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Salmonid population dynamics, river temperatures and flows: extracting information from the variability of fish Sizes-At-Ages.

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The Girnock Burn, Scotland, has a 40 year data set of river temperatures and flows and a correspondingly long assessment of the status of its Atlantic salmon (Salmo salar) population. Over this period the number of breeding adult females has dropped to 25% of its initial level, whereas the number of emigrant juvenile smolts has only fallen by 25%. The greater stability of the smolt numbers has been accompanied by a dramatic alteration of the age-distribution of emigrant smolts, from mainly three year olds to mainly twos, over the same period. However, the body size of smolts has remained very constant, implying altered growth rates. Stream temperatures have altered rather little over the period, although significant increases have occurred in spring, probably resulting from reduced snow-melt.

In recent years a number of empirical studies and mechanistic models have been developed to illuminate the effects of environmental (temperature, flow) and biotic (density-dependent, food supply) factors on the monthly growth rates of juvenile salmon. We present the results of a developing mechanistic model of fish growth which utilizes information on the variability of fish Sizes-At-Ages to extract additional detail on population processes from routine electro-fishing data. The model fits detailed monthly

growth data for individual cohorts, from fry to smolt emigration, while predicting the size-at-age, size-at-age variation and numbers of emigrants in both spring and autumn. Applying the model to the less detailed historical data set strongly supports the view that the younger age of smolts in recent decades results in part from seasonal changes in thermal regimes.

We indicate that detailed studies of sub-catchments, in both time and space, are necessary to begin to de-confound the effects of co-varying environmental variables such as temperature, altitude, flow, water-velocity, water quality and food supply.