# Are Prince William Sound Salmon Hatcheries A Fool's Bargain?

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We often hear that "salmon hatcheries are a fool's bargain," that they do no more than drive out and replace production by wild-spawning salmon. That usage was coined by Carl Walters in his address to the conference *Towards Sustainable Fisheries: Balancing Conservation and Use of Salmon and Steelhead in the Pacific Northwest* on 26 April 1996 in Victoria, British Columbia; he reviewed evidence that salmon hatchery programs have indirectly caused depletion of wild-spawning salmon, either through ecological interaction or through overfishing in mixed stock harvests. In the Pacific Northwest and British Columbia experts increasingly have come to accept that salmon enhancement programs provide no net gain to harvesters but only displace the productivity of wild-spawning salmon, that salmon hatcheries are a foolish bargain (CPMPNAS 1996, Chapter 12), or that, at best, hatcheries can only partially mitigate for lost habitat (ISG 1996, Chapter 8). The Alaska salmon enhancement program, particularly in Prince William Sound (PWS), also has been characterized as foolish ("There is no mitigative excuse…[the program] should be terminated"; Hilborn 1992). We believe this characterization of the salmon enhancement program in PWS has been made without careful consideration of historical data.

A recent example is worth consideration. Tarbox and Bendock (1996) wrote in favor of vigorous conservation of salmon stock diversity in Alaska and for protection of salmon habitat. In illustration of an ancillary point in their essay they wrote that "hatcheries [in Prince William Sound are] a major contributor to wild stock loss." We fully support their sentiments in favor of vigorous conservation of salmon stocks and habitat. However, a careful consideration of historical data supports neither the notion that wild stocks have been lost nor the notion that hatcheries have contributed to the loss of wild salmon.

Tarbox and Bendock base their statement on an analysis by Eggers et al. (1991). That analysis found evidence of declining wild stocks in annual escapement estimates and proposed an association between that decline and hatchery production, an apparent example of the foolish bargain. More recent data and analysis provide a basis for arguing against the twin notions that wild stocks have been "lost" and that hatcheries are responsible for such losses.

The gist of the 1991 analysis by Eggers and colleagues was that among central Gulf of Alaska pink salmon stocks neither Cook Inlet nor Kodiak stocks declined after the construction of hatcheries beginning in the mid 1970s. PWS stocks, however, after being stable from 1960 to 1978, rose to high abundance after 1978 and after 1984 declined in abundance. According to their analysis of the post-1984 decline, the most plausible explanation for the discrepancy between PWS and other central Gulf of Alaska stocks is that after 1980 more than 90% of the large hatchery stocks in PWS had been harvested. Because wild and hatchery stocks commingle in the fishery, they surmised that wild stocks had been harvested excessively, leading to a repeated underescapement of wild stocks in PWS and the observed decline of wild pink salmon stocks. This explanation is the source of the twin notions that wild stocks have been lost and that hatcheries are responsible. The argument that harvest of hatchery stocks contributed to the apparently unique decline of abundance in PWS rests essentially on the relatively large production of pink salmon hatcheries there compared to other areas; i.e., wild stocks did not decline in Kodiak or Cook Inlet because hatchery production was not large in either of those areas, and therefore, harvest rates were not excessive.

An alternative hypothesis is that the decline, not "loss," after 1984 in the historically common abundance of wild stocks in PWS, as indicated by annual estimates of spawning escapements in the districts of

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PWS (Figure 1), is related to some other phenomenon common to the sound besides hatcheries. Support for this alternative comes from recent reconstruction of harvest rates (Templin 1995; Templin et al. 1996), suggesting that wild pink salmon stocks originating in the Southeastern District of PWS are not harvested in the same districts in which hatchery salmon are harvested. Presumably, those stocks have been unaffected by harvests of hatchery salmon, yet they have followed the general abundance pattern of all PWS: a rise from relatively low numbers beginning in the early 1970s to a peak in 1984 and a decline in more recent years. If Southeastern District pink salmon are not harvested in mixtures with hatchery stocks, it would be difficult to ascribe the decline of Southeastern escapements to excess harvest associated with the presence of hatchery stocks in the fishery. The decline of Southeastern District escapements, absent their harvest in mixtures with hatchery stocks, would instead suggest that some other mechanism, in or beyond PWS, caused the reduced escapements of pink salmon after 1984.

The strength of this argument rests on the accuracy of the assumed migration paths of pink salmon in PWS by Templin (1995) and Templin et al. (1996), which are based on only the opinions of fishermen and fishery managers. Although Southeastern District migration patterns have not been scientifically validated, it would be difficult to accept paths radically different from those assumed. Further evidence supporting an alternative explanation for the post-1984 decline is that even after the decline, escapements in PWS wild stocks have been similar to escapements before the late 1970s (Figure 1), which could reflect a return to average production conditions. That is, perhaps the peak in the late 70s and early 80s was effected by unusual conditions or circumstances and did not characterize true production potential.

If the post-1984 escapements did decline from the true production potential, there are foolish-bargain alternative hypotheses under which Southeastern District stocks might have interacted with hatchery salmon. One is that hatchery and wild fry co-occur under conditions of food limitation, probably in the southwestern part of the sound. Neither Tarbox and Bendock (1996) nor Eggers et al. (1991) suggest this mechanism is operating in PWS; however, it has been generally proposed as a plausible cause of the fool's bargain effect (e.g., CPMPNAS 1996). Whether hatchery and Southeastern District fry co-occur in the sound is unknown, but even if they do co-occur, available evidence suggests they are not food-limited. Cooney (1993) estimated that the combined abundance of hatchery and wild salmon fry could have had only a minimal predatory impact on PWS zooplankton, demanding only 3 to 10% of macrozooplankton production. Another possibility — that pink salmon production in PWS is not food-limited but rather is spawning habitat-limited — is supported by the unusual prevalence of intertidal spawning on the tectonically active and steep shores of the sound. Half or more of the pink salmon in PWS spawn intertidally, whereas typically fewer that 15% spawn intertidally elsewhere (Heard 1991).

A third mechanism that might underlie a foolish bargain in PWS is genetic interaction between hatchery and wild salmon (e.g., Waples 1991), whereby the fitness and productivity of wild stocks are degraded through interbreeding with hatchery stocks. This degradation might occur because hatchery stocks have been artificially selected, intentionally or unintentionally, and therefore diverge genetically from wild stocks, or simply because hatchery stocks have ancestrally different genomes from the wild stocks with which they interbreed. This is a potentially serious effect; however, pink salmon in PWS hatcheries are exposed to artificial selection only during embryo and fry stages, unlike other cultured salmonids that are artificially cultured through parr and smolt stages. Also, pink salmon in PWS hatcheries are ancestrally from PWS, not from geographically and, presumably, genetically distant populations.

In the case of salmon enhancement, particularly in PWS, Alaska is clearly not "failing to learn or adapt based on experiences of other areas," as was suggested by Tarbox and Bendock (1996). We do not dispute that hatchery pink salmon harvested with commingled PWS wild stocks in the western districts exacerbate the already intense difficulty of managing the harvest rationally. The year-by-year tendency of the increasingly powerful fishery to harvest pink salmon earlier in the run, when constituent stocks are more thoroughly mixed, also exacerbates this difficulty (Geiger et al. 1992). However, hatchery managers and harvest managers have begun an ambitious mass-marking program to identify hatchery-produced salmon in the catch. Virtually all (over 500 million) pink salmon fry from the hatcheries are now given an identifying otolith mark that can be used during the harvest season to estimate the proportion of wild salmon in the catch (Hagen et al. 1995). Even before the mass-marking technology became available, vigorous programs of tagging hatchery salmon were in place in PWS and were used inseason by managers (Geiger et al. 1992). Other examples of Alaska's clear ability to learn from the experiences of others are its model systems of regulations and policies designed to reduce risks of

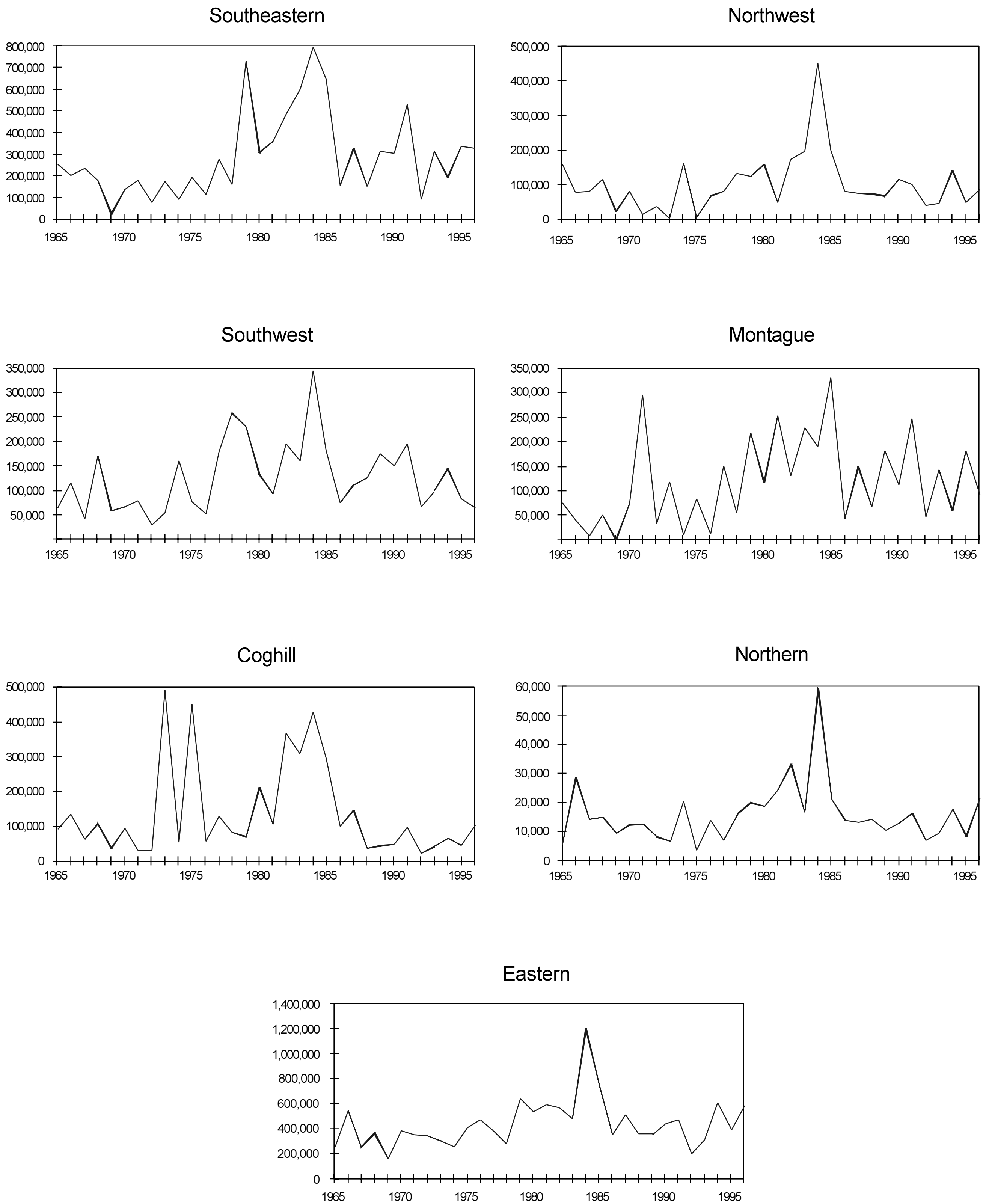


Figure 1. Estimates of pink salmon spawning escapements in districts of Prince William Sound. Data from Sharp et al. 1996.

pathogen dissemination and of genetic introgression (Holmes and Burkett 1996).

We do not accept that the PWS salmon enhancement program has been a fool's bargain. In the quarter century before the hatchery program, the annual harvest of pink salmon was never above 8 million, and there were 5 years in which managers closed fisheries to conserve spawning stocks: 1954, 1955, 1959, 1972, and 1974 (Koernig and Noerenberg 1976). Since 1980, when appreciable harvest of hatchery stocks began, the harvest has not been below 8 million, and there have been at least 2 years in which hatchery stocks sustained the harvest: 1988 and 1992 (Sharp et al. 1996). It may well be that the 25 years preceding the hatchery program were characterized by climatic conditions that produced low marine survival of pink salmon in the northeast Pacific Ocean and that the years since have been characterized by good climatic conditions and high marine survival (Hare and Francis 1995). That is, much of the relatively high production may be attributable to a shift of the marine climate rather than to the hatchery program. However, the PWS hatchery program was not developed to ameliorate poor marine survival of pink salmon. Rather, it was developed to ameliorate limitations of the freshwater environment, specifically the extreme mortality associated with winter dessication and freezing of incubating pink salmon embryos (Koernig and Noerenberg 1976). Arguably, the PWS hatchery program has been successful in that goal: harvests have increased, and harvests have been possible in years when wild stocks were necessarily protected from harvest.

## LITERATURE CITED

Cooney, R. T. 1993. A theoretical evaluation of the carrying capacity of Prince William Sound, Alaska, for juvenile Pacific salmon. Fisheries Research 18:77–88.

CPMPNAS (Committee on Protection and Management of Pacific Northwest Anadromous Salmonids). 1996. Upstream: salmon and society in the Pacific Northwest. National Academy Press, Washington, D.C.

Eggers, D. M., L. R. Peltz, B. G. Bue, and T. M. Willette. 1991. Trends in abundance of hatchery and wild stocks of pink salmon in Cook Inlet, Prince William Sound, and Kodiak, Alaska. Alaska Department of Fish and Game, Division of Commercial Fisheries, Professional Paper 35, Juneau.

Geiger, H., J. Brady, W. Donaldson, and S. Sharr. 1992. The importance of stock identification for management of the Prince William Sound pink salmon fishery. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 5J92-12, Juneau.

Hagen, P., K. Munk, B. Van Alen, and B. White. 1995. Thermal mark technology for inseason fisheries management: a case study. Alaska Fishery Research Bulletin 2:143–155.

Hare, S. R., and R. C. Francis. 1995. Climate change and salmon production in the northeast Pacific Ocean. Pages 357–372 *in* R. J. Beamish, editor. Climate change and northern fish populations. Canadian Special Publication of Fisheries and Aquatic Sciences 121, Ottawa.

Heard, W. R. 1991. Life history of pink salmon (*Oncorhynchus gorbuscha*). Pages 119–230 *in* C. Groot and L. Margolis, editors. Pacific salmon life histories. UBC Press, Vancouver.

Hilborn, R. 1992. Hatcheries and the future of salmon in the northwest. Fisheries 17:5–8.

Holmes, R. A., and R. D. Burkett. 1996. Salmon stewardship: Alaska's perspective. Fisheries 21:36–38.

ISG (Independent Scientific Group). 1996. Return to the river: restoration of salmonid fishes in the Columbia River ecosystem. Northwest Power Planning Council, Document 96-6, Portland, Oregon.

Koernig, A., and W. Noerenberg. 1976. First year activities of the Prince William Sound Aquaculture Corporation. Pages 163–170 *in* D. H. Rosenberg, editor. Proceedings of the conference on salmon aquaculture and the Alaskan fishing community. University of Alaska Fairbanks, Alaska Sea Grant Report 76-2.

Sharp, D., S. Morstad, and J. Johnson. 1996. Prince William Sound management area salmon report to the Alaska Board of Fisheries. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Regional Information Report 2A96-41, Anchorage.

Tarbox, K. E., and T. Bendock. 1996. Can Alaska balance economic growth with fish habitat protection? A biologist's perspective. Alaska Fishery Research Bulletin 3:49–53.

Templin, W. D. 1995. Reconstruction of wild pink salmon (*Oncorhynchus gorbuscha*) runs in Prince William Sound, Alaska. Master's thesis, University of Alaska, Fairbanks.

Templin, W., J. S. Collie, and T. J. Quinn II. 1996. Run construction of the wild pink salmon fishery in Prince William Sound, 1990–1991. Pages 499–508 *in* S. D. Rice, R. B. Spies, D. A. Wolfe, and B. A. Wright, editors. Proceedings of the Exxon Valdez oil spill symposium. American Fisheries Society Symposium 18.

Waples, R. S. 1991. Genetic interactions between hatchery and wild salmonids: lessons from the Pacific Northwest. Canadian Journal of Fisheries and Aquatic Sciences 48 (Supplement 1):124–132.