A REVIEW OF NATURES APPROACHES

TO INCREASE PACIFIC SALMON

POST-RELEASE SURVIVAL

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EXTENDED ABSTRACT ONLY – DO NOT CITE

Natural Rearing Enhancement System (NATURES) research focuses on developing salmon culture practices to enable hatcheries to produce wild-like salmonids with increased postrelease survival. Conventional hatchery-reared salmonids lack many of the natural behavioral and morphological characteristics needed to survive after release (Maynard et al. 1995, Maynard et al 1996a). NATURESs researchers hypothesized that exposing salmonids to more natural rearing conditions in the hatchery would induce them to develop wild attributes needed to survive after release. Seminatural raceway habitats, automated underwater feeders, exercise current velocities, live food diets, and predator avoidance training were proposed as ways to enrich the artificial rearing environment of hatchery salmonids (Maynard et al 1995). The following abstract reviews our research on how these rearing strategies affect the behavior, morphology, health, and postrelease survival of Pacific salmon.

Rearing chinook salmon (*Oncorhynchus tshawytscha*) in seminatural raceway habitat can increase juvenile outmigration survival (Maynard et al. 1996a,b; Maynard et al. 2001). This NATURES habitat is composed of natural substrate (sand, gravel, epoxy resin rock pavers, or exposed aggregate pavers), structure (plastic aquarium plants or confers), and overhead cover (solid opaque or camouflage net) that simulates the natural environment found in streams and rivers. The biology of chinook salmon reared in seminatural and conventional raceway habitat has been compared in four experiments since 1992. In seminatural raceway habitat, chinook salmon exhibit more natural agonistic behaviors than fish reared in conventional barren raceway environments. The growth of chinook salmon reared in seminatural raceway habitat is usually slightly less than that of controls, but their health is usually better. Seminaturally reared chinook salmon always develop cryptic skin coloration that blends into stream and river backgrounds. This enhanced camouflage coloration is thought to be responsible for their increased (1-67%) downstream migration survival observed in 16 out of 17 releases (Fig. 1).

Using live foods training to increase predator skills of hatchery salmon has only shown limited success (Maynard et al. 1996, 2001). Supplementing chinook salmon diets with live food increased interest in pursuit of live prey in laboratory test arenas. However, this approach did not lead to better foraging when groups of fish were placed in riverine and marine test arenas. Rearing chinook salmon on a live food only diet increased the amount of material they consumed when individually confined in stream enclosures, but the results were not statistically significant nor large enough to economically justify live food diet use.

Two studies evaluated the effectiveness of automated underwater feed delivery systems (Maynard et al 1996, 2001). When this feed delivery system was incorporated into a seminatural raceway habitat study, chinook salmon exhibited more natural territorial behavior and seemed less likely to strike at debris falling on the surface than hand fed fish. While encouraging, the effect of the feeder could not be separated out from the other experimental variables. In a followup study examining the effect of the feeder alone, hand fed and auto fed chinook salmon exhibited similar depth preferences and predator vulnerability. Fish in both treatments gave natural fright responses to novel visual stimuli appearing above the water surface. The only observable difference was that hand fed fish approached humans, while auto fed fish fled them.

Downstream migratory survival of chinook salmon was increased by predator avoidance training (Maynard et al. 2001). Fall chinook salmon provided limited exposure to caged predators (hooded mergansers, largemouth bass, etc) had a 26% higher downstream migratory survival than predator-naïve controls (Fig. 2). This NATURES training strategy resulted in few inculture mortalities and could be easily implemented at most salmon enhancement hatcheries.

Developing an exercise protocol to increase chinook salmon postrelease survival has been an elusive goal. A modification of the Burrows pond concept that could be retrofitted to raceways at most modern hatcheries was successfully developed (Maynard et al. 2001). However continuously exercising fall chinook salmon in this system at one body length/sec for over a week produced greater inculture mortality than occurred in unexercised controls. Further, the exercised fish did not have a greater downstream survival than controls. Limiting the exercise protocol to 2 hours per day eliminated the inculture mortality problem, but failed to demonstrate an increase in downstream survival or reduction in predator vulnerability. At this point, further research is needed to confirm Burrow's (1969) observation of a 61% increase in recruitment for exercised salmon.

The success of seminatural raceway habitat and predator avoidance at increasing downstream migration survival has led to production scale evaluations determining their effects on recruitment to the fishery and spawning population.

References

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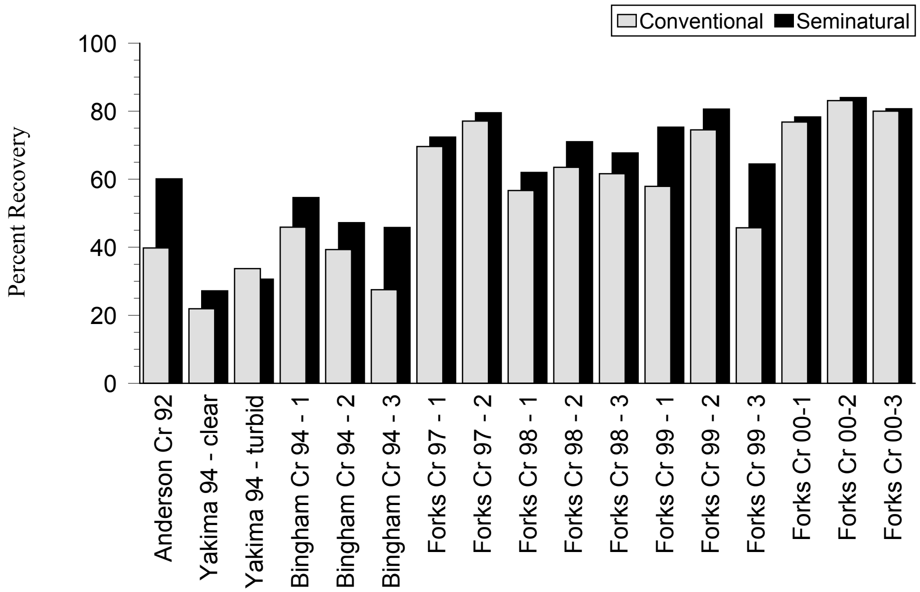

Figure 1. Comparative downstream migration survival of chinook salmon reared in conventional and seminatural raceways habitat in four NATURES studies conducted since 1992.

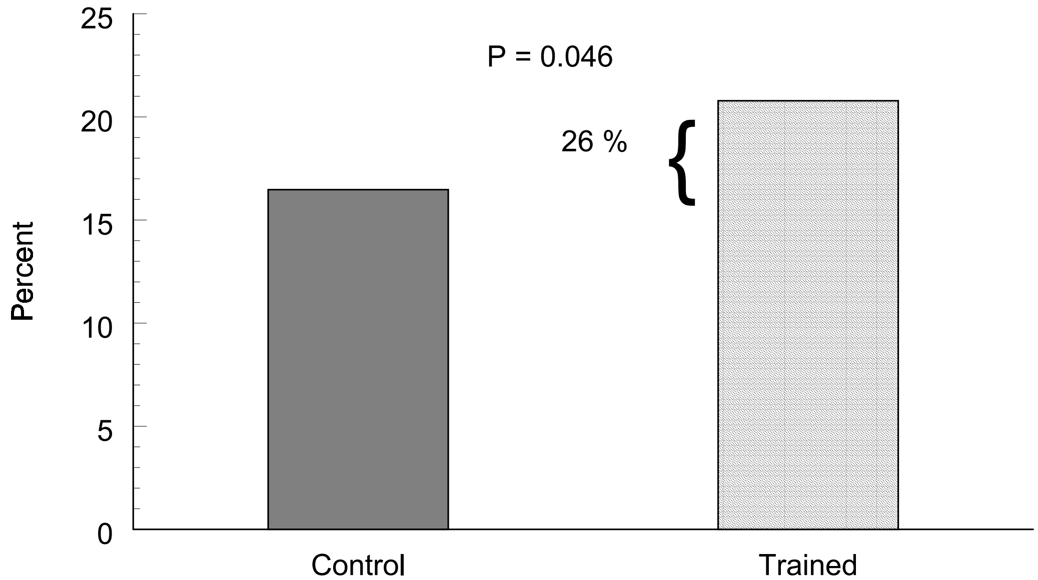

Figure 2. Comparative downstream migration survival of control and predator trained fall chinook salmon.