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RELATIONS OF RELATIVE WEIGHT (W_R) WITH GROWTH, PREY BIOMASS, AND ENVIRONMENTAL CONDITIONS

Condition indices such as W_r are widely used in the assessment of freshwater fish populations. W_r measures the plumpness or robustness of fish and is easily calculated from length-weight data. Although W_r is commonly assumed to reflect characteristics of fish such as health, well-being, reproductive state, and growth, as well as characteristics of the environment such as habitat quality, water quality, and prey availability, evidence for these relations is somewhat sparse. Using a large pumpkinseed *Lepomis gibbosus* and golden shiner *Notemigonus crysoleucas* database from 10 southern Quebec lakes, we analyzed sources and patterns of variation in W_r and explored relations of W_r with growth, fish biomass, prey biomass, and limnological variables. The results of this evaluation illustrate strengths and weaknesses of W_r as an assessment tool for fish populations in nature and will help guide the use of W_r in other species.

FISH SAMPLED IN TEN LAKES TO EVALUATE W_R

We sampled fish in each lake during early and late summer over 2 years to assess temporal variation in W_r and fish biomass. Annual growth was estimated from Fraser–Lee back-calculations and, because of significant length effects, both W_r and growth were expressed on a size-specific basis. We used the length categorization system of Gabelhouse, defining stock lengths as 80 mm and 70 mm and quality lengths as 150 mm and 120 mm for pumpkinseed and golden shiner, respectively. We used a variety of methods to assess prey biomass and limnological conditions. Because no W_s equations existed for these species before the present study, we developed W_s equations by using data from about 300 populations of each species.

W_R VARIED WITH FISH LENGTH, LAKE, AND TIME

W_r showed variable relations with fish length, depending on species, lake, and sampling date. Regressions of W_r on length were significant in 40% of the pumpkinseed samples and 33% of the golden shiner samples. In both species, 31% of the significant regressions had positive slopes and 69% had negative slopes. Thus, correlations with length were ephemeral, perhaps reflecting changing relative ecological conditions for fish of different sizes over time. W_r of both species varied among lakes, years, and seasons. All interactions were significant in ANOVAs for both species, indicating that temporal variation in W_r was asynchronous among lakes. Because of this temporal asynchrony, among-lake comparisons are based on lake averages rather than W_r estimates from individual sampling periods.

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FEW RELATIONS OF W_R WITH GROWTH, FISH BIOMASS, AND ENVIRONMENTAL CONDITIONS

We found little evidence for a relation between W_r and growth. There were no significant correlations of size-specific W_r estimates with corresponding size-specific growth estimates among lakes. Although the results suggest a general lack of relation, they are based on lake means of seasonally and annually varying W_r estimates and therefore could potentially contain confounding individual and temporal variations. As a test of the relation of W_r and growth among individual fish, we examined correlations of growth residuals (length-corrected estimates of recent growth) with W_r in each population sample. These correlations compare late summer W_rs with growth during that summer among individual fish in subsamples. Eighty percent of these correlations for both species were nonsignificant, and 75% of the significant correlations were negative, contrary to the a priori expectation of a positive relation.

We found no evidence of density-dependence in W_r estimates among lakes for either species. Neither correlations of W_r with total fish biomass nor with conspecific biomass were significant. Chlorophyll *a* was the only limnological variable significantly correlated with W_r, and only for pumpkinseed. Correlations with chlorophyll *a* were positive (stock length: $r = 0.67$, $P = 0.035$; quality length: $r = 0.75$, $P = 0.019$). All correlations of W_r with temperature and macrophyte biomass were nonsignificant.

W_R POSITIVELY CORRELATED WITH PREY BIOMASS

The strongest relations in our dataset were between W_r estimates and benthic prey biomass estimates among lakes, especially for pumpkinseed. W_r of both stock- and quality-length pumpkinseed was positively correlated with total benthos biomass; the quality-length relation was particularly strong. W_r of stock-length pumpkinseed was positively correlated with chironomid biomass (Figure, *a*), and W_r of quality-length pumpkinseed was positively correlated with gastropod biomass (Figure, *b*). W_r of quality-length golden shiner was positively correlated with chironomid biomass. We found no significant correlations between W_r of either species and littoral zooplankton biomass.

W_R SHOULD BE INTERPRETED WITH CARE

W_r varies with fish length in some populations, but not in others. Furthermore, the existence and even the sign of this relation in a population might change over time. We urge biologists to test for length relations before using mean population W_r.

W_r will generally vary temporally, but temporal variation may be asynchronous among populations. Thus, assessing W_r at one standard period (e.g., fall electrofishing) for comparison among populations may not provide a true comparison; W_r in one population might be at its maximum while others could be increasing or decreasing. We suggest that biologists measure W_r at different times in a coordinated fashion among populations to examine the pattern of temporal variation. If temporal variation is negligible or if the pattern is consistent among populations, comparisons based on a standard sampling period are justified. Otherwise, comparisons of W_r among populations should probably be based on temporal averages.

The common assumption of a positive relation between W_r and growth should be reconsidered. W_r may reflect growth of some species under certain circumstances, but this should be empirically or experimentally demonstrated before W_r is used as a predictor of growth. Uncritical use of W_r as a growth indicator may lead to substantial errors in field assessment of fish populations.

W_r may be a good predictor of prey availability, especially for species with relatively narrow or well-defined diets. We suggest that W_r could be used as a working index of prey availability, but recommend verifying this relation if possible.

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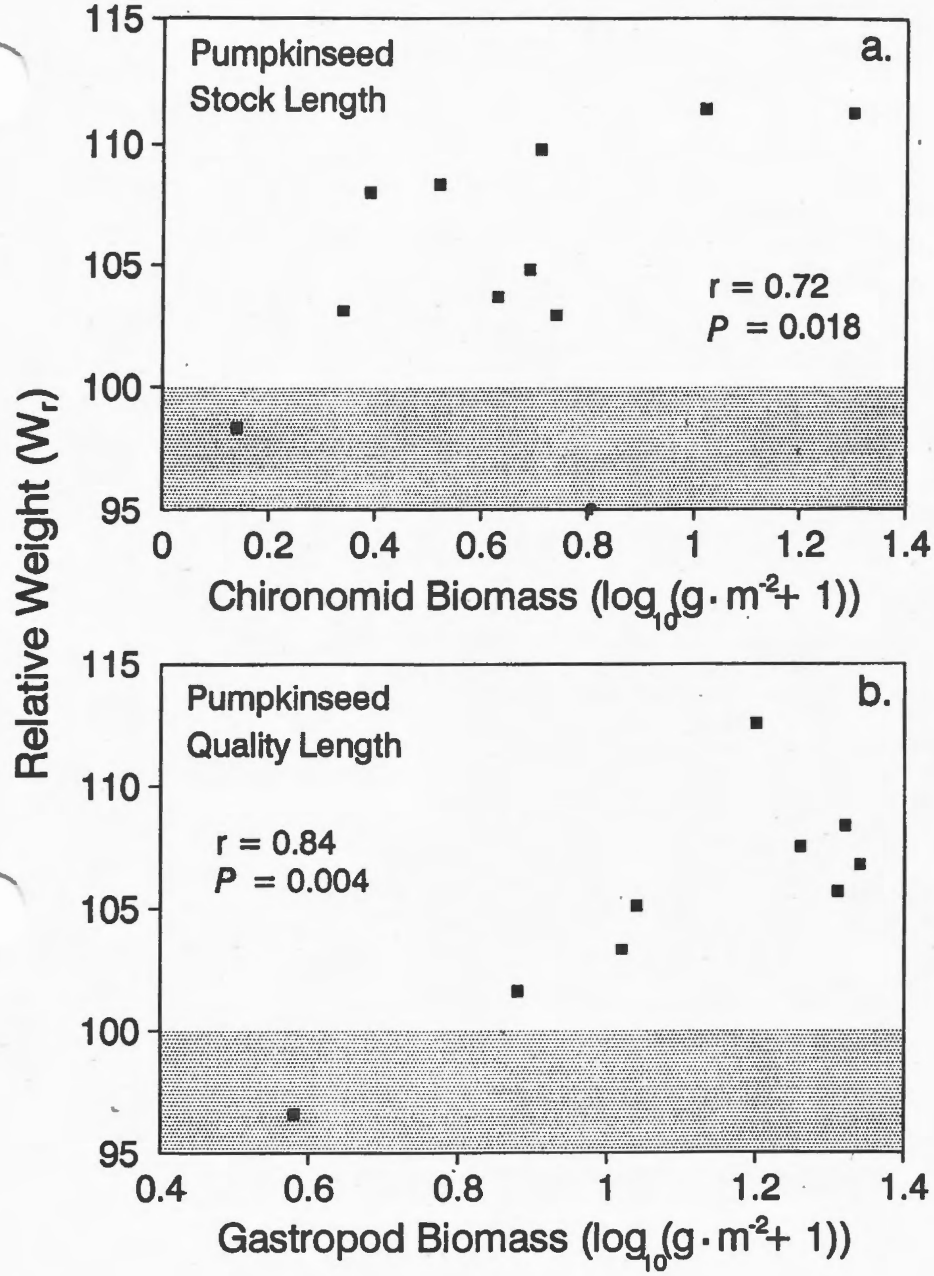

Figure. Relations of relative weight (W_r) of stock-length (80 mm) pumpkinseed with chironomid biomass (*a*), and quality-length (150 mm) pumpkinseed with gastropod biomass (*b*) in southern Quebec lakes. Data points represent lake averages. Shaded areas indicate W_r < 100.