STUDY PERFORMANCE REPORT

State: Michigan **Project No.:** F-80-R-1

Study No.: 475 **Title:** Development and implementation of conservation genetic initiatives for Michigan inland and Great Lakes fisheries

Period Covered: October 1, 1999 to September 30, 2000

Study Objectives: (1) to develop genetic guidelines and policies governing broodstock and hatchery production and release for the Fisheries Broodstock Committee of the Michigan Department of Natural Resources; (2) to assess levels of genetic diversity in Lake Sturgeon and other threatened species in Michigan Great Lakes and inland waters, and to assist in the implementation of genetics guidelines to aid in species restoration efforts; (3) to collect, analyze, and interpret demographic and genetic data bases for Great Lakes sport fisheries to assist in efforts to establish the extent of interaction of hatchery supplemented fisheries to natural reproduction; (4) to collect, analyze, and interpret demographic and genetic data bases for Great Lakes sport fisheries to assist in efforts to identify areas of endemism and of high genetic diversity which could serve as species conservation areas or management zones.

Summary: Significant deficiencies in Michigan Department of Natural Resources hatchery and stocking policies were found based on extensive travels to hatcheries throughout the state and through interactions with Departmental hatchery and management personnel. Six state hatcheries were visited. All fish production figures involving broodstock origin, development, and maintenance were collated together with species, strain, and hatchery-specific records of methods of crossing, gamete takes, brood rearing, and stocking.

Recommendations were offered in the form of 2 drafts prepared for Fisheries Division hatchery and management personnel, and for Division Broodstock and Stocking Committees. Recommendations were approved and implementation is beginning in the form or circulation of written reports and oral presentations to hatchery personnel. Sources of many salmonid strains were of unknown or suspect origin. Greater attention is needed to develop rotational lines for all species and strains, as there is strong potential for inbreeding and loss of genetic variation. Sources of natural recruitment into each strain and species should be identified or developed to episodically infuse greater diversity into broodstocks. Greater attention to methods of crossing eggs and milt are needed to maximize retention of genetic diversity in progeny. Great attention is needed regarding mixing of progeny in the hatchery prior to stocking to ensure representation of all adults to stockings in all locations. Stocking should be directed to minimize impacts to native or naturalized populations.

Job 2. Title: Write general guidelines and policy governing genetic broodstock and hatchery management for the Broodstock Committee of the Michigan Department of Natural Resources.

Findings: The draft report outlining general concepts and principles governing gamete takes, broodstock management, and stocking has been completed and has been approved by the state Broodstock Committee. Integration of this document into the revision of the Broodstock Management Plan is underway. Implementation of the principles into practices is ongoing

through circulation of written reports, site visits by the geneticist to individual hatcheries, and presentations to Hatchery Division meetings.

Job 3. Title: <u>Write genetic guidelines regarding the status of existing broodstock strains and establish guidelines for future assessment of potential replacement strains and for supplementation of existing strains</u>.

Findings: The draft report outlining general guidelines for development and monitoring of current state hatchery broodstocks has been completed and has been approved by the state Broodstock Committee. The Geneticist met with hatchery personnel from Oden, Harietta, Marquette, and Platte River Hatcheries to discuss current practices and future breeding and management strategies. Discussions resulted in a series of recommendations for management of brown trout, lake trout, and brook trout strains in current use. Recommendations included: 1) the need to identify sources of wild stocks to infuse genetic material into broodstocks on a regular basis; 2) the need to mate individuals across year classes to minimize the potential for inbreeding; 3) the need to take broodstock eggs on more of a regular basis and when larger numbers of adults are available for production; and 4) the need to further randomize progeny from all spawned individuals when placed into raceways. Recommendations were specific to each species and strain. Recommendations were tailored to management goals, space and resource limitations, as well as genetics principles.

Job 5. Title: <u>Work with hatchery biologists and support staff working with salmonid production (coho, chinook, and steelhead) to identify aspects of hatchery operations which could be improved to enhance the genetic diversity of supplemental fisheries</u>.

Findings: The geneticist worked with agency personnel in a number of capacities to identify aspects of breeding and rearing activities which could be improved in light of Genetic Guidelines approved by the Broodstock Committee.

First, we conducted a controlled experiment to examine the effects of different gamete take strategies on levels of relatedness and effective population size of progeny. We chose steelhead as the species to conduct the experiment with. All adult and juvenile samples have been analyzed for microsatellite loci for six treatments representing a range of gamete-taken strategies.

Treatment 1 – 1 female mated to 1 male
Treatment 2 – 1 female mated to 2 males where both males were used for each of 2 females
Treatment 3 – eggs from 5 females mixed with mixed milt from 5 males
Treatment 4 – eggs from 10 females mixed with mixed milt from 10 males
Treatment 5 – eggs from 1 female mixed with mixed milt from 2 males
Treatment 6 – eggs from 1 female mixed with milt from 2 males added sequentially

Ten males and ten females were used for the first four treatments. Ten females and 20 males were used for treatments 5 and 6. We standardized the amount of eggs used per female (50 mls) and the volume of milt used (1 ml) per male. Milt and eggs were mixed and eggs were allowed to water harden. Eggs were incubated until emergence at the Wolf Lake Hatchery. We genotyped all adults and 160-194 progeny from each cross (Table 1). We assigned male and female parentage to all offspring. We determined mean and variance in male and female reproductive success. Based on parentage information we were able to assign a mean level of genetic relatedness across all individuals (mean coancestry). Further, we were able to estimate effective population size under each mating strategy. Male and female reproductive variance was much

higher in Treatments 2, 3, and 4 presumably due to differences in male gamete quality or sperm penetrance. Effective population sizes for Treatments 2, 3, and 4 also were lower and mean coancestries were higher. Results showed that 1:1 male to female mating is a preferred strategy.

Second, review of the chinook spawning and stocking records suggested that there had likely been selection for smaller size and age at sexual maturity due to a combination of factors including environmental selection for age-specific survival due to disease considerations (e.g., BKD), and due to the time and duration of gamete takes. We suggested that directed selection toward larger (and thus older) spawning fish could be used as a means of selection for later age at spawning. The public would thus realize a larger and older fish returned to the creel. This should however be conducted so as not to compromise the total numbers of fish spawned.

Third, it was apparent that though large numbers of anadromous salmon were typically spawned, the progeny of these adults were not randomized in the hatchery environment. Due to constraints in rearing facilities, eggs and subsequently juveniles are housed by size class. Thus, when stocking occurs, the progeny stocked are not drawn from all spawned adults but likely from a much smaller number reflecting the number that were spawned (and housed in the hatchery) during a single time period. Recommendations were forwarded to improve the degree of randomization of offspring; particularly those restocked into streams used for gamete takes. This would include Swan and Little Manistee Rivers for chinook salmon, the Little Manistee for Steelhead, and the Platte River of coho salmon.

Job 6: <u>Conduct surveys of naturalized and supplemental salmonid fisheries to identify the extent of spatial variation in genetic diversity, how the diversity is partitioned (i.e., by lake basin, and drainages within basin), and of the impact of hatchery supplementation to overall genetic diversity</u>.

Findings: Work is currently underway for steelhead, which will address the effects of hatchery supplementation on homogenization of genetic characteristics across drainages. Sampling for this effort is described in Federal Aid report "Evaluation of alternative mechanisms underlying spatial genetic diversity of lake Michigan steelhead: an assessment using genetic markers". In addition, collections are being made for the 2 strains of coho, and for chinook salmon in each of the two broodstock streams used for gamete takes.

Further, we have completed analyses and a report documenting levels of genetic variability and relatedness for each strain and year class of brown trout housed in DNR hatcheries. We have also assayed levels of genetic variability and levels of relatedness for rainbow trout of the Eagle Lake and Shasta strains, which are obtained annually from the USFWS. Summaries of the results of the brown trout and rainbow trout analyses have been provided to the Chief of Hatchery Division and will be distributed to all Division personnel. Results from the brown trout analysis suggest that levels of diversity are related to length of time a strain has been in domestication. Further, there is evidence for shifts in allele frequency among age classes that were produced from the same parental stock suggesting that relatively few individuals were actually transmitting genes to progeny in the next age class. Analyses of USFWS domestic rainbow trout suggest that Eagle Lake strain fish have higher background levels of relatedness than to the Shasta domestic strain or naturalized populations of rainbow and steelhead from Michigan streams. Further, we were able to address a management concern over the origin of Pine River rainbow trout. Based on our analysis it appears that the rainbow trout above the dam on the Pine River are steelhead and not rainbow trout.

Job 7. Title: Work towards a predictive genetic model of the potential for change in the genetic and demographic architecture of Lake Michigan salmonid fisheries as a function of hatchery supplementation and natural reproduction.

Findings: Work has been initiated to accumulate historical background information on stocking levels for all drainages in Lake Michigan for chinook, coho, and steelhead. Scale samples for steelhead are being analyzed to determine hatchery-wild ratios for many Michigan streams. After empirical data on genetic characteristics of each species from spawning runs in different rivers have been accumulated over the next several years, we will be able to develop a model that will predict changing distribution of genetic variation under different models of hatchery stocking rates and locations of stocking. Such information will provide information on plausible levels of hatchery-wide introgression. Further, we will be able to combine estimates of straying rates form genetic data with estimates from tag returns and based on analyses of scales.

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