kaedah anggaran parametrik menunjukkan model yang dicadangkan dapat mengungguli prestasi berbanding model yang sedia ada. Prestasi yang baik dari model yang dicadangkan membawa kepada penggunaannya sebagai rujukan untuk mengira parameter kelicinan kernel (*smoothing kernel*) bagi kes anggaran bukan parametrik. Hasil simulasi untuk kes ini juga menunjukkan keunggulan menggunakan model yang dicadangkan sebagai rujukan bagi model separuh-normal (*half-normal*) yang disyorkan di kebanyakkan kes didalam bidang kajian ini. Akhirnya, kedua-dua kumpulan data yang terkumpul dan tidak terkumpul dipertimbangkan di mana contoh pengiraan berangka menggunakan data simulasi dan sebenar digunakan untuk menggambarkan dan membincangkan, dan dianalisis dengan menggunakan model yang telah dicadangkan dan dibangunkan. Model yang dihasilkan bagi kes data terkumpul dinilai berdasarkan varians penganggar $f(0)$, dan didapati bahawa penganggar yang dihasilkan menunjukkan prestasi yang lebih baik daripada model lain yang sedia ada dengan memberikan nilai varians terendah $f(0)$ untuk semua kes yang dipertimbangkan didalam kajian ini.

ABSTRACT

Line transect sampling is a frequentist statistical method used in ecology to estimate the population abundance or density of objects in an interested study area. This thesis provides a new method for generating a new detection function based on the line transect sampling theory. The feature of the presented method provides a flexible and automatically monotonic non-increasing model. Based on this method, a new parametric model is developed to estimate the population density based on the line transect data. The advantages of the proposed model are to be strictly monotonically decreasing with perpendicular distance and it satisfies the shoulder condition assumption. Some statistical properties of the proposed model are presented and inference about the estimator $f(0)$ is obtained by considering the method of moments estimation (MME), maximum likelihood estimator (MLE) and the asymptotic distribution for the proposed model are also considered. There are mainly two ways to estimate the population density which are parametric and non-parametric estimation methods. This thesis focus on using the maximum likelihood estimator (MLE) to estimate the parameter of $f(0)$ as the parametric estimation method. For non-parametric estimation methods, a non-parametric kernel is used to propose new estimator for $f(0)$ by combining the kernel estimator with the proposed model. The use of kernel estimator together with the proposed model to compute the smoothing parameter of the kernel estimator is also considered. The performance of the proposed estimator for the developed model is estimated and evaluated using a parametric and non-parametric estimation method via a simulation study and is later compared to existing models in the literature. The developed model is measured by evaluating the performance of the proposed estimators in terms of Relative Mean Error (RME) and the Relative Bias (RB). The results of the simulation study of estimation methods show promising statistical properties of the proposed model which out-performed the existing models. The good performances of the proposed model led to the use of it as a reference to compute the smoothing parameter of the non-parametric kernel estimator. The simulation results also show that the superiority of using the proposed model as a reference over the recommended half-normal model in most considered cases. Finally, both the grouped and ungrouped data are also considered whereby a numerical example using real data is used to illustrate and discuss and has been analysed using the developed model. In addition, the developed model is evaluated based on the variance of the estimators $f(0)$, it is found that the proposed estimator appears to fit data better than the other considered models with the lowest values of variance of $f(0)$ for all cases considered.

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