

Northeast Consortium Cooperative Research Annual Progress Report, June 2008

Project Title: Genetic Identification of Atlantic Cod Spawning Stocks in U.S. Waters using Microsatellite and SNP DNA Markers

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Project Objectives: Our research objectives are to identify the spatial and temporal stock structure of Atlantic Cod (*Gadus morhua*) in US waters, using genetic analyses. Specifically, our aim is to identify and sample major spawning aggregations throughout the Gulf of Maine (GOM), Georges Bank, and areas south of Georges Bank, and to determine if these aggregates are genetically unique stocks.

Methods and work plan:

Cod are sampled via live catch and release at targeted spawning aggregations with the cooperation of participating fisherman. Fin clips are obtained from all sampled fish for genetic analysis using multiple genetic marker loci. After genotyping, population genetic analyses are used to characterize population structure and determine genetic differentiation among spawning aggregates.

Work Completed to Date:

During the reporting year samples were collected from the following locations:

Site	Name	Date	n	Condition
Ipswich Bay	IPS(2)	6/07	78	Spent females
Bigelow Bight	BB	7/07	70	Spent females
Jeffrey's Ledge	JL	12/07	73	Spawning adults
Massachusetts Bay	MBS(2)	6/08	50	Ripe females

During the reporting period, 4 spawning aggregations were sampled in the Gulf of Maine: Ipswich Bay (spring), Bigelow Bight (off of Cape Elizabeth, ME), Jeffrey's Ledge (winter) and Massachusetts Bay (spring). Three of these populations have been sampled in multiple years of the study, facilitating the evaluation of temporal stability of population structure. Although to date we have had success obtaining samples from the majority of our proposed sites, identifying spawning aggregations in coastal and downeast Maine has proven difficult, as these historic spawning populations may no longer exist in appreciable numbers. Additionally, in the last few winters, cod have not been aggregating in Ipswich Bay, as they did in previous years.

Genetic analysis of 762 samples was completed during this reported period. These samples include collections from the previous and current reporting periods: winter-spawning fish from Massachusetts Bay, Coxes Ledge, Block Island and Georges Bank; spring and summer spawning fish from Ipswich Bay, Coxes Ledge, Stellwagen Bank and Bigelow Bight; and a non-spawning population from New York Bight. In addition, the analysis of the 123 most recently collected samples (Jeffreys Ledge and Massachusetts Bay) are currently underway. Statistical analyses of stock structure are underway and have generated some preliminary findings (see below).

Results to Date:

Preliminary analyses have revealed weak but significant genetic discontinuities within the Gulf of Maine and areas south. These results suggest a northern Gulf of Maine population, including fish spawning in Ipswich Bay and southern coastal Maine (Bigelow Bight and Platts Bank) in the spring and early summer, that is distinct from fish spawning in inshore and offshore Massachusetts Bay and areas south. No significant differentiation occurs among cod spawning in Massachusetts Bay, Stellwagen Bank, Nantucket Shoals, Block Island, and Coxes Ledge; yet these populations are all differentiated from the populations in coastal Maine and Ipswich Bay spring. Our data also suggest that temporal differences in spawning in Ipswich and Massachusetts Bay contribute to a more complex structure. Cod spawning in Ipswich Bay in the winter are more genetic similar to those in Massachusetts Bay in the winter, than those in Ipswich Bay in the spring. Similarly, cod spawning in Massachusetts Bay in the spring are more similar to those spawning in Ipswich Bay in the spring than to those in Massachusetts Bay in the winter. Spawning aggregations on the Northeast Peak of Georges Bank appear to be somewhat heterogeneous, with genetically similarity to some but not all populations in the Gulf of Maine and marginal differentiation with populations south of the Gulf of Maine. Additional analyses are underway to better understand these dynamics.

Our results to date also indicate that the observed population structure is temporally stable, with sites sampled in consecutive years showing no differentiation over time.

Partnerships:

Our fishermen-scientist partnerships have proven critical in sample collection of Atlantic cod. In the past year we have collaborated with fishermen Carl Bouchard, David Goethal, Chris Odlin, Jeff Carver and Jeff Raveur for sample collections. Our partnership with Dr. Steven Cadrin (UMASS Dartmouth) has also been invaluable and has resulted in sample collections from Coxes Ledge and Massachusetts Bay.

Presentations:

Preliminary results were presented at the 64th annual Northeastern Association of Fisheries and Wildlife Agencies (NEAFWA) conference held in Galloway, NJ on 28 April 2008. Poster title: "Spawning stock identification of Atlantic cod (*Gadus morhua*) in U.S. waters using microsatellite and SNP genetic markers."

Impacts: Our research involves collaboration between scientific researchers, managers and commercial fisherman. We have been working closely with our steering committee members in sample collection and have made every effort to communicate our preliminary findings through scientific publications seminars and meetings. Our project is generating much interest and we anticipate that our findings will be incorporated into the scientific information used to develop fisheries management plans.

Student Participation: Timothy Breton, a masters level graduate student at UNH, was responsible for much of the DNA extraction and data analysis for this phase of the project.

Published Reports and Papers: The initial findings of this study were published as: I. Wirgin, A. Kovach, L. Maceda, N.K. Roy, J. Waldman and D.L. Berlinsky. Stock identification of Atlantic cod in U.S. waters using microsatellite and single nucleotide polymorphism (SNP) DNA analysis. 2007. Transactions of the American Fisheries Society 136:375-391.