ABSTRACT:

The thesis examines the problem of determining the optimal selectivity and age-specific catch for multiple cohort fisheries with an empirical application to the Northern cod fishery (NAFO division 2J3KL). Two of the main assumptions of the previous literature are examined: exogenously fixed age selectivity and the use of a Schaefer production function (which is Cobb-Douglas with constant marginal productivities of effort and stock numbers). The latter assumption's validity is empirically tested for the harvest of Northern cod and age selectivity is endogenously determined in a general analytical model and in numerical simulations for the Northern cod fishery.

The optimal harvest of ocean fisheries has been studied or analyzed in single cohort models or in multiple cohort models with restrictive assumptions. Analytical results about age selectivity have been derived in a multiple cohort model by Clark (1973,1990) under the restrictive assumptions of zero harvesting costs and by Stollery (1984) for a steady state age distribution with nonzero harvesting costs. Several numerical simulations have derived optimal harvest rates at fixed age selectivity levels. The thesis derives optimal age selectivity and the optimal harvest path for a two-cohort model and therefore provides the first analytical extension of Clark's single cohort model without assuming a steady state solution. Dynamic optimisation results indicate that optimal harvest paths can differ substantially from those indicated by single-cohort models. The optimal harvest starting age for each cohort is determined and it is shown that knife-edge selectivity always dominates perfect selectivity when the harvest of the younger cohorts commences. Clark's single cohort model is re-evaluated by relaxing the assumption of a Schaefer production function and significant changes to the optimal harvest extraction path are discovered. The Fisherian zero harvest rule is less relevant with diminishing productivities of input factors as harvesting starts at an earlier age and continues over a longer period.

For the empirical application to the Northern cod fishery, the production function is estimated by using scientific population data and alternatively by developing an estimation technique that avoids the use of any population estimates. Production function estimation results do not support the assumption of a Schaefer production function and therefore challenge the dynamic optimisation models used in previous empirical models. Stock predictions that are based on production function estimation results differ from the Department of Fisheries and Oceans (DFO) figures and suggest that DFO's stock assessment could be biased due to incorrect assumptions about the relationship between catch data and population numbers. Production function estimations as well as regression results for a von Bertalanffy weight equation serve as inputs into a simulation of the optimal harvest rule for the Northern cod fishery that is determined in two single cohort models and in two multiple cohort models. Policy implications from the dissertation suggest a methodological change in stock assessment and an alteration of the age selection of fishing gear that consists of allowing more young fish to escape.