International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean

Preliminary result about the effect of the difference in data distribution[1]

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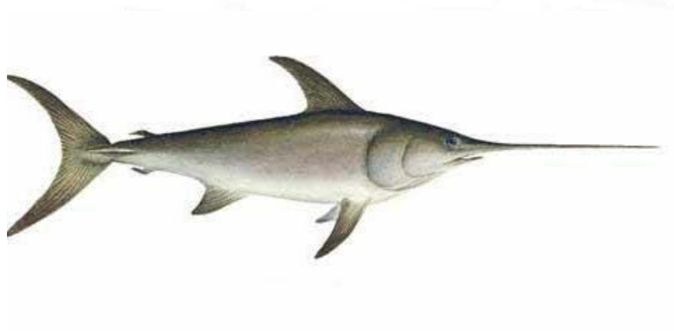

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Abstract

Japanese longline fishery data may have different error distribution because it changed historically under biological, political and/or social reasons. In these days, the coverage area of data was decreasing and that is one of the major reasons why error distribution was changed. In such a situation, if we still assume that error distribution is same historically, it can make biased error on stock abundance indices like standardized CPUE. In this study I will show that there is a probability in which biased error will occur under such a situation by using analytical and simulation method. It should be considerable problem on stock assessment of tuna and pelagic fishery.

Introduction

Japanese longline fishery has risen and fallen historically by biological, political and/or social reasons. Recently, the area coverage of Japanese longline fishery is decreasing and it will decrease more in future. Such a change must make effect to the distribution of observation error in these data, especially to the variance of distribution. Here I want to show Japanese longline data of sword fish in North Pacific Ocean (5x5 degree, yearly and monthly) as example. When we look at the historical change of nominal CPUE, we can see there is some change on that distribution around 1974 (Fig. 1). If data has such a difference in error distribution, that may make some bias on standardization (Flewelling & Pienaar 1981). If the decline of area coverage will make the biased error to the predicted trend, we need to consider about how to solve and remove that biased error. It is my purpose of this study that I will clarify whether and how big such a bias occurs by using analytical and simulation method.

Method

Analytic study

I try to estimate the bias from difference of error distribution by using simple analytical model. I assume the true value of stock abundance is in *a* and it has error with log-normal distribution ($\ln(a+\varepsilon) = n(\mu, \sigma_\varepsilon^2)$). I assume true number is in the mode of that distribution. I assumed the variance in year *t* is σ_1^2 and next year's (*t*+1) one is σ_2^2.

Simulation study I

I made the data by using sword fish catch data of Japanese longline fishery in 1980, because in that year we have most area coverage and that year is most recent year of years in which area coverage is wide. First we predict catch by using GLM with equation,

C~Year+Month+log(hooks)+hpb.

Using this predicted value as "true value", I calculate residual (R) between predicted catch (C_p) and observed catch (C_o), i.e. $R = C_o - C_p$. For simulated first 5 years, I use C_o as observed catch and for last 5 years, I use $C_p + 2R$. The simulated data distribution is showing in Fig. 2. I predict the catch by using GLM with equation,

log(C+1)~Year+Month+log(hooks)+hpb.

Simulation study II

Used original data is same with simulation study I. For first 5 years, I use observed catch directly as simulated data and for last 5 years, I use only the data whose hooks data is larger than 10000. This is the simulation which the coverage area is decreasing. The simulated data distribution is showing in Fig. 5. The GLM equation which is used for standardization is same with simulation study I.

Result

Analytic study

Log-normal distribution's average is known as $\mathrm{Exp}(\mu + \frac{\sigma_\varepsilon^2}{2})$, and when mode is *a*, $\mu = \mathrm{Log}(a) + \sigma_\varepsilon^2$. In this situation average becomes $a \times \mathrm{Exp}(\frac{3\sigma_\varepsilon^2}{2})$. Then the angle becomes $a\left(\mathrm{Exp}(\frac{3\sigma_2^2}{2}) - \mathrm{Exp}(\frac{3\sigma_1^2}{2})\right)$.

Simulation study I

For last 5 years, the standardized CPUE has wider distribution (Fig. 3) and relative annual trend showed higher than first 5 years (Fig. 4).

Simulation study II

For last 5 years, the standardized CPUE has narrower distribution (Fig. 6) and relative annual trend showed lower than first 5 years (Fig. 7).

Discussion

In this study, I showed the change of error distribution can make biased error on abundance indices. It may make misunderstanding to the annual trend of stock abundance.

In recent year, the number of Japanese longline boat has been decreasing and it probably make decline of area coverage. In near future, the decline will continue and the biased error which I showed in this study will increase.

It is very important to analyze such an effect because such a biased error can hide the true trend of stock abundance. Because if boat will gather to good fishery area, that make overestimating in abundance indices and in same time the decline of coverage area make underestimating in it. These are conflicting effect and we don't know which effect is higher or lower. It may make serious effect to stock management.

Because this study is just started and result is preliminary one, I can not show exact way to solve this problem. However, I have some ideas to try to solve this problem by using model selection method and/or adding the parameter to show the error distribution's change. I will try to study solution of this problem.

Reference

Flewelling, JW., and LV. Pienaar, 1981, Multiplicative regression with lognormal errors., Forest Science Vol. 27 p281-289.

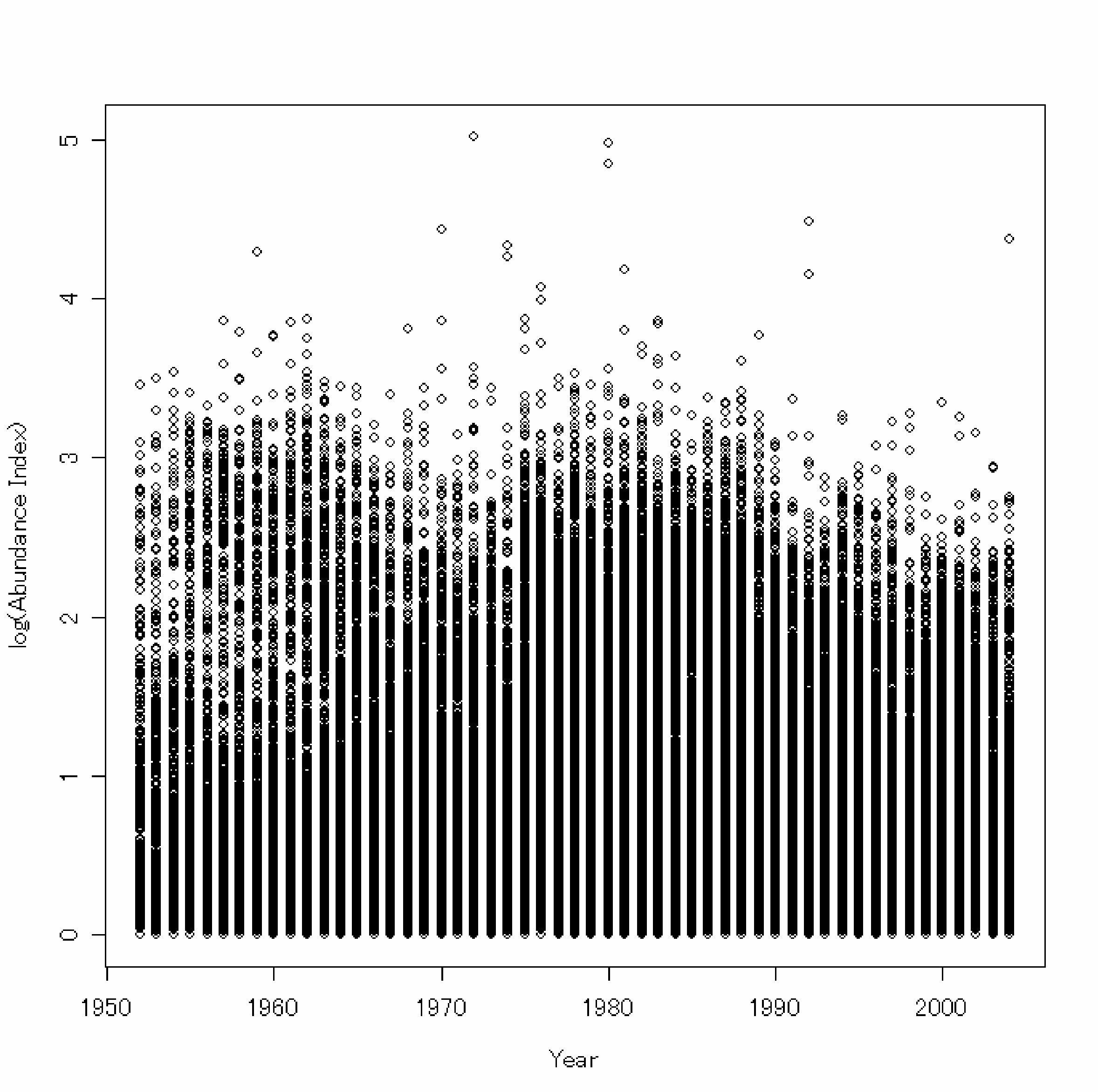

Fig. 1 logged Nominal CPUE of sword fish. There is some difference in distribution between before and after 1974.

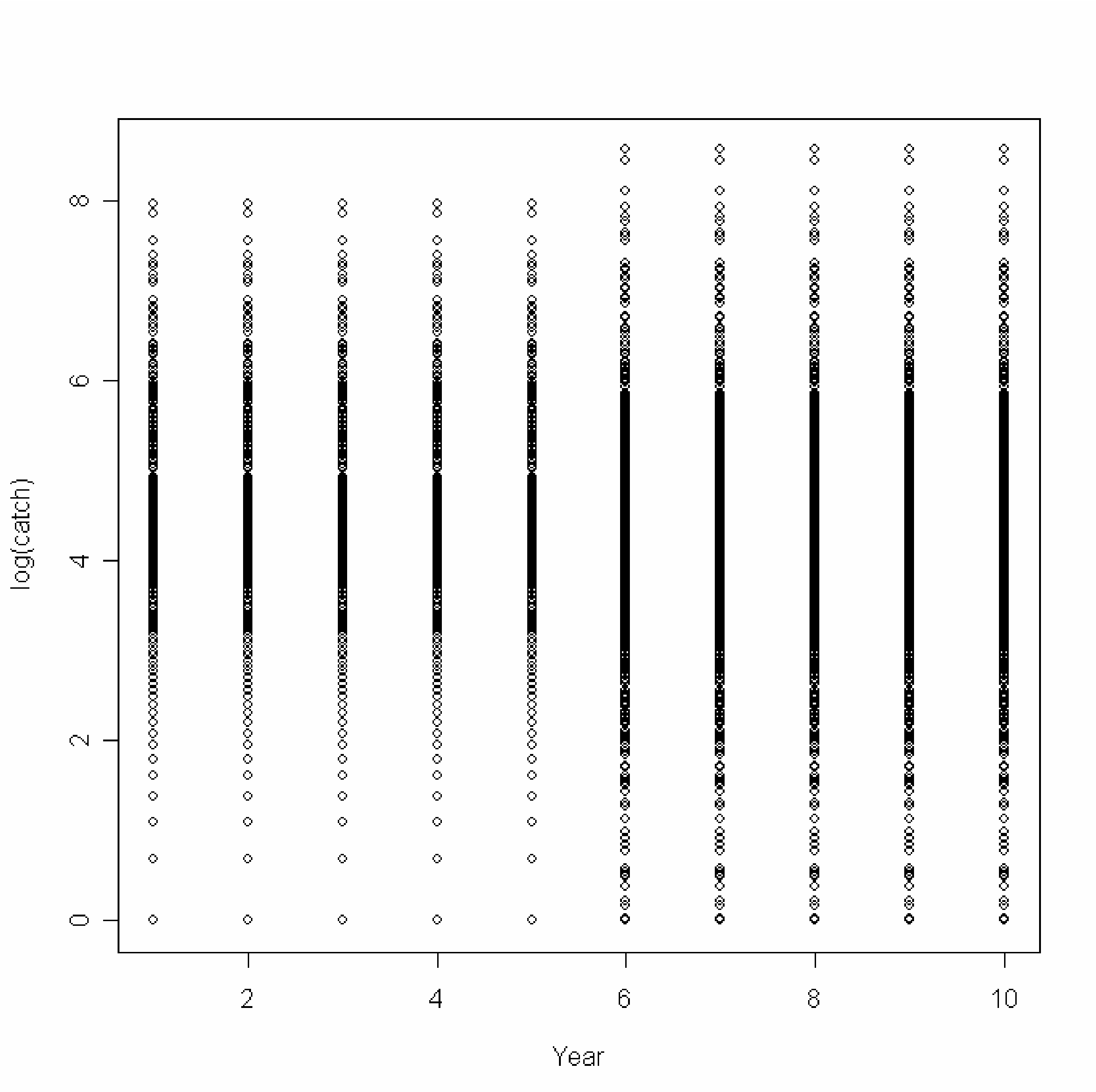

Fig. 2 Logged catch which is used on simulation study I.

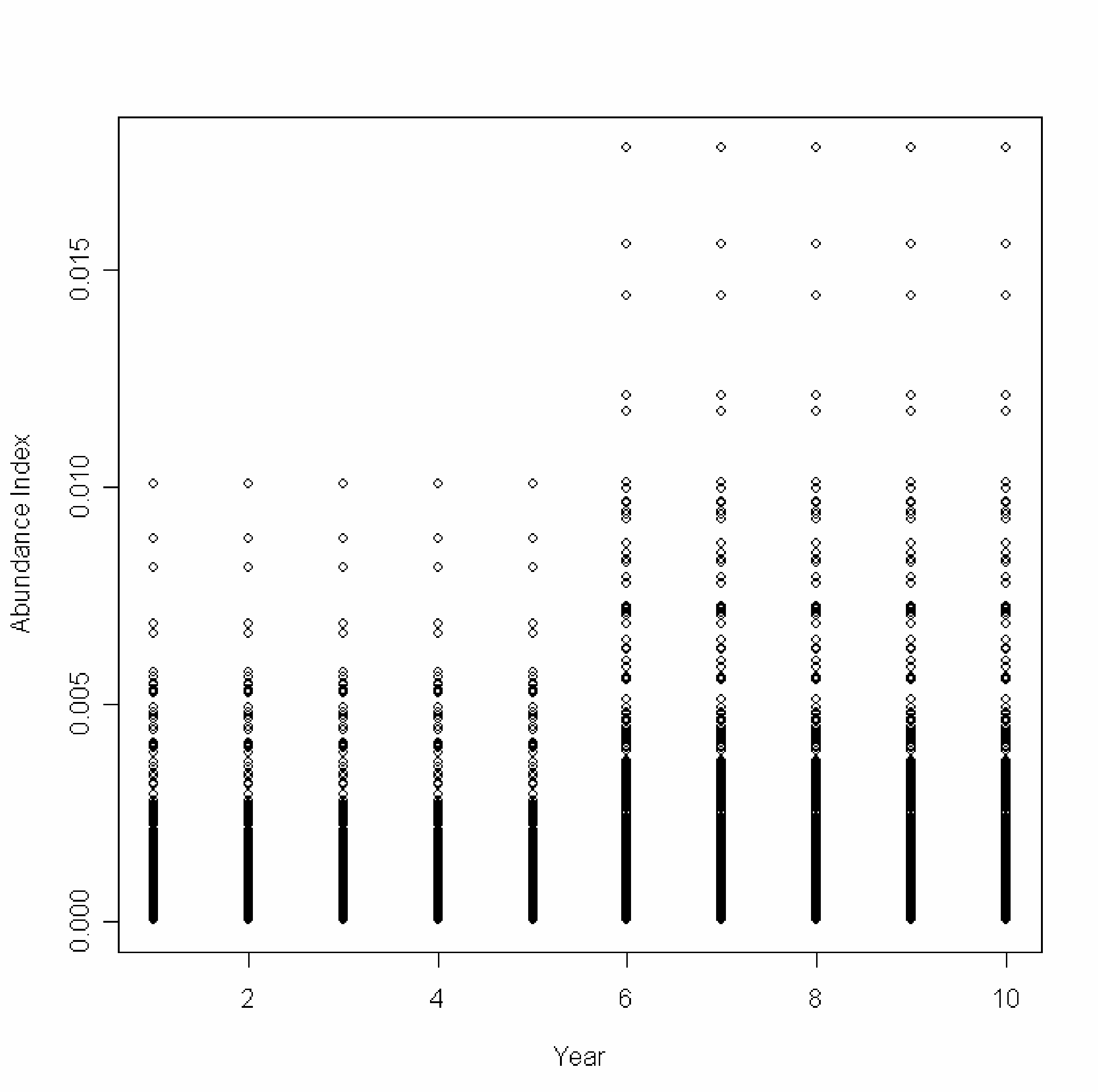

Fig. 3 Standardized CPUE in simulation study I.

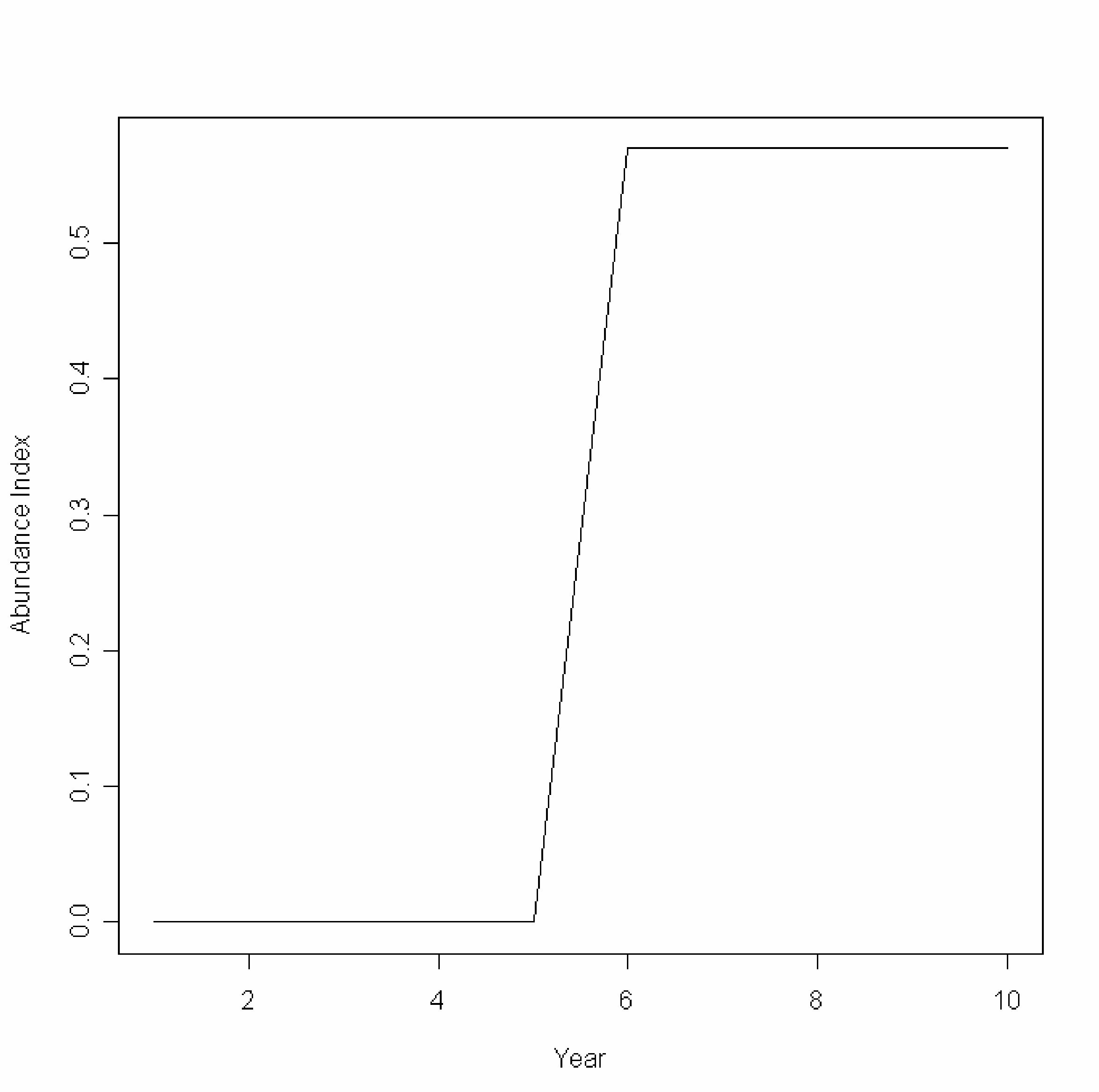

Fig. 4 Relative annual trend of standardized CPUE in simulation study I.

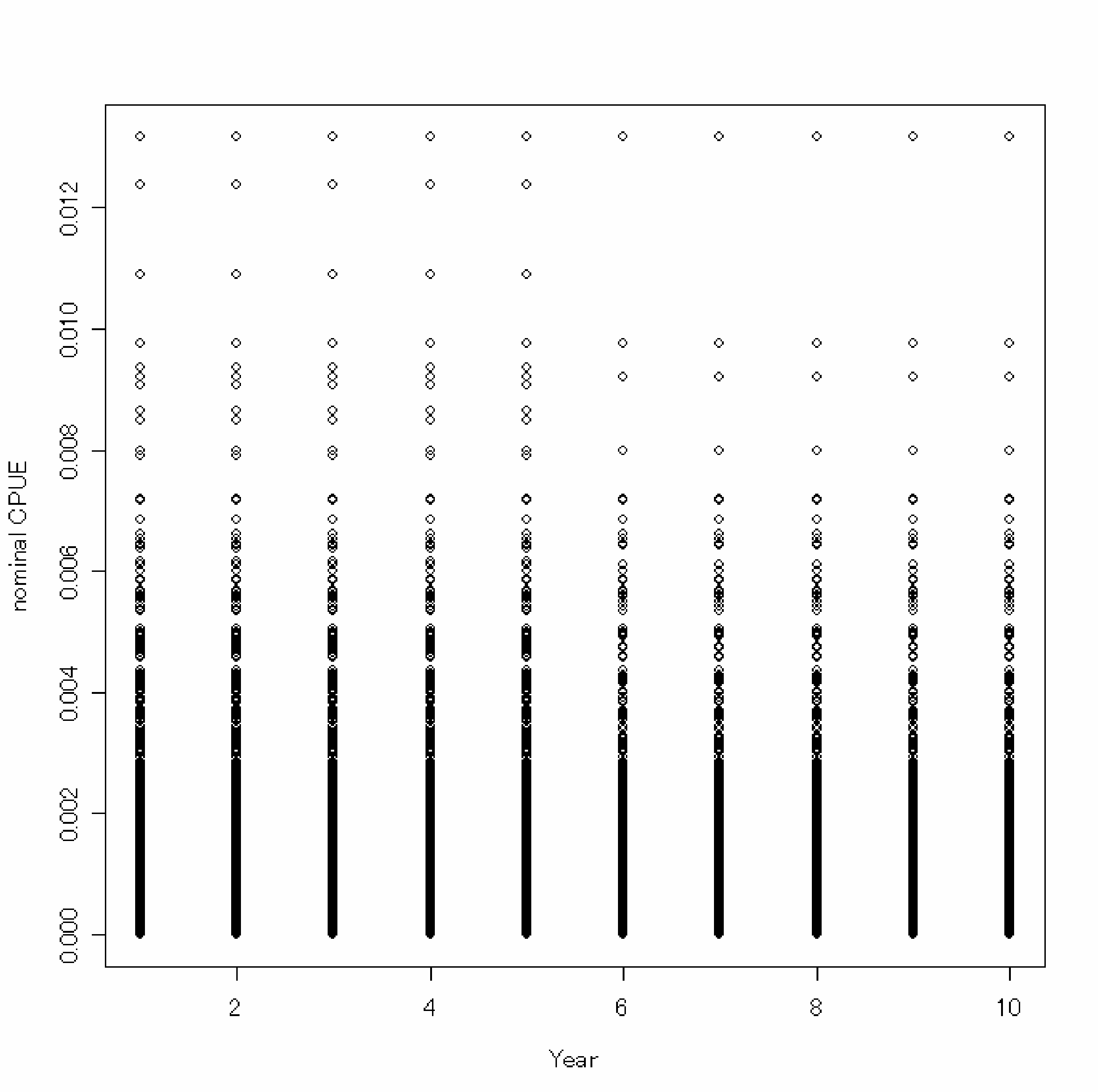

Fig. 5. Nominal CPUE which is used in simulation study II.

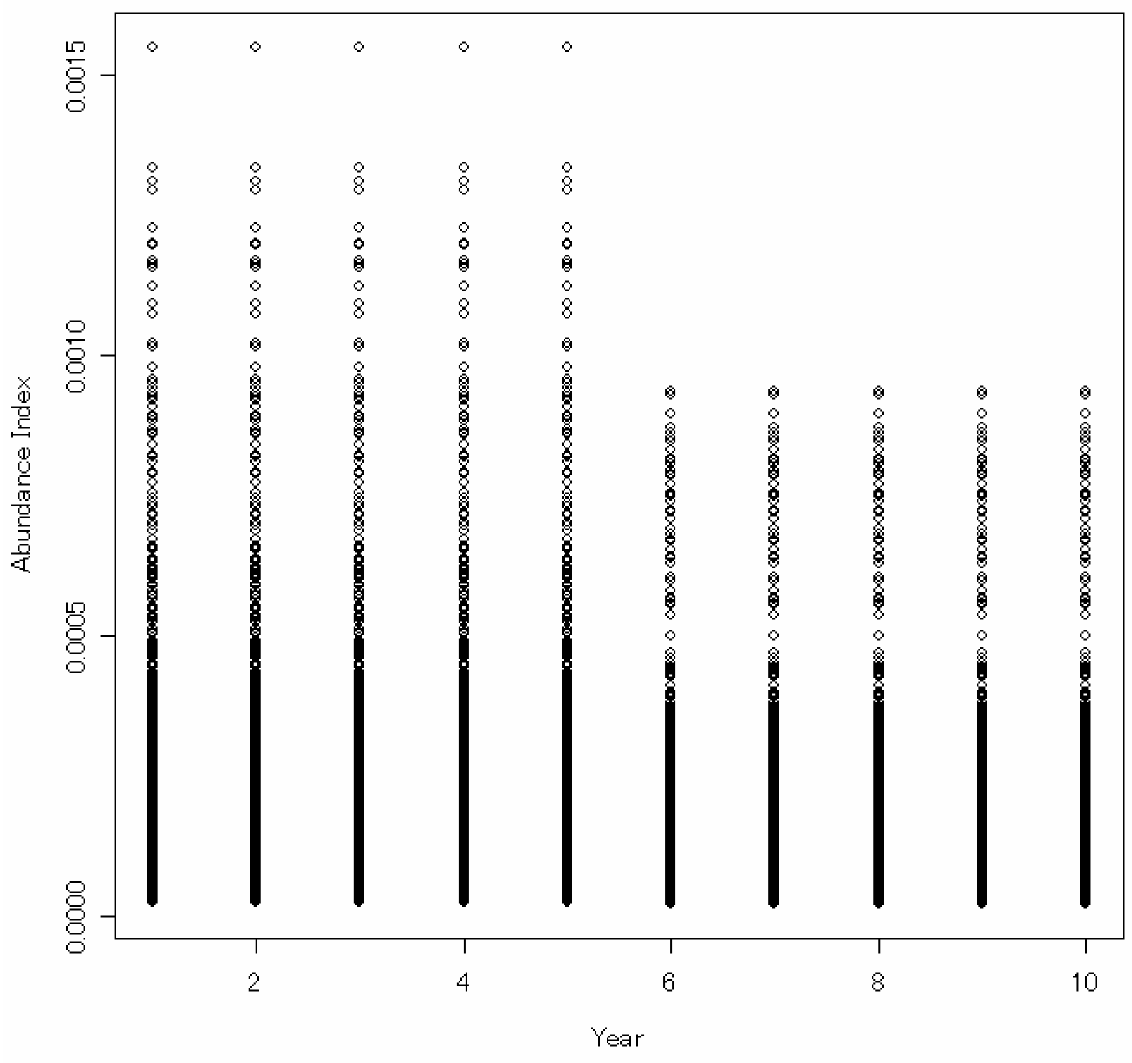

Fig. 6 Standardized CPUE in simulation study II.

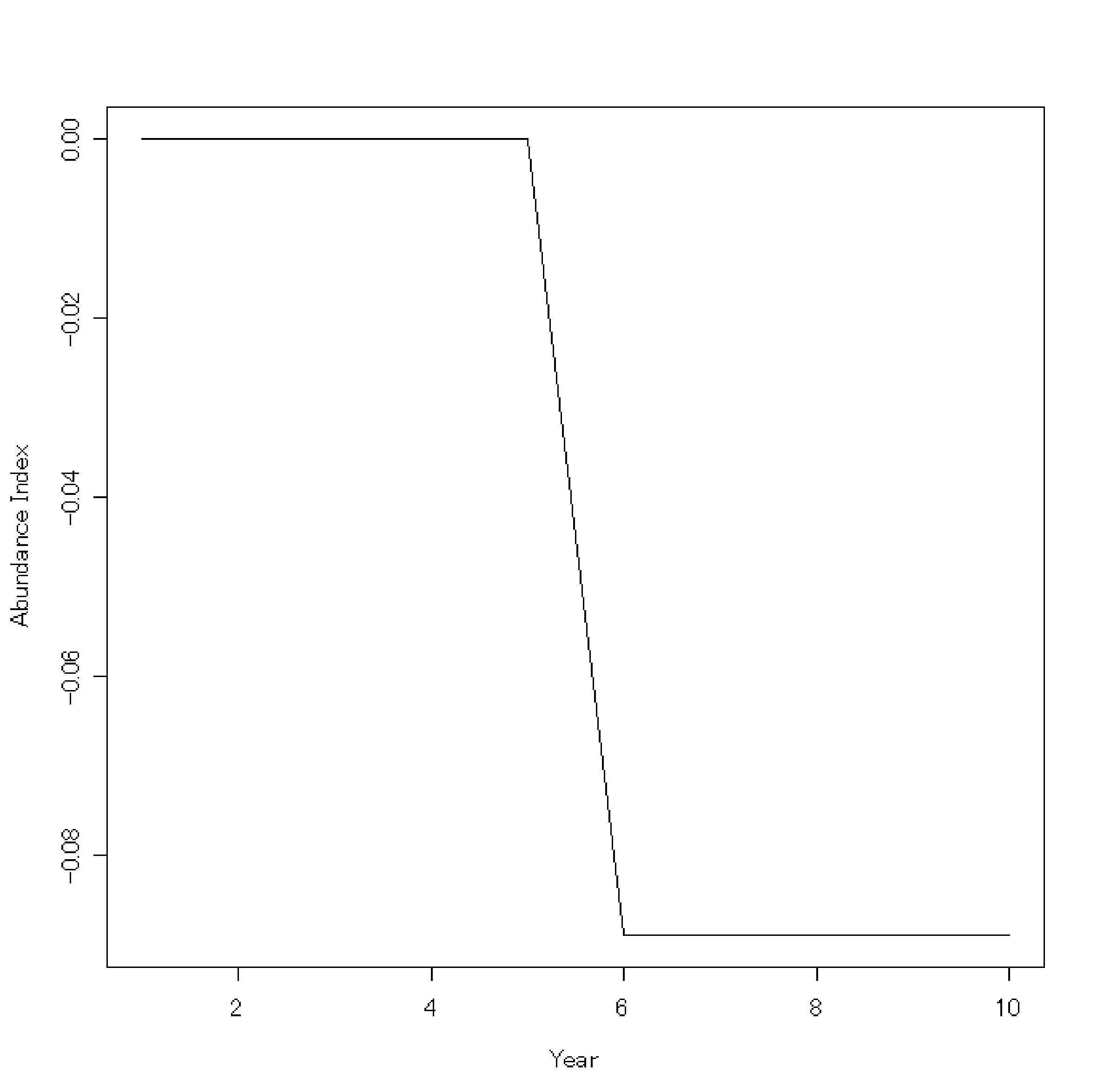

Fig. 7 Relative annual trend of standardized CPUE in simulation study II.