Fish Culture Technical Bulletin

Best Management Practices

GENETIC CONSIDERATIONS OF STOCKING AND SPAWN COLLECTIONS[1]

An important consideration during wild spawn collections and stocking is the maintenance of genetic variability and integrity of the native population. As Currens and Busack (1995) point out this is an important management concern.

> "Genetic variation is the raw material for natural selection. Consequently, variation within and among populations of fish determines their capability to persist in changing environments and to meet human wants and needs. Long-term production and usefulness of populations of fisheries depend on conserving genetic variation among and within populations."[2]

To understand this concept fully it is important to understand what is meant by within and among populations. A population itself is defined as a group of interbreeding individuals which differs from neighboring populations in one or all of the following dimensions: genetic, phenotypic (appearance), demographic, ecologic, and/or geographic. Therefore, when talking about maintaining genetic variability within a population it is referring to variability between individuals of one specific population. Variability among populations refers to maintaining uniqueness of groups of the same species in a geographically related area (i.e. populations of deep water spawning vs. populations of shallow water spawning lake trout in Lake Ontario).

This variability can be maintained through careful planning and management during wild spawn collections and stocking. When planning wild spawn collections, attention should be given to where the fish that develop from these fertilized eggs are going to be stocked. A representation of the populations in the area to be stocked should be collected so that the true genetic picture of that area is maintained. For example, if the goal of the stocking effort is to rehabilitate a deep-water spawning population of lake trout in Lake Ontario, eggs should not be collected from the shallows. Stocking the wrong genotype (set of genetic information specific to a population) will not help to rehabilitate that species; it may actually hinder the rehabilitation effort if the genotype stocked is from a competing or differently adapted population.

Fisheries managers must be aware of the populations of each species that exist in the waters being stocked. If they do not take genetic differences into account, stocked fish and managed populations can have reduced fitness and survival through inbreeding, outbreeding and/or domestic selection.

Inbreeding Concerns

Loss of genetic variation in a population increases the probability of inbreeding within that population. Inbreeding is defined as the loss of vigor that occurs in most sexually reproducing organisms as a result of the reduction of genetic variation accompanying breeding of closely related individuals. Inbreeding caused by reduced genetic variability will act to further reduce the variability of the breeding population in a cycle similar to a positive feedback loop. This loss of variability is termed inbreeding depression and is due to the loss of diversity in genes. The deleterious effects of inbreeding are apparent in such traits as egg and fry survival, reduced growth rates and feed conversion efficiency, and body shape. As generations proceed, the effects of inbreeding generally become amplified and will often lead to a reduction in population size and fitness. Inbreeding depression is also a contributing factor to the extinction of species.

Outbreeding concerns

Outbreeding occurs when significantly different individuals among populations of the same species breed. In some cases this can have a greatly beneficial effect on the first generation hybrid species in areas such as growth, survival, and in some cases even fertility. These beneficial effects are only noticeably expressed in the first generation of offspring, and will level off in subsequent generations. Although this process occurs as a rare event in nature, significant levels of outbreeding can quickly result in the loss of local adaptations and associated fitness of stocks.

Beneficial effects resulting from outbreeding are not usually considered a legitimate goal for fish stocking programs. This is due to the risk of outbreeding depression. Outbreeding depression occurs when local adaptations of each of the parent populations are destroyed as a result of two populations mating. This could negatively affect the future generations of this species because they would lose the adapted advantages of their parents for their environment.

Domestic Selection

Domestic selection occurs mainly in broodstock lines. As generations proceed, conditions in the hatchery may favor the propagation of traits in the fish population that would be considered disadvantageous in the natural environment. The term can also be applied when sections of a population are allowed to survive in the hatchery that would not necessarily have survived in nature due to less predation and competition for resources within the hatchery environment. In both cases the fish are eventually termed domesticated and the population as a whole will have less natural vigor then it otherwise would have if it had propagated in the natural environment.

CONSERVING GENETIC DIVERSITY IN WILD SPAWN COLLECTIONS

Source history

Many preliminary steps must be taken in order to avoid loss of genetic diversity and rear offspring which are as close to the founding population as possible. If feasible, the genetics of the wild spawn source should be determined. This will allow Fisheries Managers to determine whether or not the receiving waterbody (that which is to be stocked) is suitable for a particular stock of fish. Once a suitable donor population has been determined, a spawn collection management plan should be prepared. It is imperative that spawn be collected in a manner which ensures the genetic integrity of the donor population is maintained, as is outlined below.

Number of donors required

The recommended number of spawn donors varies, however, to a certain extent the larger the number, the lower the risk of genetic drift and inbreeding. The minimum number should reflect a near 100% retention of genetic variability present in the founding population. It is understood that donor population size will vary and so it is suggested that at no time should more than 20% of the donor population be collected[3]. These statements are true for both the founding of a brood stock and the annual collection of wild spawn for hatchery rearing.

Due to the high fecundity of some species (e.g., walleye) a very small number of fish may provide the entire egg target (in the case of walleye one female may produce one quarter of a million eggs). Although it may be tempting to do this, particularly under difficult field conditions, this will cause significant problems to the stocking program over the long run. Obtaining eggs and milt from as many fish as possible is preferable. Spawn collection should be taken over the full duration of the natural run, with egg collection proportionate to the numbers of adult spawners observed (Figure 1). Fish may be partially spawned and returned to the waterbody (where they will spawn naturally), thus allowing the egg target to be achieved while maintaining genetic integrity.

Choosing donors

Fish used for spawn collection should be chosen at random. Fertilization should be 1:1 (one male to one female); therefore an equal number of males and females ought to be collected. Fish should be collected throughout the spawning run, in various areas of the donor waterbody (do not collect all of your fish from a single spawning bed). Each egg or sperm donor should only be used once, if at all possible. If not kept for disease testing, fish used for spawn collection should be permanently marked (fin clip) and returned to the wild. If genetic tracking of the stocking program is desired, fin clips from each parent pair should be retained and sent to the MNR genetics lab. Donors should include multiple year classes. The collection should be focused solely on wild fish. Avoid fish which have been fin-clipped and allow them to spawn naturally. This will help retain genetic diversity.

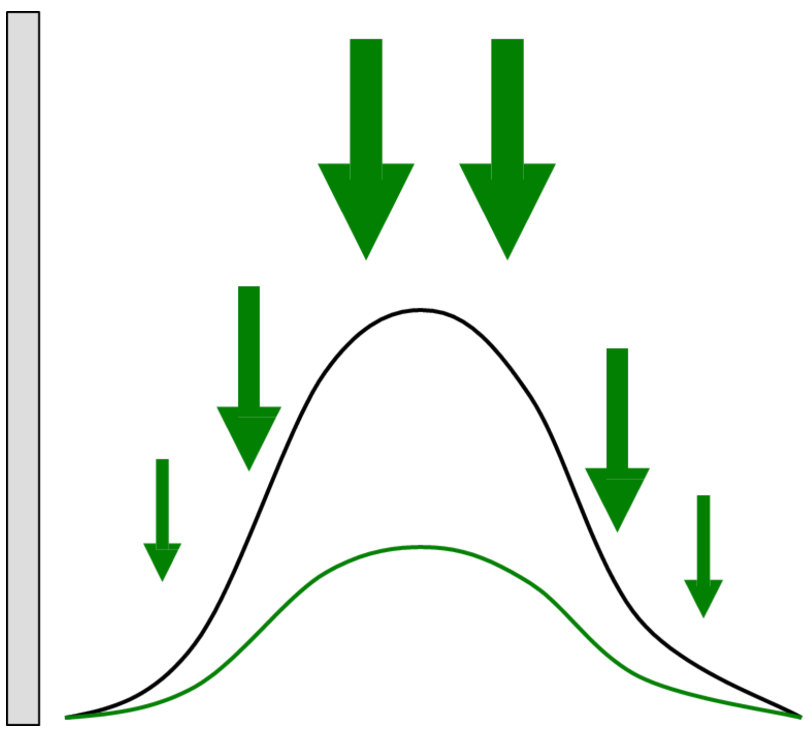

Figure 1[3]: Sampling effort (arrows) and number of spawning pairs used for wild egg collections should reflect the duration and intensity of the natural

[1] Adapted from Wedemeyer, Gary A., editor. 2001. Fish Hatchery Management, second edition. American Fisheries Society, Bethesda Maryland. Unless otherwise stated.

[2] Busack C.A., and K.P. Currens. 1995. Genetic risks and hazards in hatchery operations: fundamental concepts and issues. p. 71-80 *In* H.L. Schramm and R.G. Piper,

editors. Uses and effects of cultured fishes in aquatic ecosystems. American Fisheries Association, Symposium 15.

[3] Wilson, Dr. C. 2003. Research Scientist – Wildlife Forensic DNA Laboratory. Personal Communication.