SELF-THINNING IN BROWN TROUT:

LINKING GROWTH

AND POPULATION DYNAMICS

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EXTENDED ABSTRACT ONLY – DO NOT CITE

Self-thinning is the reduction in density of a cohort of growing organisms that is close to the system's carrying capacity due to competition for limiting resources as the size of each individual member of the cohort and its demand for those resources increase concomitantly. Thus, self-thinning can potentially link those factors affecting growth to population abundance. The phenomenon is common in plants and sessile animals and, following the initial observation of Begon et al. (1986) has been reported for mobile animals as well. Most evidence for self-thinning in mobile organisms (all for wild populations) comes from stream-dwelling salmonid fishes (Grant 1993, Elliott 1993, Bohlin et al. 1994). However, it is not yet clear if limitations in either food or space (mediated through territorial behavior) generally cause self-thinning in stream salmonids. Ideally, they might be distinguished because the slope of the relationship between log body-weight and log density would be the negative of the allometric coefficients of either energetic requirements or territory size (provided the availability of the resource remains constant relative to body weight). However, those coefficients can be similar enough that the errors associated with parameter estimates from field data preclude its distinction.

Moreover, a recent reanalysis of previous evidence has found proof of significantly non-linear thinning trajectories, which has been related to the capacity of mobile animals to respond with niche shifts to resource shortages (Armstrong 1997).

We have examined the density *vs*. body size relationships for 42 brown trout, *Salmo trutta,* cohorts (11 year-classes, four different sites) in a stream in northern Spain. They displayed two distinct phases with different slopes whose transition occurred at trout lengths of 14-15 cm (Figure 1). Split-lines fitted the trajectories significantly better than single straight lines in 32 of 42 cases and, explained a total of 87.2% of the variation in trout abundance. When a single split-line was fitted to the pooled 42 cohorts, weight accounted for 53.2 % of density variance. This suggested that spatio-temporal variation in thinning trajectories was substantial.

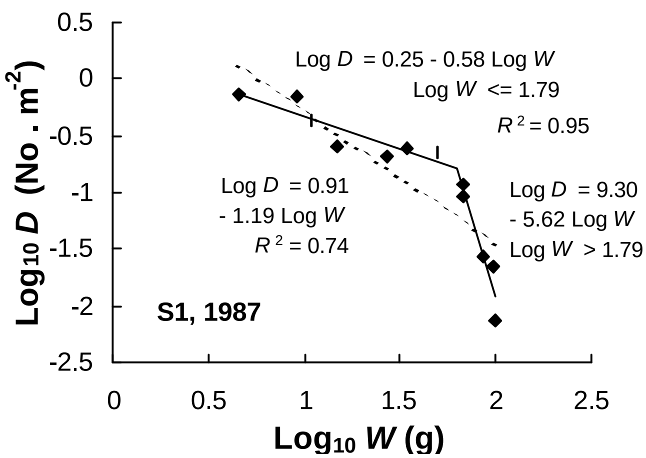

Figure 1. Example of straight and split lines fitted to the thinning trajectory of the 1987 brown trout year-class in site 1 with their corresponding equations and coefficients of determination (r^2).

The slopes of the first phase of the thinning trajectories were typically shallower than those predicted by either energetic or territorial allometry, whereas those of the second phase were steeper. Both, but particularly the first one, were quite variable among sites and year-classes. In contrast, estimates of the breakpoint were remarkably similar (Table 1).

Table 1. Variability (coefficient of variation) in the estimates of the slopes of the first (b_1) and second phase (b_2) and of the breakpoint (c) of the split-lines describing the relationship between log-transformed mean weight and abundance of brown trout year-classes at each of the four study sites.

Site	b_1	b_2	c
S1	504.6 %	73.9 %	18.9 %
S2	138.7 %	26.4 %	8.2 %
S3	78.1 %	22.3 %	8.4 %
S4	866.5 %	33.1 %	16.3 %
All	206.6 %	67.1%	13.0 %

Percent Habitat Saturation (PHS), defined as: PHS = 100 D T, where D is density (inds.m^{-2}) and T is individual territory size (m^2), is an estimate of the proportion of total habitat that the members of a cohort actually occupy. It has been empirically shown that density-dependent responses in growth or mortality rates of stream salmonids are more likely when PHS values reach over 27. At our sites PHS first increased with body size up to the point where the break occurred, when it was close to 27, and then decreased with size (rather than remaining fluctuating around a value of 27). Together with the thinning trajectories, this pattern indicated that in our study sites cohorts were not initially self-thinning, but that resources (probably pool habitat) became progressively limiting once trout grew over 14-15 cm.

Our findings reflect how size affects resource use differently in sessile and mobile organisms. A larger size may allow mobile animals to exploit previously inaccessible resources, but may also impose new resource quality requirements to add to those of resource quantity. Thus, resource availability is not independent of size. It may increase with it at times, but, even when it decreases, it may do so at rates dependent on local conditions and not directly predictable from simple allometry of food or space needs.

References

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