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Monitoring Stock of Round Scads in Thailand with CUSUM Control Chart

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Abstract

This study proposed the cumulative sum (CUSUM) control chart as the statistical process control (SPC) technique in detecting the stock profusion of round scads in Thailand. The result of study exemplified the CUSUM control chart was apparently capable to monitor changing in the stock of round scads. The negative deviation of CUSUM statistic obviously illustrated a distinguishable signal of Thai round scad resources was severely decreasing from 2008 to 2011.

Keywords: Round Scads, CUSUM control chart

Mathematics Subject Classification: 62-07, 62G35

INTRODUCTION

Carangidae is a family of fish which includes the jacks, pompanos, jack mackerels, runners and scads [1]. Three Decapterus (D. maruadsi, D. macrosoma and D. russelli) known as round scads are the pelagic marine fish discovered in the southern Indochina peninsular of Thailand which is composed of two long coasts along the Gulf of Thailand and the Andaman Sea. The round scads play the considerable national economy of Thai marine fisheries because they are easily caught with seine also they are popularly consumed as sushi. The department of Fisheries reported in 2007 that the catch of round scads (20,779 metric tons) was over 30% of the maximum sustainable yield (MSY) and the value of round scads (604.66 million baht) was over 40% of the maximum sustainable economics yield (MEY) [2]. As of all mentioned reasons, it implied the inclination of round scad resources was significantly decreasing.

Initially, control chart is widely used to investigate the abnormalities of manufacturing processes [3], [4], [5]. The cumulative sum (CUSUM) is one of the

favorably important control charts. It is applied for detecting small change of process in many fields particularly in fishery researches, for example, [6], [7], [8], [9], [10], [11]. Both of two statistic values (positive and negative deviations) of CUSUM are plotted against the sample order or the time into the chart containing the center line (CL.) and the upper and lower control limits ($UCL. = h$ and $LCL. = -h$). This study then practically demonstrated using the CUSUM control chart in monitoring the stock of round scads in Thailand by tuning two CUSUM parameters in accordance with [9], [10]. The parameters of allowance and decision limit were subsequently set equal to 1.3 and ±1 (or $k = 1.3$ and $h = \pm 1$).

MATERIALS AND METHODS

The stock of round scads in Thailand was supplied in the amount of 1,000 tons during 1994-2011 by Fisheries Statistics, Department of Fisheries [12]. A pilot study was considered to determine two parameters, mean and standard deviation of round scad amount, for a reference period due to data of fish resources was just systematically reported in recently.

Suppose a stock set of round scads (x_i) was recorded at time i; $i = 1994, 1995, \ldots, 2011$ and estimate the in-control mean ($\bar{x}$) and standard deviation (s) of round scads for the in-control state (1994-2006). Three steps of monitoring stock of round scads were as follows.

1. Transforming each of the amount of round scad (x_i) to the standardized value of round scad amount (z_i) with $z_i = \frac{x_i - \bar{x}}{s}$ where $\bar{x}$ and s be the estimated value of mean and standard deviation of the amount of round scads, respectively.
2. Calculating two test statistic values plotted into the CUSUM control chart discovered by [13]. The one-sided upper CUSUM is defined as $S_i^+ = \max[0, S_{i-1}^+ + z_i - k]$ called the positive deviation. On the other hand, the other statistic value known as the negative deviation is the one-sided lower CUSUM computed with $S_i^- = \min[0, S_{i-1}^- + z_i + k]$ where k be the CUSUM parameter known as the allowance or reference value. S_i^+ and S_i^- are generally set equal to zero for the starting values ($S_i^+ = S_i^- = 0$).
3. Constructing the CUSUM control chart established with the three reference lines, $UCL./LCL. = \pm 1$ and $CL. = 0$, by plotting both of positive and negative deviations against i. The process is notified as the in-control state if either S_i^+ or S_i^- is laid between the upper and lower control limit. Otherwise, it is indicated the out-of-control state.

RESULTS

When the standardized values of round scad amount (z_i) were obtained, the positive and negative deviations (S_i^+ and S_i^-) were determined. Then, the CUSUM control chart of round scad stock in Thailand was illustrated as of Figure 1 after plotting both of S_i^+ and S_i^- into the chart.

The obtaining CUSUM control chart apparently figured the stock of round scads was severely decreasing from 2008 to 2011 as seeing of the values of S_i^- at the year 2008-2011 were plotted below the lower control limit. In addition, all values of S_i^+ still maintained between the upper and lower control limits.

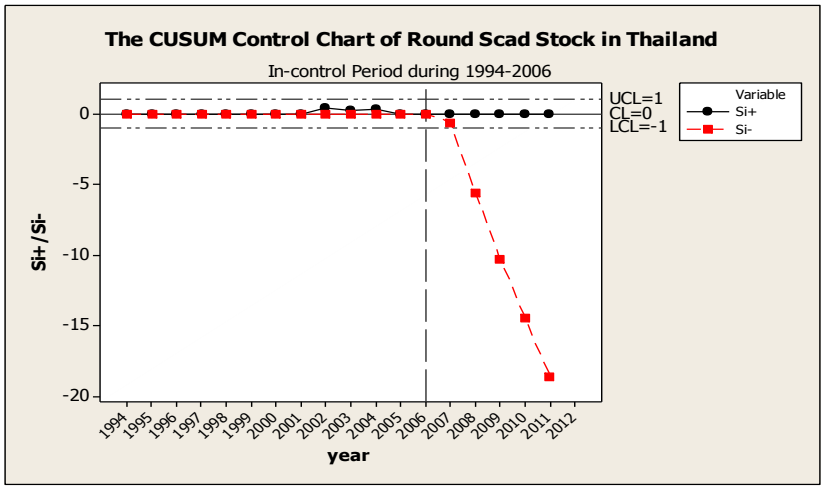

Figure 1: The CUSUM Control Chart of Round Scad Stock in Thailand

DISCUSSION

The positive and negative deviations of CUSUM control chart are equally important so it is very useful in many applications of real life including in fishery because it does not assume any characteristic change. The results of this study were convinced that the CUSUM control chart appropriately appraised in monitoring small change. This finding pointed out the stock of round scads was sharply deceasing from 2008 to 2011. Moreover, this result would be helpful to notify the one who committed to operate, control and turn the round scad stock of Thai resources back to the stability of marine ecosystem.

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