

研究论文

松花湖富营养化发生的阈值判定和概率分析

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摘要 湖泊、水库富营养化是目前国内外环境科学领域关注的热点, 也是我国面临严峻的水环境问题。选择松花湖为研究对象, 以2002~2004年松花湖水体中与富营养化相关指标的特征为依据, 运用多元相关分析和多元逐步回归分析以及室内藻类模拟实验和蒙特卡罗随机模拟的方法, 围绕松花湖富营养化主要限制因子识别、富营养化发生的阈值判定和概率分析开展研究。结果指出: 总磷和总氮是松花湖富营养化的主要限制因子, 总磷是水体富营养化的第一限制因子; 松花湖富营养化发生的阈值为: 总磷含量 $0.065\text{mg}\cdot\text{L}^{-1}$ 、总氮含量 $0.843\text{mg}\cdot\text{L}^{-1}$ 和叶绿素a浓度 $11.90\text{ }\mu\text{g}\cdot\text{L}^{-1}$; 松花湖水体发生富营养化的概率为0.69, 其中, 无风险的区域占19.21%、一级的区域占9.79%、二级占20.31%、三级占16.5%、四级占25.8%、五级占8.39%, 可见, 松花湖大部分区域处于轻度富营养化阶段, 小部分区域处于中营养阶段。该结论对全面、合理地了解松花湖富营养化的现状以及有效地预防和控制松花湖富营养化的发生和保护湖泊水质具有重要的参考价值, 也为水体富营养化的定量化和制定富营养化的标准提供了可行的途径和方法。

关键词 松花湖 富营养化 阈值 总磷 总氮

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Probability and threshold values for recognizing eutrophication in Lake Songhua

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Abstract : Eutrophication of lakes or reservoirs as a consequence of human activity is a worldwide problem. The process of eutrophication was investigated in Lake Songhua in the Northeast China. Chlorophyll a concentrations and 18 physico-chemical (Water depth, Water temperature, EC, pH, Transparency, DO, COD, TOC, TP, TN, PO_4^{3-} -P, NO_3^- -N, NH_4^+ -N, NO_2^- -N, Organic nitrogen, T-Fe, SiO₂, Chlorophyll a) parameters were monitored and analyzed during 2002-2004 in the lake water. At the same time, a predominant algal species (unialgal strain *Microcystis aeruginosa*) from the summer planktons of the lake was separated and purified. Multiple correlation and stepwise multiple regression analysis were applied to the monitoring data. The results indicated that the total phosphorus concentration was the first impact factor for eutrophication followed by total nitrogen.

The effects of available phosphorus and available nitrogen on algal growth were studied in the laboratory by a culture experiment. The relationships between maximum specific growth rate of algal and available phosphorus and available nitrogen concentrations in water were expressed graphically. An inflexion in each curve identified the threshold values of available phosphorus and nitrogen to initiate eutrophication in the lake: these values were $p=0.025\text{ mg}\cdot\text{L}^{-1}$ and $N=0.55\text{ mg}\cdot\text{L}^{-1}$.

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1. A relationship was established between the concentrations of total aqueous P and N and their available values and hence with those of chlorophyll a. Finally, appropriate threshold eutrophication values were derived for Lake Songhua, namely, $TP=0.065\text{mg}\cdot\text{L}^{-1}$, $TN=0.843\text{mg}\cdot\text{L}^{-1}$ and chlorophyll a= $11.9\mu\text{g}\cdot\text{L}^{-1}$.

The frequency distribution and cumulative frequency distributions were computed for the three analytes. For chlorophyll a, 69% of values exceeded $11.9\mu\text{g}\cdot\text{L}^{-1}$. Thus the probability of eutrophication in 2002-2004 for lake Songhua was 0.69. A Monte Carlo random simulation model yielded 6 classes. Using these as limits in a probability map derived from Arc/info 8.01 showed the risk-free area was 19.21%, first class area was 9.79%, second class area was 20.31%, 3rd class area was 16.5%, 4th class area was 25.8%, and 5th class area was 8.39%. Therefore, most of Lake Songhua water is probably at the slight eutrophication stage. In contrast, eutrophication at the mouths of rivers Huifahe and Jiaohe is serious only.

Key words : Songhua Lake _ _ eutrophication _ _ threshold _ _ TP _ _ TN

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