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A STANDARD WEIGHT (W_S) EQUATION FOR WHITE STURGEON

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The relative weight index (W_r) contrasts with traditional condition assessments such as Fulton or Le Cren condition factors by facilitating comparisons among populations and among individuals of disparate lengths (Murphy et al. 1990, 1991, Willis et al. 1991). Relative weight values are obtained by dividing the actual weight of a fish by a standard weight (W_s) for fish of that length and then multiplying by 100 (Wege and Anderson 1978). This index thus requires a standard weight equation for the fish species of interest. This note describes a standard weight equation for white sturgeon (*Acipenser transmontanus*), a valuable fish in sport and commercial fisheries, and in commercial hatcheries, along the Pacific coast of North America.

Weight-length equations were compiled from the literature for 15 white sturgeon samples collected from locations representative of the geographical range of the species (Fig. 1, Table 1). Equations were standardized algebraically to the form:

$$W = \alpha L^{\beta}$$

where W = weight in kg and L = total length in cm. Fork lengths were converted to total lengths using a factor of 1.110. This conversion factor was derived from a linear regression of paired total length and fork-length data (n = 1,750) calculated for fork lengths from 1 cm to 250 cm in 1-cm intervals using each of seven conversion equations from various white sturgeon samples (Table 2). Fits of conversion equations were identical with ($b_0 = 2.216$, $b_1 = 1.096$) and without ($b_0 = 0$, $b_1 = 1.110$) the intercept term ($r^2 = 0.996$); however, omitting the intercept term simplified algebraic solution.

The standard weight-length relationship for white sturgeon (Table 3) was calculated from literature weight-length functions with the regression-line-75th-percentile technique (RLP) recommended as the standard by Murphy et al. (1991). The 15 weight-length functions (Table 1) were used to calculate mean weights for each 1-cm total length interval from 1 cm to 250 cm. The 75th-percentile weights for each 1-cm interval in this statistical population (n = 3,750) were then regressed on length to develop the standard weight equation. The standard weight function thus represents the condition that could be expected in a better than average white sturgeon population. Murphy et al. (1991) noted that W_s equations have been defined in most cases to represent populations in better-than-average condition, based on the assumption that attempting to produce fish populations that attain only average condition generally does not represent a typical management goal. All statistical analyses were performed with the Statistical Analysis System (SAS) for personal computers (SAS Institute 1988). Equivalent equations for English units and fork lengths were calculated

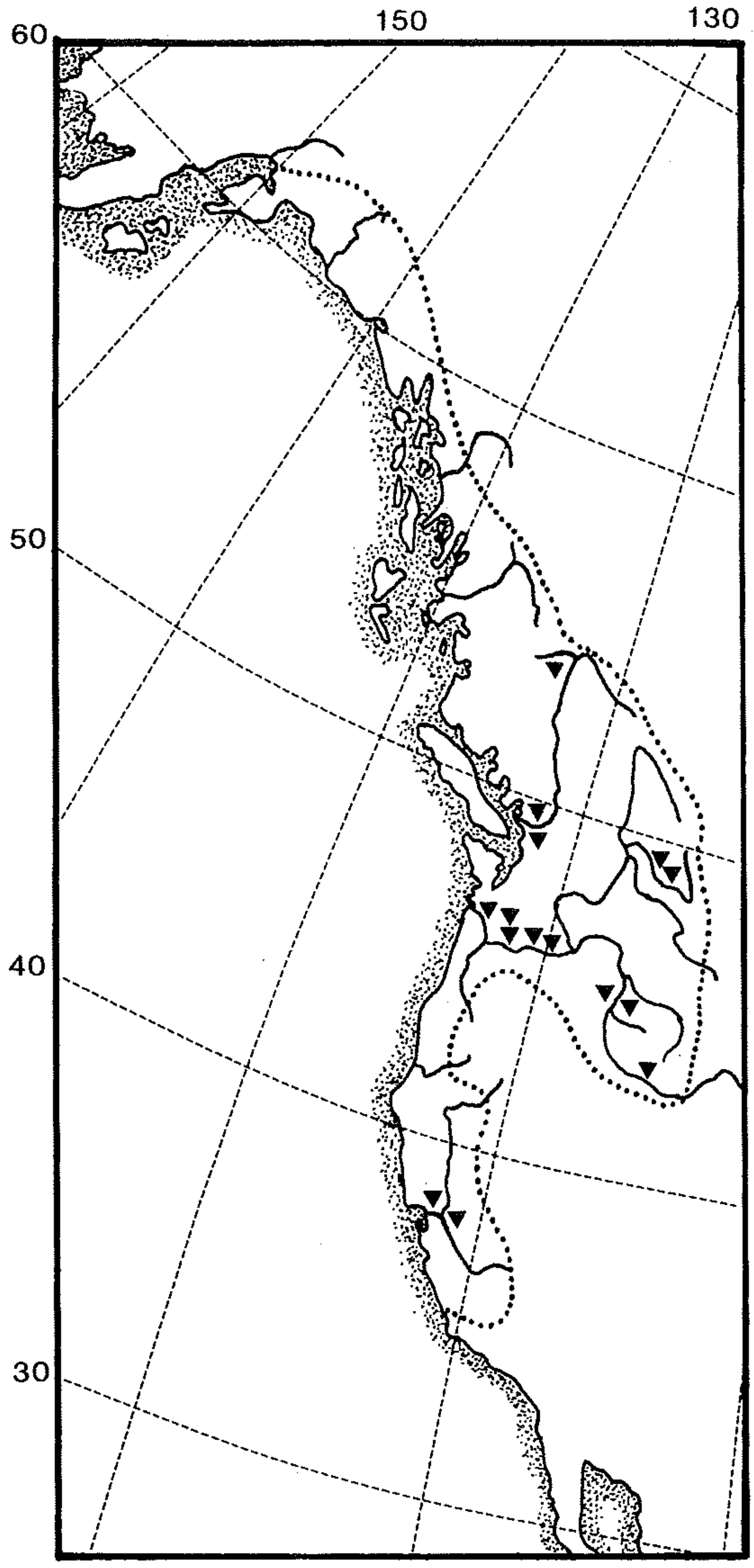

Figure 1. Geographical distribution of samples (denoted by triangles) of weight-length data used for estimation of a standard weight equation for white sturgeon, Pacific coast, North America. The range of white sturgeon (Scott and Crossman 1973) is circumscribed with a dotted line.

Table 1. Intercept (α), slope (ß), and correlation coefficient for regression[a] of weight (kg, dependent variable) on total length (cm) and mean relative weights (Wr) for 15 white sturgeon samples.

River	n	Lengths	α	ß	r^2	W_r	Reference
Sacramento-San Joaquin Rivers							
San Pablo Bay (1965-70)	209	102-203	1.18E-06	3.348	0.910	103	Kohlhorst et al. 1980
San Pablo Bay (1984-85)	124	31-224	2.19E-06	3.189	0.850	92	Brennan 1987
Columbia River							
Lower[b]	5,338	37-263	7.66E-06	2.958	0.961	117	Tracy, unpublished
Bonneville Res. (1976-78)[b]	2,516	34-269	1.63E-06	3.277	0.980	103	Malm 1979
Bonneville Res. (1988-90)	2,405	31-292	2.65E-06	3.161	0.958	99	Author, unpublished
The Dalles Res.	2,850	35-276	9.70E-07	3.376	0.968	96	Author, unpublished
John Day Res.	1,024	32-254	1.81E-06	3.249	0.982	100	Author, unpublished
Kootenai River							
(1980-82)	341	50-224	1.66E-06	3.26	0.980	97	Partridge 1983
(1989-91)	223	88-211	7.13E-07	3.394	0.841	77	Apperson, unpublished
Snake River							
Upper	560	46-270	3.0 E-07	3.612	—	91	Cochnauer 1983
Middle (1972-75)	602	45-274	1.14E-06	3.31	—	83	Lukens 1985
Middle (1982-84)	478	45-280	6.50E-07	3.43	—	83	Lukens 1985
Fraser River							
Lower (males)[b]	—	—	2.87E-06	3.13	—	93	Semakula and Larkin 1968
Lower (females)[b]	—	—	2.64E-06	3.15	—	94	Semakula and Larkin 1968
Upper	65	73-249	5.97E-07	3.444	0.998	82	Dixon 1986

[a] $W = \alpha * TL^{\beta}$

[b] Converted from fork length using TL = FL * 1.110

Table 2. Fork length to total length (cm) conversion equations[a] reported for several populations of white sturgeon.

Location	n	b_0	b_1	r^2	Reference
Sacramento-San Joaquin Estuary	366	1.343	1.093	0.922	Kohlhorst 1980
Columbia River (lower)[b]	2,039	2.06	1.09	0.994	Tracy, unpubl.
Columbia River (middle)[c]	3,612	1.240	1.095	0.972	Author, unpubl.
Columbia River (middle)[d]	2,516	5.06	1.08	--	Malm 1979
Fraser River	14	4.91	1.088	0.998	Dixon 1986
Kootenai River	341	0.77	1.104	--	Partridge 1983
Kootenai River	223	0.13	1.124	0.984	Apperson, unpubl.

[a] $TL = b_0 + b_1 * FL$.
[b] Downstream from Bonneville Dam.
[c] Bonneville, The Dalles, and John Day Reservoirs.
[d] Bonneville Reservoir.

algebraically from the standard metric equation based on total length (Table 3).

Weight-length parameters for the 15 samples were generally based on a broad range of fish sizes from minimum total lengths of 30 cm to maximum total lengths exceeding 200 cm (Table 1). Murphy et al. (1990, 1991) recommended using a comparison of the ratio of variance to mean $\log_{10}$ weight for fish among 1-cm length intervals to specify minimum applicable lengths. This comparison for samples from Columbia River reservoirs (Fig. 2), indicated that restricting analyses to lengths of 70 cm or more will minimize effects of errors in weighing small fish and of developmental changes in body form from juveniles to adults.

Mean relative weights for the 15 samples ranged from 77 to 117 (Table 1). Samples with the lowest mean relative weights were all from headwaters of the Columbia and Fraser River systems, which often support unproductive white sturgeon populations because of limited food availability or poor recruitment (Cochnauer et al. 1985). The Kootenai River population, which is declining and in danger of extinction, had the lowest mean relative weight. White sturgeon with access to marine and estuarine resources in the lower Columbia River had the largest mean relative weight.

Murphy et al. (1991) suggested that condition factors provide an indirect means of evaluating ecological relations and the effects of various management strategies but that analyses limited to simple calculation of mean relative weight may conceal management problems in particular size classes of fish. Hence, size-specific comparisons within or among populations may provide more insight into factors affecting white sturgeon abundance and productivity.

Table 3. Standard weight-length equations[a] for white sturgeon in metric and English units for total length and fork length measurements.

Length measurement	Length units	Weight units	α	ß
Total	cm	kg	1.952E-6	3.232
Total	in	lb	8.747E-5	3.232
Fork	cm	kg	2.735E-6	3.232
Fork	in	lb	1.226E-4	3.232

[a] $W = \alpha * L^{\beta}$

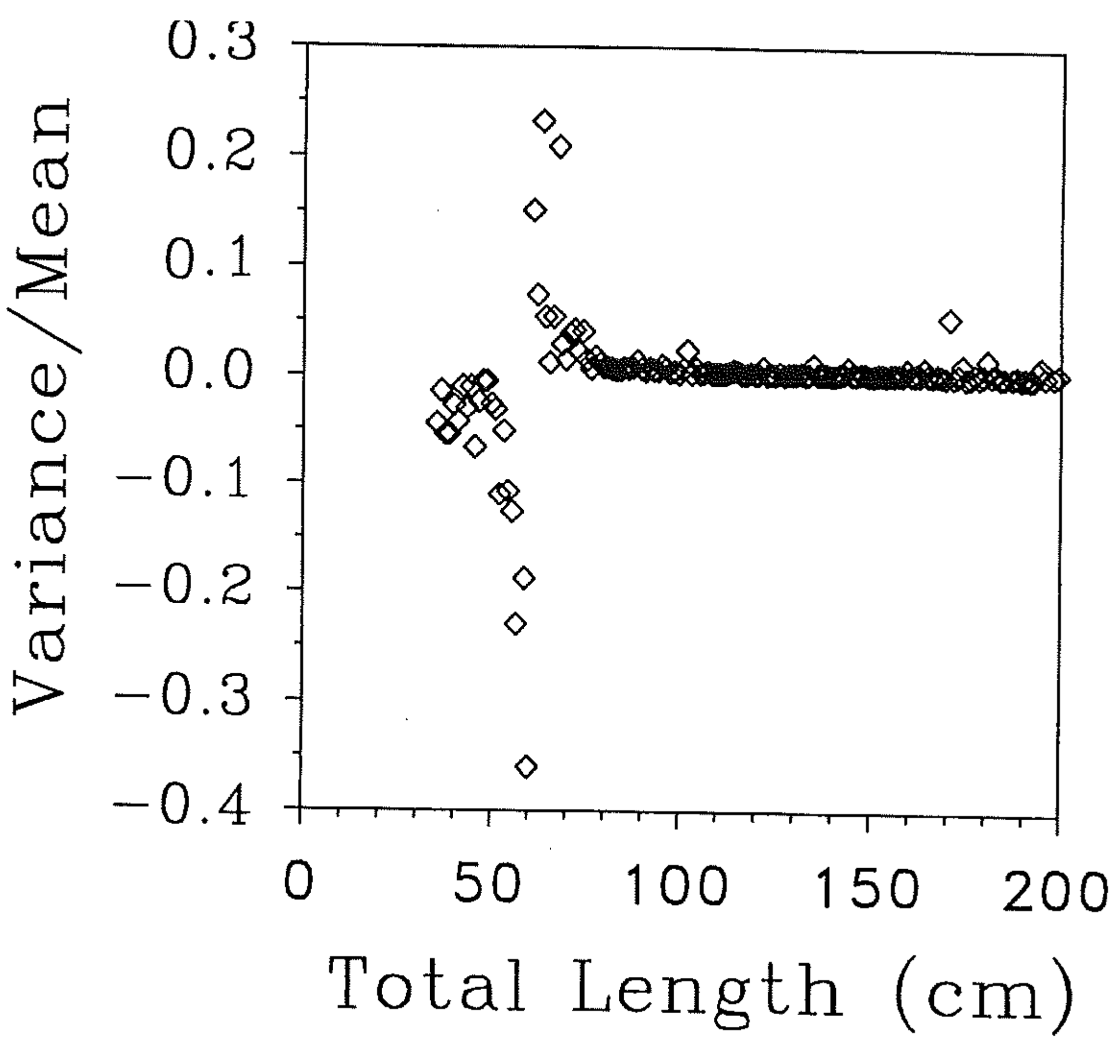

Figure 2. Variance/mean ratio for $\log_{10}$ weight by centimeter length group for 6,279 white sturgeon collected from Bonneville, The Dalles, and John Day reservoirs in the Columbia River using techniques outlined by Elliott and Beamesderfer (1990).

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