WASHINGTON SEA GRANT
PROJECT COMPLETION SUMMARY REPORT

WSG Project Number: **R/F-147**
Project Title: Genetic Stock Structure in Pacific Cod

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Objectives

We propose to evaluate the genetic structuring of Pacific cod (*Gadus macrocephalus*) across large and small geographic scales to assess the degree of connectivity (via gene flow) among putative populations. The study will focus on the Gulf of Alaska and eastern Bering Sea, where Pacific cod are harvested in localized fisheries managed under both state and federal plans. Within these areas, we will examine fine-scale spatial differences among demographic populations currently managed as single population stocks. We will also examine temporal stability of genetic variation to evaluate the predictive power of the data. Results will be interpreted in terms of a cod metapopulation framework, providing a background for informed, sustainable management of this important resource.

Rationale

Fisheries management is predicated upon harvesting renewable stocks. Detection of stable geographic and temporal genetic differentiation among stock components provides the most stringent definition for fishery conservation and management practices. Failure to recognize genetic structure within exploited species may not only result the loss of less productive or abundant stocks, with concomitant losses of genetic diversity, but may also affect overall long-term productivity of the fishery.

Pacific cod supports the second largest commercial groundfish fishery in the north Pacific Ocean and Bering Sea. Global catch landings and ex-vessel value in 2006 were 235,296 metric tons 182.1 million dollars, respectively. Atlantic cod (*Gadus morhua*) and the congeneric Pacific cod (*G. macrocephalus*) share similar traits in distribution, ecology, and reproductive biology. Earlier studies on genetic population structuring in both species using allozyme markers showed little or no differentiation among putative stocks. However, the higher variability of microsatellite markers allowed much more powerful analyses and revealed considerable substructuring of Atlantic cod at surprisingly small

geographical scales. Microsatellite markers have not yet been applied in a study of Pacific cod, and so our state of knowledge for this species is equivalent to that in Atlantic cod 15 years ago. We postulate that similar levels of genetic structuring are likely to exist among Pacific cod populations but have not been examined using the appropriate class of genetic markers or sampling strategies.

Methodology

Genetic variability at 11 microsatellite DNA markers was screened in 13 samples consisting of 1012 adult Pacific cod collected in the spawning season from nine geographic locations. Standard tests of genetic differentiation among and within sample locations were conducted. Mean dispersal distance per generation was calculated from the regression relationship of genetic differentiation and geographic distance, and a new spatial analysis was used to detect genetic discontinuities within this general pattern.

Major findings

Three patterns relevant to management and conservation of Pacific cod were detected. First, a deep genetic subdivision was found between populations from Asia and North America. Second, a highly significant genetic isolation-by-distance pattern was found among North American coastal samples (Washington State to the central Aleutian Islands). Dispersal estimates based upon the regression of genetic differentiation with geographic distance were below 100 km per generation over effective population densities of 10 – 10,000 individuals. Third, Pacific cod from a fjord-like estuary (Strait of Georgia, British Columbia) were clearly differentiated from coastal cod populations. This result showed that, like Atlantic cod, Pacific cod can form localized, mostly self-recruiting populations in fjord environments.

Significance of results

Our results provided the first conclusive evidence for limited dispersal in coastal North American cod populations. While not identifying discrete coastal stock boundaries, the genetic isolation-by-distance pattern and estimated dispersal distances provide useful information about spatially relevant scales for management of this valuable marine resource. In addition, the detection of a discrete transboundary (US – Canada) stock within the Strait of Georgia, which has declined significantly for several decades, may help in development of international conservation management strategies.

Students supported

One student, M.S. level

Partnerships

Collaborations for sample collection were established with the Washington Department of Fish and Wildlife, Alaska Department of Fish and Game, Hokkaido National Fisheries Research Institute, and Department of Fisheries and Ocean Canada.