

## Post-Cephalic White Spot Syndrome in Salmonids

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This report documents a phenomenon in salmonids involving one or more white spots generally located in the mid-dorsal nape or occipital region immediately posterior of the fishes' head. The syndrome, post-cephalic white spot (PCWS), varies widely among populations. When present it often is found in less than 0.1% of individuals in a population although in some instances occurrence rates can be considerably higher. This anomaly is easily overlooked and often goes unnoticed, especially when viewing a large number of fish. The white pigment spots, only a few millimeters in diameter in juveniles, grow allometrically and are larger in older fish.

I first observed PCWS in juvenile sockeye salmon in 1975 (Fig. 1). These fish were progeny of adults from Nakvassin Creek at the west end of Port Herbert, a 4.8 km fiord on Baranof Island in Southeast Alaska. Adult salmon were collected and taken to the nearby National Marine Fisheries Service Field Station at Little Port Walter where they were spawned as part of a study to evaluate rearing of smolts in estuarine net pens (Wertheimer et al. 1983).

Since first observing PCWS the anomaly has been found to occur in all five species of North American salmon, rainbow trout, Dolly Varden char, and Atlantic salmon. Documentation of these findings was accomplished through careful observations by myself and by the solicited assistance of many other individuals. Much of this information documents the presence of PCWS in 37 different populations of salmonids from Alaska, Washington, Oregon, British Columbia, New Hampshire, Australia, and Hokkaido, Japan. In some instances sufficient data were collected in certain stocks of wild-and hatchery-origin sockeye and coho salmon to provide preliminary estimates on PCWS occurrence rates in the populations (Fig. 2). Occurrence rate data were also collected on eight populations of hatchery-origin chinook salmon smolts from Alaska, British Columbia, and Oregon that ranged from 0.01 to 0.86 percent.

While PCWS is found in all life stages including adults (Fig. 3) it is more commonly seen in juveniles suggesting, when present, the syndrome carries a distinct survival liability. Although it has been observed in both wild- and hatchery-origin salmonids PCWS is more commonly seen in hatchery populations (Fig. 4), perhaps because large number of hatchery-origin juveniles can often be more readily observed than large numbers of wild juveniles. However, in some instances, for example during monitoring of wild sockeye salmon smolts outmigrating from the Hugh Smith Lake system in southern Southeast Alaska, considerable numbers of PCWS juveniles are found (Fig. 5).

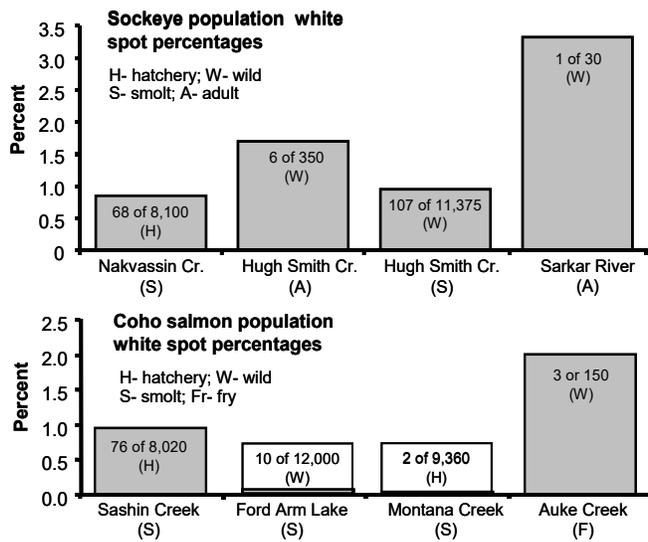
Initial histological comparisons of juvenile chinook and sockeye salmon with and without PCWS show subcutaneous differences including a lack of melanocytes in epidermal tissues and the likely presence of purine crystals in vacuolated area causing the white pigments in dermal tissues (Fig. 6). Pathological examination of sibling sockeye salmon with and without white spots revealed no significant differences although one specimen without PCWS did have a protozoal gill infection.

A different but perhaps related white pigmented anomaly has also been observed in juvenile chum and coho salmon. In these cases a white slash from the post-cephalic dorsal region traverses downward ventrally toward the pectoral fin. White slashes occur either on the right or left side and are associated with deformation of the pectoral girdle, fin, or operculum (Fig. 7). I have only seen white slash anomalies in hatchery-origin fish.

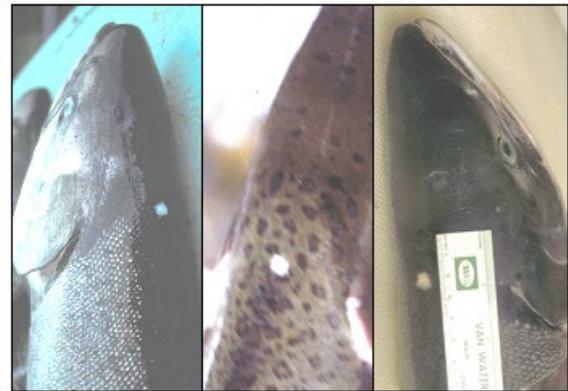
**Fig. 1.** Hatchery-origin sockeye salmon with post-cephalic white spots from Nakavassin Creek parents.



**Fig. 2.** Occurrence rates of post-cephalic white spots in sockeye salmon above, and coho salmon below.



**Fig. 3.** Adult salmon with post-cephalic white spots: left chinook; middle pink; right chum.



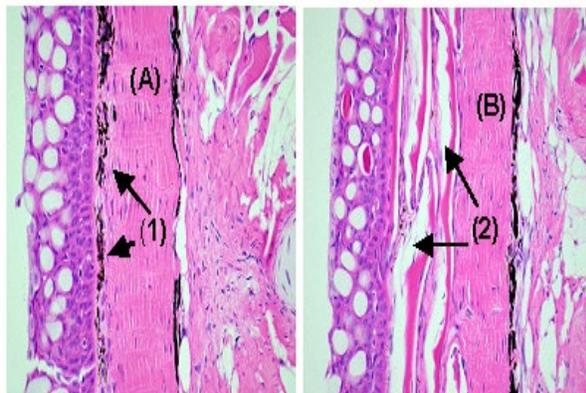
**Fig. 4.** Tahani River chinook salmon smolts at DIPAC Hatchery near Juneau have at least one post-cephalic white fish in the group. Can you find it?



**Fig. 5.** Wild Hugh Smith Creek sockeye salmon smolts with post-cephalic white spots May 19, 1988.



**Fig. 6.** Cross sections of juvenile chinook salmon: (A) pre-PCWS region showing prominent chromatophores beneath epidermal cell layer (1); and (B) PCWS region showing lack of chromatophores between dermal and epidermal tissues and vacuolated areas in dermal tissue that may contain prurine crystals causing white pigment (2).



**Fig. 7.** Perhaps related to post-cephalic white spots, a coho salmon parr with a "white slash" along pectoral girdle. Note deformed operculum.



Causes of either PCWS or white slashes is unknown although some possibilities could include teratogenic malformed anomalies due to exogenous environmental factors causing chromosomal aberrations in one or the other parent, inappropriate mate selection, or interactions of genetic and environmental factors during embryogenesis. Preliminary DNA comparisons of sibling hatchery-origin chinook salmon with and without white spots suggest a genetic linkage; in one instance 7 of 27 fish with white spots from a population of over 218,000 juveniles came from the same parents.

Various literature searches (Dawson 1964) failed to find previous accounts of these phenomena although I am certain others have noted post-cephalic white spots and perhaps the white slashes in salmonids. A popular internet search engine was queried for “white spots in fishes” that yielded thousands of hits. Many hits were associated with the common white spot disease, or ich, caused by a ciliated protozoan. Other references have identified “white spot condition” with abraded skin on salmonids caused from sea lice parasitism (White 1940).

Dorothy Leonard prepared the histological tissue sections, these individuals provided information or observations on PCWS; Jim Cochran, Kent Crabtree, Ted Meyers, Monte Miller, Jerry Koener, Trish Mc Hugh, Al Hemmingsen, Kenneth Johnson, Joe Verret, Diana Tersteeg, Sam Rabung, Dick Crone, Lou Barr, Bill Farris, Luran Donaldson, D. Asuburner, Hiroshi Kawamura, Adrian Celewycz, Andy Gray, Jeff Hard, Jim Miles, Jerry Taylor, Frank Thrower. I would appreciate hearing from others who may have observations or comments on these phenomena.

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