On the dynamic pool model for a fishery

Teruhiko Marutani
Department of Economics, Kwansei Gakuin University

Abstract Ecosystem-based fishery management (EBFM) is a new direction for fishery management, essentially reversing the order of management priorities to start with the ecosystem rather than the target species. This concept of management is a direct extension of the concept of a holistic approach incorporating interspecific interactions and physical environmental influences. However, because of the limited understanding of the complexity of marine ecosystems, few fisheries are actually managed on a multispecies basis. Even now, in order to specify a practical fishing policy we need a single-species model and utilize it by partially taking account of the effects of other factors mentioned above on the target species biomass. In fact, it is contended that in systems with moderate amounts of data, EBFM could be characterized by effective single-species management with the addition of precautionary set-asides for unknown ecosystem components. Hence, it is still necessary to examine a single-species model so as to clarify the extent of its applicability. The model investigated in this paper is what is called the dynamic pool model, which was proposed by C.W. Clark in the mid-1970s as a dynamic optimization of the classic Beverton and Holt static model for a fishery, in an attempt to make the process of growth and aging inherent in each of creature resources reflect directly into the economic process. This dynamic model has been applied to a wide variety of commercial fish species. However, the applications have been largely confined to computer simulations using the discrete-time stand-by of the original Clark continuous-time model. This situation is caused mainly by the complexity of the mathematical structure of the Clark model. In this paper, we first specify the material related to the complexity. Subsequently, we provide a rigorous proof for the long-standing conjecture due to Clark concerning the optimal path or harvesting schedule. In addition, two derivative cases are examined: one is the case in which a year-class of fish leaves a given fishing sea area permanently before its natural biomass peaks, the other is the case in which the escapement of a year-class is required to be more than a given minimum level.

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