

## Information bulletin

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# Skin Reflectance as a Nonlethal Measure of Smoltification for Juvenile Salmonids

The change from an undeveloped, dark-colored parr to a developed, silvery smolt is caused by the deposition of guanine crystals in the skin and is one of the most obvious physical changes associated with smoltification. Estimates of the level of smoltification using measures of silvering, including skin guanine concentrations and visual classifications, have been used. However, assessing skin guanine concentration requires sacrificing the fish, and although visual assessment of silvering is nonlethal, it is subject to bias between observers and differences in light.

I developed a system of measuring skin reflectance to quantify the silvering of juvenile salmonids without harming the fish. Skin reflectance is a measure of the amount of light reflecting from the surface of the fish. The objectives were to determine if skin reflectance changes during the period of smoltification and to examine correlations between skin reflectance and other measures of smoltification including gill ATPase activity and skin guanine concentration.

## Video and Computer-based System to Measure Silvering

The photo reflectance video analysis system was designed to illuminate a fish with diffuse, consistent light, record an image of the fish, and calculate skin reflectance. Diffuse light, from photo bulbs and an opaque plexiglass box, reflects from the surface of the

fish and is recorded by using a high-resolution video camera and a video camera recorder (VCR). An IBM-compatible computer retrieves the image from the VCR and calculates skin reflectance as the amount of light reflected from a section of skin based on a grey scale calibrated from 0 to 10. Skin reflectance, gill ATPase activity, and skin guanine were measured on freeze-branded juvenile steelhead (*Oncorhynchus mykiss*) and chinook salmon (*O. tshawytscha*) sampled from hatcheries (prerelease) and dams (migrants) along the Snake and Columbia rivers.

## Skin Reflectance Correlated With Other Measures of Smoltification

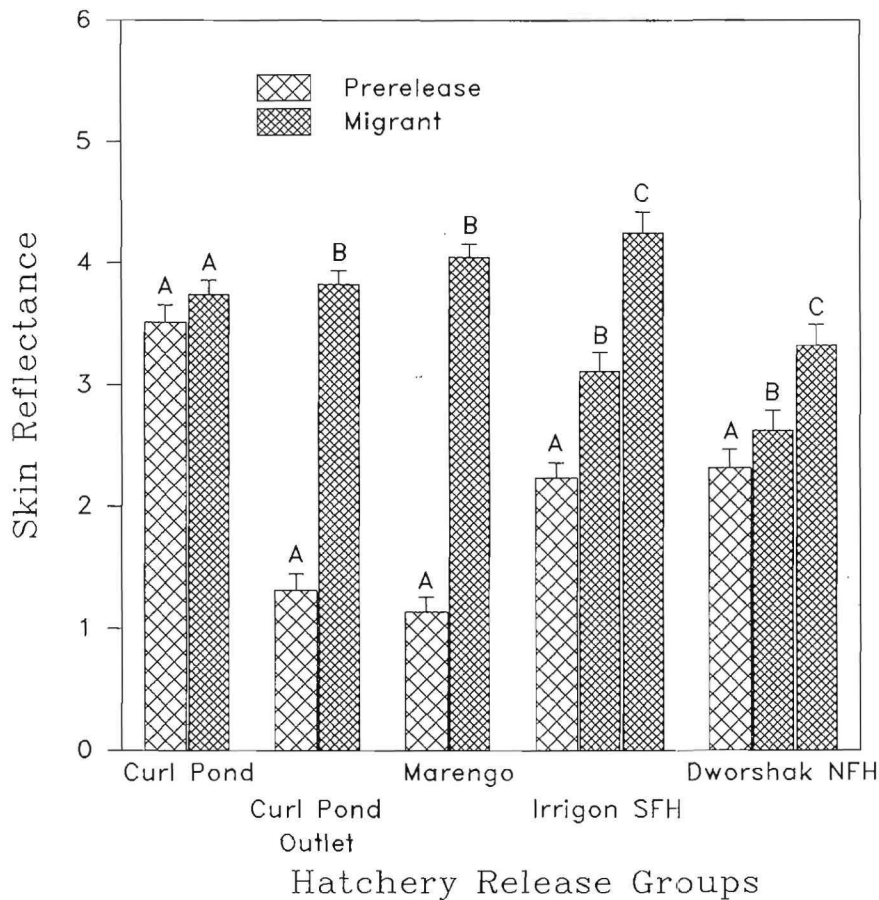
Skin reflectance increased during smoltification in migrating juvenile salmonids as shown by significantly higher mean skin reflectance in 11 of 13 freeze-branded groups of steelhead, spring chinook salmon, and fall chinook salmon recaptured as migrants when compared to samples collected before release (Fig. 1, representative steelhead data shown). Skin reflectance of marked groups of juvenile salmonids collected in 1991 and 1992 were correlated significantly with gill ATPase activity and skin guanine (Fig. 2, representative steelhead data shown), with correlation coefficients ( $r$ ) for mean values between 0.56 and 0.98 for all three species.

I have shown that migrating salmonids recaptured at downstream sites had significantly

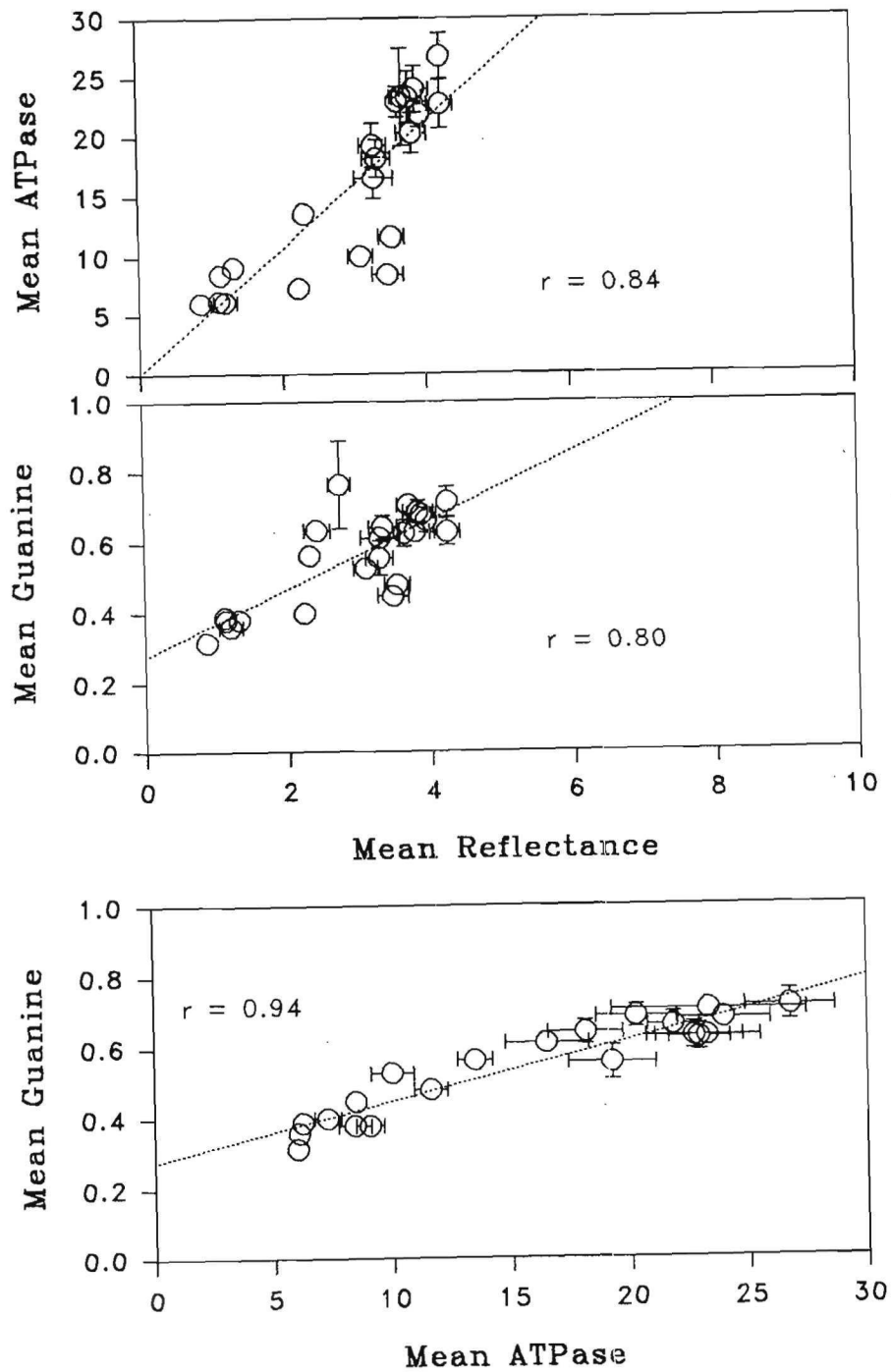
higher skin reflectance than samples collected before release, and that skin reflectance correlates significantly with gill ATPase activity and skin guanine for juvenile steelhead, spring chinook salmon, and fall chinook salmon. This technique for measuring skin reflectance is an objective, nonlethal measure of silvering and can be used as an indicator of smoltification in juvenile salmonids.

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**Fig. 1.** Skin reflectance (mean  $\pm$  SE) of juvenile steelhead sampled in 1992 before release from the hatchery (prerelease) and after migrating to Lower Granite or McNary dams (migrant) from Lyons Ferry Washington State Fish Hatchery (releases at Curl Pond, Curl Pond Outlet, and Marengo), Irrigon Oregon State Fish Hatchery and Dworshak National Fish Hatchery. Letters denote bars that differ significantly ( $F$ -test,  $P \leq 0.05$ ) within each release group.



**Fig. 2.** Correlations between mean ( $\pm$  SE) skin reflectance, gill ATPase activity ( $\mu\text{moles P}_1 \cdot \text{mg prot}^{-1} \cdot \text{hr}^{-1}$ ), and skin guanine ( $\text{mg guanine}/\text{cm}^2$  skin) from juvenile steelhead sampled in 1992. Correlation coefficients ( $r$ ) are significant ( $P \leq 0.05$ ).