

Appendix to the Working Draft of “Proposed Policy on the Consideration of Hatchery Production in Endangered Species Act Listing Determinations for Pacific Salmon and Steelhead”

- Studies considered in evaluating whether supplementation can be used to provide a net long-term benefit to natural populations
- Tables 1-5 present brief summaries of the findings for the studies referenced below.

Key References Considered ^{*}:

- Bachman, R. A. 1984. Foraging behavior of free-ranging wild and hatchery brown trout in a stream. *Trans. Am. Fish. Soc.* 113: 1-32
- Berejikian, B. A., Tezak, E. P., Schroder, S. L., Knudsen, C. M., and Hard, J. J. 1997. Reproductive behavioral interactions between spawning wild and captively reared coho salmon (*Oncorhynchus kisutch*). *ICES J. Mar. Sci.* 54: 1040-1050.
- Berejikian, B.A. 1995. The effects of hatchery and wild ancestry and environmental factors on the behavioral development of steelhead trout (*Oncorhynchus mykiss*) fry. Ph.D. dissertation, University of Washington, Seattle, Wash.
- Berejikian, B.A. 1995. The effects of hatchery and wild ancestry and experience on the relative ability of steelhead trout fry (*Oncorhynchus mykiss*) to avoid a benthic predator. *Can. J. Fish. Aquat. Sci.* 52: 2476-2482.
- Berejikian, B.A., Mathews, S.B., and Quinn, T.P. 1996. Effects of hatchery and wild ancestry and rearing environments on the development of agonistic behaviour in steelhead trout (*Oncorhynchus mykiss*) fry. *Can. J. Fish. Aquat. Sci.* 53: 2004-2014.
- Chilcote, M.W., Leider, S.A., and J.J. Loch. 1986. Differential reproductive success of hatchery and wild summer-run steelhead under natural conditions. *Trans. Am. Fish. Soc.* 115: 726-735.
- Chilcote, M.W. (in press). The adverse reproductive consequences of supplementing natural steelhead populations in Oregon with hatchery fish. *Can. J. Fish. Aquat. Sci.*
- Einum, S. and Fleming, I.A. 1997. Genetic divergence and interactions in the wild among native, farmed, and hybrid Atlantic salmon. *J. Fish. Biol.* 50: 634-651.
- Fleming, I. A., and Gross, M. R. 1989. Evolution of adult female life history and morphology in a Pacific salmon (coho: *Oncorhynchus kisutch*). *Evolution* 43: 141-157.
- Fleming, I. A., and Gross, M. R. 1992. Reproductive behavior of hatchery and wild coho salmon (*Oncorhynchus kisutch*): does it differ? *Aquaculture* 103: 101-121.
- Fleming, I. A., and Gross, M. R. 1993. Breeding success of hatchery and wild coho salmon (*Oncorhynchus kisutch*) in competition. *Ecol. Appl.* 3: 230-245.
- Fleming, I. A., and Gross, M. R. 1994. Breeding competition in a Pacific salmon (coho: *Oncorhynchus kisutch*): measures of natural and sexual selection. *Evolution* 48: 637-657.
- Fleming, I. A., Jonsson, B., Gross, M. R., and Lamberg, A.. 1996. An experimental study of the

- reproductive behavior and success of farmed and wild Atlantic salmon (*Salmo salar*). J. Appl. Ecol. 33: 893-905.
- Fleming, I. A., Jonsson, B., and Gross, M. R. 1994. Phenotypic divergence of sea-ranched, farmed, and wild salmon. Can. J. Fish. Aquat. Sci. 51: 2808-2824.
- Fleming, I. A., Lamberg, A., and Jonsson, B. 1997. Effects of early experience on the reproductive performance of Atlantic Salmon. Behav. Ecol. 8: 470-480.
- Fleming, I.A, K. Hindar, I.B. Mjølnerod, B. Johsson, T. Balstad , and A. Lamberg. 2000. Lifetime success and interactions of farm salmon invading a native population.. Proc. R. Soc. Lond. 267: 1517-1523.
- Fleming, I.A. and Einum, S. 1997. Experimental tests of genetic divergence of farmed from wild Atlantic salmon due to domestication. ICES J. Mar. Sci. 54: 1051-1063.
- Johnsson, J., Höjesjö, J., and Fleming, I.A. 2001. Behavioral and heartrate responses to predation risk in wild and domesticated Atlantic salmon. Can. J. Fish. Aquat. Sci. 58: 788-794.
- Johnsson, J.I. and Abrahams, M.V. 1991. Interbreeding with domestic strain increases foraging under threat of predation in juvenile steelhead trout (*Oncorhynchus mykiss*): an experimental study. Can. J. Fish. Aquat. Sci. 48: 243-247.
- Johnsson, J.I., Petersson, E., Jönsson, E., Björnsson, B.T., and Järvi, T. 1996. Domestication and growth hormone alter antipredator behaviour and growth patterns in juvenile brown trout, *Salmo trutta*. Can. J. Fish. Aquat. Sci. 53: 1546-1554.
- Kallio-Nyberg, I., and M.-L. Koljonen. 1997. The genetic consequence of hatchery-rearing on life-history traits of Atlantic salmon (*Salmo salar L.*): a comparative analysis of sea-ranched salmon with wild and reared parents. Aquaculture 153: 207-224.
- Lieder, S.A., Hullett, P.A., Loch, J.J., and M.W. Chilcote. 1990. Electrophoretic comparison of the reproductive success of naturally spawning transplanted and wild steelhead trout through the returning adult stage. Aquaculture 88: 239-252.
- McMichael, G. A., Pearsons, T. N., and Leider, S. A. 1999. Behavioral interactions among hatchery-reared steelhead smolts and wild *Oncorhynchus mykiss* in natural streams. Trans. Am. Fish. Soc. 19: 948-956.
- McMichael, G.A., C.S. Sharpe, and T.N. Pearsons. 1997. Effects of residual hatchery-reared steelhead on growth of wild rainbow trout and spring chinook salmon. Trans. Am. Fish. Soc. 126:230-239.
- McGinnity, P., Stone, C., Taggrt, L.B., Cooke, D., Cotter, D., Hynes, R., McCamley, C., Cross, T. and A. Ferguson. 1997. Genetic impact of escaped farmed Atlantic salmon (*Salmo salar L.*) on native populations: use of DNA profiling to assess freshwater performance of wild, farmed and hybrid progeny in a natural river environment. J. Mar. Sci. 54: 998-1008.
- Nickelson, T. S., Solazzi, M. F., and Johnson, S. L. 1986. Use of hatchery coho salmon (*Oncorhynchus kisutch*) presmolts to rebuild wild populations in Oregon coastal streams. Can. J. Fish. Aquat. Sci. 43:2443-2449.

- Nielsen, J. L. 1994. Invasive cohorts-impacts of hatchery-reared coho salmon on the trophic, developmental, and genetic ecology of wild stocks. *In Theory and Application in Fish Feeding Ecology*, D. Stouder, K. L. Fresh, and R. Feller (editors), pp. 361-385. The Belle Baruch Library in Marine Science, University of South Carolina, Columbia.
- Petersson, E. and Järvi, T. 2000. Both contest and scramble competition affect the growth performance of brown trout, *Salmo trutta*, parr of wild and of sea-ranched origins. *Environ. Biol. Fish.* 59: 211-218.
- Reinhardt, U.G. 2001. Selection for surface feeding in farmed and sea-ranched Masu salmon juveniles. *Trans. Am. Fish. Soc.* 130: 155-158.
- Reinhardt, U.G., Yamamoto, T., and Nakano, S. 2001. Effects of body size and predators on intracohort competition in wild and domesticated juvenile salmon in a stream. *Ecol. Res.* 16: 327-334.
- Reisenbichler, R.R. and McIntyre, J.D. 1977. Genetic differences in growth and survival of juvenile hatchery and wild steelhead trout, *Salmo gairdneri*. *J. Fish. Res. Board Can.* 34: 123-128.
- Reisenbichler, R.R. and S.P. Rubin. 1999. Genetic changes from artificial propagation of Pacific salmon affect the productivity and viability of supplemented populations. *ICES J. Mar. Sci.* 56: 459-466.
- Swain, D.P. and Riddell, B.E. 1990. Variation in agonistic behavior between newly emerged juveniles from hatchery and wild populations of Coho salmon, *Oncorhynchus kisutch*. *Can. J. Fish. Aquat. Sci.* 47: 566-571.

Unpublished Data Considered:

- Ford, Fuss and Hard (*unpublished data*)
- Kostow, Phelps and Marshall (*unpublished data*)
- McLean, Bentzen and Quinn (*unpublished data*)
- McGinnity et al. (*unpublished data*)
- Moran and Berntson (*unpublished data*)
- Rubin and Reisenbichler (*unpublished data*)

- * This list of key references is by no means a complete and comprehensive list of peer-reviewed scientific publications instructive to the relationship between artificially propagated and naturally-produced fish.