Winter concealment by subyearling rainbow trout: space size selection and reduced concealment under surface ice and in turbid water conditions

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Abstract: The proportion of rainbow trout (*Oncorhynchus mykiss*) concealing themselves in simulated interstitial spaces was examined in the presence of surface ice, in turbid water, and in clear water. Tests were conducted in enclosures in a small Idaho stream with structures that provided five rectangular spaces varying in width and height, one circular space, and one triangular space. Space use was assessed each morning by trapping test fish inside the structures. Significantly more fish concealed themselves under clear water conditions than under either surface ice or turbid water conditions. Spaces narrower than the width of a test fish with extended pectoral fins and spaces taller than the height of a test fish with dorsal fin extended were used less than would be expected if space use was random. The frequency with which two or more fish occurred together in the same space was similar to that expected if fish occurred together at random. Fish rarely returned to the same space on consecutive nights.

Résumé : La proportion des Truites arc-en-ciel (*Oncorhynchus mykiss*) qui se sont cachées dans des interstices artificiels a été examinée en présence de glace de surface, en eau turbide et en eau claire. Les tests ont été effectués dans des enceintes, dans un petit ruisseau d'Idaho comportant des structures offrant divers types d'abris, cinq interstices rectangulaires de largeur et hauteur variables, un interstice circulaire et un interstice triangulaire. Chaque matin, le nombre de poissons expérimentaux dans les interstices était relevé. Les poissons ont utilisé les abris plus fréquemment en eau claire qu'en eau turbide ou que sous la glace. Les interstices plus étroits que la largeur d'un poisson expérimental avec les nageoires pectorales étendues et les interstices plus hauts que la hauteur des poissons expérimentaux avec la nageoire dorsale étendue étaient utilisés selon une fréquence moindre que la fréquence aléatoire théorique. La fréquence avec laquelle deux poissons ou plus se retrouvaient dans le même interstice était semblable à la fréquence théorique aléatoire. Les poissons occupaient rarement le même espace au cours de deux nuits consécutives. [Traduit par la Rédaction]

Introduction

Interstitial spaces in the substratum provide important habitat for many species of trout and salmon during their first winter. When water temperatures drop below a threshold level, usually about 7–10°C, subyearling salmonids use these spaces for concealment (Hartman 1965; Chapman and Bjornn 1969; Rimmer et al. 1983; Cunjak 1988). Campbell and Neuner (1985) found that, in winter, subyearling rainbow trout conceal themselves during the daytime and emerge at night. This pattern has been described as a response to temperature (Rimmer et al. 1983) and light (Kwain and MacCrimmon 1969; Contor and Griffith 1995). It has been hypothesized that daytime concealment reduces energy expenditure (Heggenes et al. 1993), helps fish avoid displacement by ice or floods (Hartman 1965), and reduces the risk of predation (Fraser et al. 1993).

These hypotheses have been developed primarily by observing fish in clear, ice-free streams. Although rock substratum, surface ice, and turbid water all offer cover habitat (as defined by Shirvell 1990), we use the term concealment to refer to fish moving into interstitial spaces (Griffith and Smith 1993). If fish are concealing themselves to conserve energy or avoid displacement, we hypothesize that they also display such behaviour when the water is turbid or when surface ice is present. However, if fish are concealing themselves in rock substratum primarily to avoid aerial or aquatic predators, we hypothesize that most fish conceal themselves under clear, open water conditions, fewer under surface ice, and even fewer in turbid water conditions, as each situation progressively offers protection from a wider variety of predators. To test these hypotheses, one objective of this study was to assess the proportion of subyearling rainbow trout that concealed themselves during the day when surface ice was present and in turbid water and clear water conditions.

In some streams in North America the availability of winter habitat appears to limit the abundance of subyearling salmonid fishes (Bustard and Narver 1975; Mason 1976; Nickelson et al. 1992). Smith and Griffith (1994) found, in an Idaho river, that subyearling rainbow trout survival was 11–24% higher in enclosures containing rock which provided interstitial spaces versus enclosures without rock, even though enclosures excluded predators. Higher survival in enclosures containing rock was attributed to protection from physical damage by ice, reduction in daytime energy expenditure, and a thermal benefit offered by interstices in rock. Field studies have described the minimum rock size necessary to produce interstitial spaces that fish will utilize

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