Title	Real-time spatial management using surveillance information: A case study of short mackerel purse seine fishery [an abstract of entire text]
Author(s)	MEEANAN, Chonlada
Description	この博士論文全文の閲覧方法については、以下のサイトをご参照ください。 https://www.lib.hokudai.ac.jp/dissertations/copy-guides/
Degree Grantor	北海道大学
Degree Name	博士(食資源学)
Dissertation Number	甲第16027号
Issue Date	2024-03-25
Doc URL	https://hdl.handle.net/2115/92629
Type	doctoral thesis
File Information	Chonlada_Meeanan_summary.pdf

博 士 論 文 の 要 約

博士の専攻分野の名称：博　士（食資源学）　　　　氏名　Chonlada Meeanan

学 位 論 文 題 名

Real-time spatial management using surveillance information:
A case study of short mackerel purse seine fishery
（監視情報を利用したリアルタイム禁漁区管理：
グルクマ属魚類 *Rastrelliger brachysoma* を対象としたまき網漁業の事例研究）

I. Introduction

Area and time restriction has become one of the most extensively utilised fisheries management strategies due to its simple implementation, benefits for conservation, and potential for fisheries improvement. In response to the limitations associated with static closures (STCs) concerning the uncertainty surrounding fish migrations, dynamic closures or real-time closures (RTCs) have been increasingly implemented in fisheries worldwide. RTCs are a relatively new fisheries innovation that needs enormous amounts of data to be analysed rapidly to drive management decisions. RTC aims to track the movement of target fish within fishing zones and safeguard them at the most favourable time and place, considering the unpredictable shifts in fish distribution. The effectiveness of management relies on the careful design of dynamic closure rules. Rapid and accurate data gathering on fish catches and the geographical distribution of fishing effort, a fishing operation in a unit of time spent on fishing grounds, is essential in the design of dynamic closure. Surveillance systems like the Vessel Monitoring System (VMS) have become popular globally, providing accurate data on fishing activities and fish abundance in near real-time. The aim of this research is to validate and utilise surveillance data as credible scientific data to support and develop a dynamic closure strategy and a simulation-based approach for evaluating potential management measures to enhance the management of migratory species and ensure sustainable fisheries management processes.

II. Estimation of the spatiotemporal distribution of fish and fishing grounds from surveillance information using machine learning: the case of short mackerel (*Rastrelliger brachysoma*) in the Andaman Sea, Thailand

In order to demonstrate a procedure to find the best method in machine learning algorithms for detecting fishing operations from surveillance data, VMS data of purse seiners targeting short mackerel in Thai waters of the Andaman Sea during 2020 were used for the study. Twenty-five spatiotemporal, environmental, and fisheries-related parameters were investigated as predictors to detect and map the fishing activity. Eight algorithms were used to compare the model performance using cross-validation. The total catch per trip was reallocated to the predicted fishing locations of the trip from the best algorithms to depict the fishing ground.

The results show that operation time and vessel speed are essential elements for determining the fishing operation of purse seiners. The most-relevant predictors are the calculated speed, operation time, and instantaneous speed. The Random Forest (RF) algorithm performed the best, with 86% accuracy, and therefore was used as the final model to detect the fishing operations. However, all reallocation approaches performed similarly well in depicting fish distribution. The reallocation of catch data equally to the fishing position is recommended since it is the most straightforward technique. In contrast, reallocation catch using the RF algorithm prediction ratio for visualising the catch per unit effort (CPUE) distribution achieved the best performance (with a slope of 1) compared with the training data. This study provides the first decent procedures for using surveillance information to detect and identify the prospective fishing operation of purse seiners—an approach that allows for a better understanding of short mackerel distribution.

III. Surveillance data utilisation for the estimation of spatial and temporal patterns of short mackerel purse seine fishery: Potential implications for time-area closure management in Thailand

In order to apply machine learning to surveillance data for estimating the geographical and temporal distribution of fishing activities and fish abundance in the Gulf of Thailand (GOT) and Andaman Sea (ADS) to provide useful information to support seasonal closures, the spatiotemporal pattern of estimated fishing effort and the CPUE was visualised bimonthly and during seasonal closures.

As a result, the fishing effort in 2020 for ADS increased from 2018 to 2019, while the fishing effort in GOT peaked in 2019. Over three years of observation, no significant spatiotemporal distributional trends of CPUE have been identified. Following closure regulation changes, the results demonstrate spatiotemporal adaptations in the distribution of fishing efforts and CPUE for short mackerel. This study presents the first reasonable techniques for using surveillance data to provide a better understanding of the potential fishing activity of purse seiners during the implementation of the seasonal restriction.

IV. Investigating static and dynamic closure to reduce short mackerel fishing mortality using a Management Strategy Evaluation

The management strategy evaluation (MSE) was applied to examine various scenarios of time-area closures, specifically STCs and RTCs, in order to clarify the efficacy of using dynamic closure instead of static closure to minimise fishing mortality, while also exploring the potential of utilising RTC appropriately for migratory fish utilising surveillance data.

The RTC approach offers more flexibility and requires less closure area compared to the efficiency with the same units to achieve management objectives via measures such as minimising mortality or income after open. Furthermore, regarding the reduction in mortality, it is also possible to establish a target based on the threshold of CPUE. To ensure the successful implementation of RTC, prioritising minimal space while maximising efficiency should be considered the primary approach. Employing the highest CPUE threshold level to define the closure unit and gathering data on CPUE every month to mitigate the administrative burden is recommended. It is not recommended to shut down any unit until all units achieve the threshold level.

V. Conclusion

This study represents the initial initiative to use surveillance data for monitoring and studying spatial and temporal distribution in fishing fleet dynamics and the abundance of short mackerel in near real-time. The approach used in this investigation holds potential for application in similar datasets, facilitating the assessment of the spatial and temporal patterns of fish abundance. The provided information has important implications for implementing effective time-area management approaches, including dynamic closures and the restoration of depleted fish populations or migratory species that need timely access to scientific data. To conclude, this study incorporates case studies demonstrating the superior efficacy of dynamic area closures in curtailing fishing-induced mortality within target species compared to static area closures. This research would facilitate and enhance the effective use of dynamic time area closures to mitigate uncertainty in the movement patterns of migratory species in unpredictable, fluctuating environments.