

Management Goals for Hatchery Broodstocks: Genetic Integration versus Segregation

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Hatcheries have been propagating Pacific salmon and steelhead in the Pacific Northwest for more than 100 years. Until recently, the principal purpose of these hatcheries was to produce fish for harvest. However, a new conservation role for salmon hatcheries is emerging in the Pacific Northwest. This new role has been motivated by concerns regarding the potential negative impacts of hatchery-origin fish on natural populations and recent listings of salmon and steelhead under the U.S. Endangered Species Act (ESA). In response, hatchery programs are currently undergoing reform measures to (a) reduce genetic and ecological risks to naturally spawning populations and (b) assist directly with conservation and recovery of naturally spawning populations. These reform measures have motivated a fundamental reevaluation of the basic biological premises under which hatchery programs are designed and managed. This reevaluation requires that each hatchery program explicitly state (1) the specific purpose and desired benefits to be derived from hatchery-origin fish and (2) the genetic management goals for the broodstock relative to naturally spawning populations. In the past, these purposes and goals have not been clearly defined, quantified, or distinguished. However, in the future, all hatchery programs will need to be classified as either “integrated” or “segregated” depending on the genetic management goals for the broodstock. Hatchery programs are classified as “integrated” if the principal goal is to manage the broodstock as an artificially propagated component of a naturally spawning population. An implicit goal of an “integrated” program is to artificially increase the demographic size or productivity of a population while preventing genetic divergence between the hatchery and naturally-spawning components. In an idealized integrated program, natural-origin and hatchery-origin fish represent two genetically equal components of a single gene pool. Conversely, hatchery programs are classified as “segregated” if the principal goal is to develop and manage a broodstock as a genetically discrete or segregated population relative to naturally spawning populations. Hatchery broodstocks for segregated programs are derived each year exclusively from hatchery-origin adults returning back to the hatchery. In contrast to segregated broodstocks, integrated broodstocks require natural-origin adults to be included systematically in the broodstock each year to (a) prevent genetic divergence of the hatchery broodstock from natural-origin fish and (b) minimize potential genetic domestication effects. Although segregated broodstocks are inherently simpler to operate, hatchery-origin fish from segregated programs may pose unacceptable biological risks to naturally spawning populations. In contrast, integrated hatchery programs are designed explicitly to minimize the biological risks to naturally spawning populations. Integrated programs require that the rate of gene flow from the natural environment to the hatchery environment exceed the rate of gene flow in the opposite direction. In general, at least 10-20% of a hatchery broodstock must be derived from natural-origin adults each year in integrated programs. All hatchery programs must be classified according one of the two sets of criteria; “intermediate” programs are not possible. Moreover, “integrated” and “segregated” refer explicitly to the broodstock management goals for a hatchery program and not to the presence and absence, respectively, of natural spawning by hatchery-origin fish. Recognizing the fundamental distinction between genetically integrated and genetically segregated hatchery broodstocks and their associated programs is the underlying foundation of hatchery reform in the Pacific Northwest.