White Paper No. 5[1]

Transition of Hatchery Programs

1 Introduction and Background

Hatchery programs, in order to be successful, need clearly stated goals and biological objectives as well as scientifically defensible operational guidelines. They must be designed to achieve either specific harvest or conservation purposes. Hatchery programs targeted at producing fish primarily for harvest must be consistent with conservation goals established by managers for populations that may be affected by the program in order to avoid unacceptable ecological and genetic interactions with naturally produced fish

In 2004, the Puget Sound and Coastal Washington Hatchery Scientific Review Group (HSRG) developed two technical discussion papers with the Washington Department of Fish and Wildlife (WDFW), the Northwest Indian Fisheries Commission (NWIFC), and regional treaty Tribes. The papers included definitions, theoretical premises, and operational guidelines for implementing integrated and segregated hatchery programs (HSRG, WDFW, and NWIFC 2004a and 2004b). The premises, definitions, and recommendations of the Puget Sound HSRG have been adopted by the Columbia River HSRG. Some of the conclusions found in HSRG, WDFW, and NWIFC 2004a and 2004b have been included in this document.

Expanding the HSRG hatchery review into the Columbia River Basin has allowed further consideration of the implications of hatchery reform. This has, in turn lead to additional recommendations, presented in this document, to better accomplish harvest and conservation goals. The recommendations focus on facilitation of properly integrated and segregated programs and providing guidelines for hatchery programs whose primary goal is re-introduction. Re-introduction programs were not addressed by the Puget Sound HSRG in the 2004 documents.

This paper presents a series of "scenarios" to guide establishment of integrated and segregated hatchery programs. The scenarios address establishment of new integrated and segregated programs as well as the transition from fully and partially segregated to integrated programs and vice versa. The scenarios are based on a stated set of existing conditions within the affected watershed; recommendations and considerations are presented for each scenario.

[1] White papers were prepared by the HSRG to address topics relevant to hatchery reform. They are intended to stimulate discussion and provide background, documentation and explanations not included in the body of the HSRG's report.

2 Integrated Hatchery Programs

2.1 Implications and Constraints of Broodstock Management Guidelines for Integrated Hatchery Programs

Broodstock management guidelines for an integrated hatchery program impose limitations on the program's size. The limitations are dependent upon controlling the mix of hatchery- and natural-origin fish on the spawning grounds and in the hatchery and on factors affecting the number of natural spawners available for broodstock, i.e. the productivity of the natural environment and the harvest rate on natural fish. Identification of the options available to implement integrated programs such as i.e., changing the ratio of pNOB to pHOS and/or the size of the hatchery program, requires case-by-case analyses. Currently, few hatchery programs are meeting the broodstock guidelines recently developed by HSRG for integrated hatcheries.

2.2 Implementing an Integrated Hatchery Program

Once it is determined that an integrated program is the best method to achieve resource goals, design and implementation of the program must be addressed. Program design will depend upon:

- The genetic makeup of the current hatchery and natural population components
- Risk tolerance which varies depending on the viability of and goals for the natural population

In a recovery program, it may be necessary to rely on hatchery propagation to secure genetic resources until the receiving habitat is capable of supporting a fully integrated program. Initially, this type of program may have to be developed from one where the composite population is highly influenced by the hatchery environment, but where a detailed management plan has been structured to transition to a population dominated by the natural environment. Similarly, integrated harvest programs with goals to maintain or improve the biological significance of the stock should be operated to ensure that selective forces in the natural environment dominate. There may be circumstances where one or more elements of these approaches are not applicable.

2.2.1 Scenario 1: New Integrated Program

Initial Conditions:

- No hatchery program currently exists.
- Natural population been minimally influenced by hatchery fish.

Recommended approach:

- Initiate hatchery program by collecting representative sample of natural fish.
- Size program consistent with conservation goals, the ability of the natural population to support hatchery broodstock requirements, and gene flow limitations to the natural population.
- At a minimum, ensure that gene flow from the natural to the hatchery population is greater than gene flow from the hatchery to the natural population (PNI > 0.5; pNOB > pHOS).

- Limit contribution of hatchery fish to less than 30% of the natural spawning population (pHOS < 30%).
- For stocks of moderate or high biological significance and viability (or goals to maintain or improve the biological significance and viability of the stock), PNI should be greater than 0.67
- Collect a number of brood that allows for an effective population size of the composite population (natural plus hatchery) in excess of 500 fish.
- If a long-term goal of the hatchery program is to provide a conservation benefit, or if the natural spawning of hatchery-origin fish will be difficult to control, then the effective population size of the hatchery component should also be greater than 500 fish.

Considerations:

- *Likelihood of achieving natural adaptation:* There is a high likelihood of attaining population goals (developing a program where the natural environment drives the adaptation of the composite hatchery and natural population), as long as broodstock collection is feasible and gene flow is maintained within recommended guidelines for the goals of the population. Some loss of productivity from the natural population is expected.
- *Cost:* There is additional program cost compared to segregated programs, primarily for natural broodstock collection.
- *Effect on Harvest:* Changes in harvest contribution are dependent on productivity of the natural component of the population, as well as productivity of the hatchery component. If the recommended approach is followed, harvest can generally be increased at the cost of some loss of productivity from the natural population.

2.2.2 Scenario 2: Transition from a segregated program to an integrated program

Initial Conditions:

- Hatchery broodstock has had no systematic gene flow from the natural population.
- Natural spawning population has had little influence from hatchery fish.

Recommended Approach #1: This approach should be employed if harvest goal attainment can be interrupted during the transition to an integrated program.

- Terminate segregated harvest program.
- Initiate a new hatchery program by collecting a representative sample of natural fish.
- Size program consistent with conservation goals and the ability of the natural population to support hatchery broodstock requirements and gene flow limitations to the natural population.
- At a minimum, ensure that gene flow from the natural population to the hatchery population is greater than gene flow from the hatchery to the natural population (PNI > 0.5; pNOB > pHOS).

- Limit contribution of hatchery fish to less than 30% of the natural spawning population (pHOS < 30%).
- For stocks of moderate or high biological significance and viability (or goals to maintain or improve the biological significance and viability of the stock), PNI should be greater than 0.67.
- Collect a number of brood that allows for an effective population size of the composite population (natural plus hatchery) in excess of 500 fish.
- If a long-term goal of the hatchery program is to provide a conservation benefit, or if the natural spawning of hatchery-origin fish will be difficult to control, then the effective population size of the hatchery component should also be greater than 500 fish.

Considerations for Approach #1

- *Likelihood of achieving natural adaptation*: There is a high likelihood of attaining stock goals as long as broodstock is feasible and gene flow is maintained within recommended guidelines. Some loss of productivity from the natural population is expected.
- *Cost*: The increase in cost incurred for broodstock collection appears similar for all approaches.
- *Effect on Harvest*: A loss of contribution would be expected between termination of the segregated program and achieving the final size of the new integrated program. In the long term, if the recommended approach is followed, harvest can generally be increased at the cost of some loss of productivity from the natural population.

Recommended Approach #2: This approach should be used if harvest goal attainment cannot be interrupted during transition to an integrated program.

- Initiate new hatchery program by collecting representative sample of natural fish.
- Size program consistent with population goals and the ability of the natural population to support hatchery broodstock requirements and gene flow limitations to the natural population.
- At a minimum, ensure that gene flow from the natural population to the hatchery population is greater than gene flow from the hatchery to the natural population (PNI > 0.5; pNOB > pHOS).
- Limit contribution of hatchery fish to less than 30% of the natural spawning population (pHOS < 30%).
- For stocks of moderate or high biological significance and viability (or goals to maintain or improve the biological significance and viability of the stock) PNI should be greater than 0.67.
- Collect a number of brood that allows for an effective population size of the composite population (natural plus hatchery) to be in excess of 500 fish.
- If a long-term goal of the hatchery program is to provide a conservation benefit, or if the natural spawning of hatchery-origin fish will be difficult to control, then

the effective population size of the hatchery component should also be greater than 500 fish.

- Differentially mark and release offspring of old/new broodstock. Preferentially use returns that represent the natural origin broodstock. Phase out use of old broodstock as new broodstock returns.

Considerations for Approach #2:

- *Likelihood of achieving natural adaptation*: There is a high likelihood of attaining stock goals, as long as broodstock collection is feasible and gene flow is maintained within recommended guidelines. Some loss of productivity from the natural population is expected.
- *Cost*: The increase in cost incurred for broodstock collection appears similar for all approaches. Under this scenario, an additional cost for differentially marking the two hatchery broodstocks would be incurred. Cost in terms of operational complexity is high, but should be no greater than rearing an additional species.
- *Effect on Harvest*: The loss of contribution to harvest in Scenario 2, Approach #1, above, could be avoided during transition with additional marking cost. In the long term, if the recommended approach is followed, harvest can generally be increased at the cost of some loss of productivity from the natural population.

2.2.3 Scenario 3: Transition from a partially segregated program to an integrated program[2]

Initial Conditions:

- Hatchery broodstock has had no systematic gene flow from the natural population
- Natural spawning population has had significant influence from hatchery fish.

Approach #1: This approach is recommended if the program goal is to return the natural population to its highest level of productivity as rapidly as possible.

- Take steps to reduce the number of hatchery fish in the natural population to less than 5% through reduction in hatchery programs, selective harvest to limit strays, installation of weirs, or other measures.
- Allow a minimum of 3 to 4 generations to promoted adaptation of naturally spawning fish.
- Initiate a new hatchery program by collecting representative samples of naturally spawning fish.
- The program size should be consistent with conservation goals and the natural population's ability to support hatchery broodstock requirements while limiting gene flow to the natural population.
- At a minimum, ensure that gene flow from the natural population to the hatchery population is greater than the gene flow from the hatchery to the natural population. PNI should be greater than 0.5 and pNOB should be greater than pHOS.

[2] This is the most common scenario in many places within the Columbia River Basin.

- Limit the contribution of hatchery fish to less than 30% of the natural spawning population, i.e. pHOS should be greater than 30%.
- For stocks of moderate of high biological significance and viability or to achieve goals to maintain/improve the biological significance and viability of a stock, the PNI should be greater than 0.67.
- Collect sufficient broodstock to achieve a composite (natural and hatchery components) population in excess of 500 fish.
- The effective population size of the hatchery component should be greater than 500 fish if the long-term goal of the hatchery program is to provide a conservation benefit or if the natural spawning of hatchery-origin fish is difficult to control.
- Terminate segregated harvest program.

Considerations for Approach #1:

- *Likelihood of achieving natural adaptation*: There is a moderate likelihood of attaining population goals because of the uncertainty of adaption to the natural environment after 3 or 4 generations. The likelihood of meeting population goals increases with the amount of time allowed before initiating the new program. The approach allows the most rapid adaptation to the natural environment and improved productivity of the natural population is expected.
- *Cost*: The increased costs incurred for broodstock collection are expected to be similar for all approaches. An additional cost for differentially marking two hatchery broodstocks would be incurred if the phased approach is adopted (see Effects on Harvest)
- *Effect on Harvest*: There is a high likelihood of losing contributions to harvest since the segregated program would likely be reduced to allow adaptation of the natural stock. A phased approach during broodstock transition (including differential marking) as described in Approach 2, Scenario 2, could be used to reduce loss of the harvest contribution.

Approach #2: Recommended approach if productivity of natural population can be allowed to improve over an extended period of time.

- Take steps to reduce the number of hatchery fish in the natural population through measures such as reducing the hatchery program, employing selective harvest to limit strays, installing weirs, etc. Initiate a new hatchery program by collecting a representative sample of natural fish for broodstock (NOB) in accordance with the limitations described below.
- The program size should be consistent with conservation goals and the natural population's ability to support hatchery broodstock requirements while limiting gene flow to the natural population.
- At a minimum, ensure that gene flow from the natural population to the hatchery population is greater than the gene flow from the hatchery to the natural population. PNI should be greater than 0.5 and pNOB should be greater than pHOS.

- Limit the contribution of hatchery fish to less than 30% of the natural spawning population, i.e. pHOS should be greater than 30%.
- For stocks of moderate of high biological significance and viability or to achieve goals to maintain/improve the biological significance and viability of a stock, the PNI should be greater than 0.67.
- Collect sufficient broodstock to achieve a composite (natural and hatchery components) population in excess of 500 fish.
- The effective population size of the hatchery component should be greater than 500 fish if the long-term goal of the hatchery program is to provide a conservation benefit or if the natural spawning of hatchery-origin fish is difficult to control.

Considerations for Approach #2:

- *Likelihood of achieving natural adaptation*: There is a moderate likelihood of achieving population goals will increase over time and as the PNI increases through reduction in hatchery fish spawning naturally and/or through the incorporation of additional natural fish into the hatchery broodstock. A PNI of greater than 0.5 is necessary to regain fitness and should be the minimum broodstock management goal even during transition between hatchery programs.
- *Cost*: Increased costs incurred for broodstock collection are expected to be similar for all approaches. An additional cost for differentially marking two hatchery broodstocks would be incurred if the phased approach is adopted (see Effects on Harvest)
- *Effect on Harvest*: High likelihood of losing contributions to harvest unless the contribution of hatchery fish to the natural spawning population can be controlled without reducing the program. A phased approach during broodstock transition (including differential marking) as described in Approach 2, Scenario 2, could be used to reduce loss of the harvest contribution.

2.2.4 Scenario 4: New Integrated Re-introduction Program

Initial Conditions:

- The natural population has been extirpated.
- A hatchery stock from another watershed is available as a donor.

Recommended Approach:

- Managers should have a defensible premise that re-introduction will be successful, i.e. the conditions that led to extirpation have been corrected.
- Managers should choose the stock most likely to succeed from among the available donor stocks. Stocks with similar genetic and life history characteristics from watersheds with similar habitat should be chosen.
- If an out-of-basin hatchery stock is used, the following guidelines should be followed.
  - Continue working to develop a locally adapted (in-basin) hatchery stock as a donor.

- Cease using the out-of-basin stock once a locally adapted stock has been developed. Allow broodstock in excess of hatchery needs to spawn naturally.
- Initiate an integrated re-introduction program once there is evidence of natural production. Representative samples of naturally spawning fish should be collected for broodstock.
- The program's size should allow the natural population to support hatchery broodstock requirements while limiting gene flow to the natural population.
- Ensure that gene flow from the natural to the hatchery population is greater than that from the hatchery to the natural population, i.e. PNI should be greater than 0.5 and pNOB should be greater than pHOS.
- The program should be terminated once the naturally spawning population reaches a size that is resistant to stochastic changes (recommended 500 to 1,000 natural spawners per year).
- Monitor the population for self-sufficiency.

Considerations:

- Successful re-introduction depends on the conditions that led to extirpation being corrected to the point that the hatchery program can produce a self-sustaining stock.
- Habitat productivity and capacity should be sufficient to support the population.
- Current or expected exploitation rates should not hinder re-introduction.
- The preferred donor stock in most cases will be a naturally reproducing stock from a nearby watershed with similar habitat characteristics.
- In many cases where natural stocks have been extirpated, other local natural stocks are also depressed and hatchery stocks are the only available donors.
- Re-introduction of adults, rather than juveniles, eliminates hatchery influence at all life stages and can simplify operational problems associated with juvenile releases.

2.3 Implementing a Segregated Hatchery Program

Segregated programs are generally managed to maximize productivity of the hatchery population without regard to the ability of returning adults to reproduce naturally. As a result, segregated programs often represent major trade-offs between minimizing biological risks to naturally spawning populations and maximizing efficiency and harvest benefits of the hatchery program. These types of programs are often used to meet only harvest goals and, as such, have few operational constraints other than limiting the contribution of adults from these programs to natural spawning populations. The degree to which segregated hatchery programs are successful depends significantly on the degree to which genetic and ecological risks to natural populations can be minimized (HSRG, WDFW and NWIFC 2004b).

2.3.1 Scenario 1: New Segregated Program

Initial Conditions:

- No hatchery program exists.
- The status of the natural population in terms of past influences from hatcheries is not important.

Recommended Approach:

- Initiate the program with sufficient fish to provide a minimum effective population size of 500 fish.
- Identify HORs and NORs. Avoid unintentional inclusion of NORs in the broodstock.
- Operate the program to avoid significant genetic and/or ecological interactions with natural populations. Methods include selecting the appropriate program size in terms of the number of juveniles to be released, selective removal of adults through fisheries to limit strays, adult collection facilities or weirs, long-term acclimation at the point of release, and other measures to control straying.
- Ensure that the contribution of hatchery-origin fish spawning naturally is less than five percent of the natural spawning population.

2.3.2 Scenario 2: Transition from a partially segregated or integrated program

Initial Conditions:

- Hatchery broodstock has had no systematic gene flow from the natural population.
- The naturally spawning population has had significant influence from hatchery fish.

Recommended Approach:

- Identify HORs and NORs. Avoid unintentional inclusion of NORs in the broodstock.
- Operate the program to avoid significant genetic and/or ecological interactions with natural populations. Methods include proper sizing of hatchery program, selective removal through fisheries to limit strays, adult collection facilities or weirs, long-term acclimation at the point of release, and other measures to control straying.
- Ensure that the contribution of hatchery-origin fish spawning naturally is less than 5% of the natural spawning population

2.3.3 Scenario 3: Transition from a well-integrated program to a segregated program

Initial Conditions:

- There has been systematic gene flow to hatchery broodstock from the natural population.
- Gene flow from the natural population to the hatchery population has been greater than from the hatchery to the natural population.

Recommended Approach:

- Identify HORs and NORs. Avoid unintentional inclusion of NORs in the broodstock.
- Operate the program to avoid significant genetic and/or ecological interactions with natural populations. Methods include proper sizing of hatchery program, selective removal through fisheries to limit strays, adult collection facilities or weirs, long-term acclimation at the point of release, and other measures to control straying.
- Ensure that the contribution of hatchery-origin fish spawning naturally is less than 5% of the natural spawning population

3 References

Hatchery Scientific Review Group, Washington Department of Fish and Wildlife, and Northwest Indian Fisheries Commission. 2004a. Technical Discussion Paper #1: Integrated Hatchery Programs. (Available from www.hatcheryreform.us).

_____. 2004b. Technical Discussion Paper #2: Segregated Hatchery Programs. (Available from www.hatcheryreform.us).