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Stock Discrimination and Connectivity Assessment of Yellowfin Seabream (*Acanthopagrus latus*) in Northern South China Sea Using Otolith Elemental FingerPrints

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ABSTRACT

Connectivity between fish stocks is fundamental to the understanding of population dynamics and the design of sustainable fisheries management. Otolith microchemistry is a promising tool as it can provide information on the continuous growth of otoliths and the environmental effects on otolith composition. Such elemental fingerprints can help distinguish different stocks or life history stages, identify the origins or nursery areas of fish, and assess population structure. In this study, we examined the stock discrimination and spatial connectivity of cage-cultured and wild stocks of yellowfin seabream (Acanthopagrus latus) from the coastal waters of Shantou, Yangjiang, and Zhanjiang in China southern province Guangdong during 2012–2014, based on otolith trace-elemental signatures using multivariate statistical analysis and machine learning approaches. The concentrations of 13 elements (^{7}Li, ^{23}Na, ^{24}Mg, ^{40}Ca, ^{55}Mn, ^{56}Fe, ^{59}Co, ^{59}Ni, ^{64}Cu, ^{65}Zn, ^{88}Sr, ^{122}Sb, and ^{137}Ba) in the natal spot of fish otoliths, representing the embryonic and paralarval stages of fish, were analyzed using laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS). Stepwise discriminant analysis and random forests were used to distinguish the cultured and wild stocks of yellowfin seabream, and non-metric multidimensional scaling (NMDS) and cluster analysis were used to determine the spatial variation and connectivity of yellowfin seabream stocks. Overall, the cultured and wild stocks of yellowfin seabream could be identified with classification accuracy of 80.7% and 90.2% by using stepwise discriminant analysis and random forests respectively. When we compared site differences between cultured and wild stocks (site × stock interactions), the classification success was 60.5% for stepwise discriminant analysis and 85.7% for random forests. The misclassification of cultured and wild stocks within the three sites suggested the spatial connectivity between stocks and among sampling locations. Our findings suggested that the three wild stocks of yellowfin seabream from Guangdong coastal waters could be considered as one unit for management, and the difference between cultured and wild stocks were significant for yellowfin seabream from Shantou and Yangjiang, but less significant for yellowfin seabream from Zhanjiang. This study demonstrated that otolith elemental fingerprints can help improve our knowledge on the spatial connectivity, population structure, and life history of fish stocks, and random forests can be a useful tool for identifying cultured and wild stocks compared to the traditional stepwise discriminant analysis.

Keywords: Cluster analysis; Non-metric multidimensional scaling (NMDS); Random forests; Stepwise discriminant analysis; Stock discrimination; Sustainable fisheries management

1. INTRODUCTION

Fish stocks are generally considered as the fundamental units in fisheries management. Marine fish species often exist as mixed stocks because of the complexity of ocean conditions and fish life history (Bacha et al., 2014). Stock identification has been used in fisheries for classifying mixed stocks and tracking species movement or migration. Successful discrimination of stocks is critical for investigating population dynamics and trophic interactions with other marine resources (Pita et al., 2016), and defining stock boundaries (Cadrin, 2000; Atta et al., 2017). Stock management based on stock discrimination is increasingly used for providing guidance on fishery resources assessment, optimization of fishing efforts on stocks at spatial and temporal scales, and evaluation of management strategies (Pita et al., 2016). For example, being able to classify mixed spawning stocks can help identify the origins of fish caught, quantify the propor-