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Developing a Breeding Plan for Farm-Raised Sturgeon

Bernard May
University of California, Davis

Summary

Genetics professor Dr. Bernie May of the University of California at Davis and Sea Grant Trainee Dr. Jeff Rodzen were funded to develop a breeding program for broodstock at Stolt Sea Farm, the state's largest producer of white sturgeon caviar.

The goal of the project was twofold: to develop a breeding plan for slowing the rate of inbreeding of offspring and to investigate whether commercially desirable traits—superior growth rates, enhanced caviar yield and early sexual maturity—can be selectively bred.

White sturgeon are naturally slow-growing, late maturing, long-lived fish. Females, for instance, do not reach reproductive maturity until age 6 or 7. These traits make sturgeon a time-intensive, expensive fish to farm. Nonetheless, California's farm-raised caviar production has seen steady growth with declines in wild sturgeon stocks. Whereas eight years ago, California's sturgeon farms were producing caviar on a primarily experimental basis, in 2000, California produced approximately one-tenth of what was caught from the Caspian Sea region that year. California is the only state in the country that is currently farming sturgeon for caviar. It has four farms.

Method

For the project, the scientists first identified and characterized DNA markers that allowed them to identify individual sturgeon. They then used these genetic fingerprints to identify kinship relationships among all the members of the broodstock. In separate experiments, they looked for characteristics that appear to be inherited. For instance, they studied the degree to which body size (weight and length) is correlated with dam and sire body size. They also examined the inheritability of a variety of caviar characteristics, including weight, grade, color, firmness and yield.

White sturgeon, like the one above, can reach gargantuan proportions. Such large catches today, however, are rare. The white sturgeon is native to the San Francisco Bay–Delta and estuaries of the Pacific Northwest. Photo courtesy: Oregon Historical Society.

Findings

Body length and weight were shown to have a strong genetic component, while caviar weight was influenced predominantly by environment. Caviar yield, however, was moderately correlated with the size of the female.

Applications

By mapping the pedigree structure of a commercially viable sturgeon broodstock, the scientists provide the scientific foundation for selectively breeding sturgeon in the future. Because pedigree information also makes it possible to avoid breeding siblings and cousins, the work can be used to slow inbreeding. This in turn reduces the need to replenish broodstocks with fish caught from the wild.

Stolt Sea Farm is continuing to gather data on caviar characteristics in order to document more completely the role of genetics in caviar quality and yield.

A beluga sturgeon harvested from the Caspian Sea region, traditionally the source of the world's premier caviars. Poaching, environmental degradation and overfishing have led to a near collapse of all sturgeon populations in the Caspian Sea region. The "Caviar Emptor: Let the Connoisseur Beware" campaign is an example of the growing public awareness of Russian and beluga caviar shortages. Photo: Dr. Robert Stevens, U.S. Fish and Wildlife Service.

Cooperating Organizations

Stolt Sea Farm California LLC
The Fishery, Inc.
UC Davis Aquaculture and Fisheries Program—Aquatic Center Facility

Publications

McQuown, E.C. 2000. Inheritance of microsatellite loci and delineation of lake sturgeon (*Acipenser fulvescens*) population ogenetic structure. M.S. thesis abstract, University of California, Davis.

McQuown, E.C., B.L. Sloss, R.J. Sheehan, J. Rodzen, G.J. Tranah, and B. May. 2000. Microsatellite analysis of genetic variation in sturgeon: New primer sequences for *Scaphirhynchus* and *Acipenser*. *Trans. Am. Fish. Soc*. 129:1380–1388.

Presentations

Rodzen, J., B.P. May, and T.R. Famula. Combining molecular genetics with traditional animal breeding: the white sturgeon as a case study. Invited speaker, California Aquaculture Association Annual Meeting, March 2001, Sacramento, California.

Rodzen, J., B.P. May, and T.R. Famula. Use of microsatellite markers in a commercial breeding plan for white sturgeon. Aquaculture Symposium, Plant and Animal Genome Conference, January 2001, San Diego, California.

Rodzen, J., B.P. May, and T.R. Famula. Use of microsatellite markers in a commercial breeding plan for white sturgeon. White Sturgeon Symposium workshop, September 2000, Davis, California.

Trainee and Thesis

Rodzen, Jeff, Ph.D., Department of Animal Sciences, University of California, Davis, 2001, "Preservation of Genetic Diversity Within Aquaculture Stocks of White Sturgeon."

For more information:

Dr. Bernard May
Animal Science Department
University of California, Davis
Tel.: (530) 754-8123 or (530) 752-6351
Email: bpmay@ucdavis.edu

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California Sea Grant College Program
Russell A. Moll, Director • Dolores M. Wesson, Deputy Director • Paul Olin, Interim Associate Director for Extension • Marsha Gear, Communications Coordinator
University of California, San Diego, 9500 Gilman Drive, La Jolla, CA 92093-0232
Phone:(858) 534-4440 Fax: (858) 453-2948 Web site: http://www-csgc.ucsd.edu