

Diet of stocked and wild trout, *Salmo trutta*: Is there competition for resources?

Amílcar TEIXEIRA¹ and Rui M. V. CORTES²

¹ CIMO- Escola Superior Agrária Bragança, Campus Santa Apolónia, Apt. 1172, 5301-855 Bragança, Portugal; e-mail: amilt@ipb.pt

² Universidade de Trás-os-Montes e Alto Douro, Dep. Florestal, Apt. 1013, 5001-911 Vila-Real, Portugal; e-mail: rcortes@utad.pt

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Abstract. Stocked and wild trout diet was assessed in two north-eastern Portugal headstreams during the summer season of three successive years (2000 to 2002). Significant differences were detected in the diet composition between stocked (age 1+) trout and distinct size-class of wild trout. Stocked fish showed preference, almost exclusively, for food items captured near the surface (primarily terrestrial adult insects), emergent pupae and subimagos. In contrast, young-of-year (YOY) wild trout fed predominantly on the most available aquatic prey taxa such as Chironomidae (Diptera) larvae and Baetidae (Ephemeroptera) nymphs; however, Trichoptera larvae were not taken. Wild trout preference changed from benthic aquatic invertebrates to terrestrial origin organisms and this ratio increased with size, suggesting an ontogenetic diet variation. Significant diet overlap was only detected between stocked and dominant wild trout, which were not displaced from the energetically profitable areas. Therefore, this study showed the absence of an evident competition for food in both streams, even when trout density was largely augmented by stocking activity. However, since no obvious benefits on space and time were obtained, stocking must be carefully evaluated and alternative approaches considered, like habitat improvement and adequate fisheries management, in order to increase the natural productivity of these systems.

Key words: brown trout, stocking, feeding, intraspecific competition

Introduction

The effects of stocking activities on wild fish population are one of the major concerns of aquatic systems biologists and managers (L a i k r e 2000, H a m & P e a r s o n s 2001, W e b e r & F a u s c h 2003). The conservation, restoration and enhancement of recreational and commercial catches and the creation of new fisheries are arguments behind the establishment of stocking programs. However, the definition of objectives and the evaluation of potential environmental benefits and risks are not often safeguarded (C o w x 1998). Consequently, negative impacts like genetic contamination, disease transmission, predation and competition have been noticed (W h i t e et al. 1995, B o h l i n et al. 2002, B a t e s & M c K e o w n 2003).

Although the ecological effects of stocking on wild populations have received less attention than genetic ones, several studies reported differences in behaviour, morphology and physiology between wild and hatchery-reared salmonids, namely related to aggression, energy expenditure, predator avoidance, dispersal, size, growth and prior residence (reviewed by W e b e r & F a u s c h 2003). However, if an increase in competition has been stated as an immediate outcome of restocking programs (K e n n e d y & S t r a n g e 1986, M c M i c h a e l et al. 1997), more specific information is needed, for example, at the

level of feeding resources used by sympatric wild and stocked trout populations in natural environments. Indeed, knowledge of feeding patterns is essential to understand the ecological role and the productive capacity of fish populations and, as Li & Moyle (1981) mentioned, one should focus its attention to poor nutrient content and low productivity environments, such as the studied streams, since it is expected they are easily disrupted when manipulation or introduction of fishes is made.

Stocking as a management tool has been commonly used by governmental services in northeast streams of Portugal although monitoring programs are almost inexistent and surveys and published reports are scarce (Cortes et al. 1996). Therefore, the key issue of present study is to assess whether stocked and wild trout *Salmo trutta* (Linnaeus, 1758) compete for food resources. In detail, the objectives were to: 1) compare the diets of stocked and wild trout 2) examine the dietary similarity among size classes of both populations.

Study Area

The study was conducted in Baceiro and Sabor streams, third-order tributaries of the Douro River, located inside Montesinho Natural Park, north-eastern Portugal. Two reaches about 2.5 km long, separated by four km, were selected in both rivers. Only brown trout were present in the upper reach of River Baceiro, whereas the cyprinids, such as *Chondrostoma duriensis* Coelho, 1985 and *Squalius carolitertii* Doadrio, 1988, cohabit with trout, although in low densities, in the lower reach. The same pattern was observed for the fish communities of River Sabor but the lower reach included also *Squalius alburnoides* (Steindachner, 1866) and *Barbus bocagei* Steindachner, 1864 populations.

There are no substantial differences on habitat features along the longitudinal axes of Baceiro River. On the other hand, the Lower Sabor differs markedly of the remainder reaches by the presence of a succession of small artificial weirs creating a succession of deep pools and riffles. A dense riparian gallery (mainly alder *Alnus glutinosa* and to a lesser extent ash *Fraxinus angustifolia*, poplar *Populus nigra* and willows *Salix* sp.) is present in both streams. The water composition is characterised by a low nutrient content ($\text{NO}_3^- < 0.50 \text{ mg.l}^{-1}$, $\text{PO}_4^{3-} < 0.02 \text{ mg.l}^{-1}$) and a poor buffer capacity (conductivity $< 70 \mu\text{S.cm}^{-1}$, hardness $< 15 \text{ mg CaCO}_3.\text{l}^{-1}$, alkalinity $< 25 \text{ mg HCO}_3^-\text{l}^{-1}$). The water temperature ranged from a winter minimum of 4° C to a summer maximum of 20° C. The altitude of study areas is 725–850 m in river Baceiro and 600–775 m in the river Sabor. Like other headwater streams of northern Portugal, ecosystem function is highly dependent of the input of allochthonous materials (Cortes et al. 1995). The impact of human activities is limited because this area is scarcely populated and agriculture is extensive but with low fertilizer usage, contributing to the good water quality of these streams. However, an increase in fishing pressure, often using illegal procedures (poison, nets), is responsible for the gradual decrease of natural trout stocks and has lead local authorities to follow active management programs, like the implementation of stocking operations.

Material and Methods

Sampling was undertaken on September each year in 2000, 2001 and 2002, more precisely one month after the stocking of hatchery-reared trout of age 1+ (size minimum-maximum = 14.0–26.0 cm in total length L_T ; mean = $20.3 \pm (\text{S.D.}) \pm 0.27 \text{ cm}$; $n = 1300/\text{year}$). Before release, fish were marked with VIE- Visible Implant Elastomer tags (Northwest Marine Technology- NMT,

Seattle, USA) for posterior identification. Fish were collected by electrofishing (Hans Grassl D.C. at 300–600 V, 1.5–3 A) in upper and lower reaches of Baceiro and Sabor streams. The reaches were surveyed using the single-pass strategy (Zalewski 1985), covering about 2.5 km from down to upstream reach, during sunlight hours (8.00–20.00 h). All captured fishes were anaesthetised with a 2-phenoxyethanol solution (0.25 mg.l⁻¹), measured for total length (L_T) to the nearest 0.1 cm and weighed to the nearest 0.05 g on an analytical balance.

In order to identify the possible ontogenetic feeding variation, wild trout were grouped into the following four L_T classes: A) <10.0, B) 10.1–15.0, C) 15.1–20.0 and D) >20.0 cm. For wild trout streams, these size classes roughly correspond to age classes of 0⁺, 1⁺, 2⁺ and ≥ 3⁺ (Cortés et al. 1996). Stomach contents of several wild fishes distributed by each size class and all the stocked (S group) trout were collected using a non-destructive stomach flushing method (Hyslop 1980). After being revived in buckets of fresh water, the fish were released back into the stream at exactly the same location where they were captured. Each stomach content sample was conveniently identified and frozen to further laboratory analysis. Daily movements were taken in consideration and, consequently, observation was split into three periods: 1) morning (08.00 to 12.00), 2) afternoon (12.00–16.00), 3) evening (16.00–20.00). At the same time, the relative abundance of benthic macroinvertebrates in each reach was determined by a kick-sampling procedure along the different riffle and pool habitat units, using a constant effort of 5 minutes (C.P.U.E.) through a hand net (25 x 25 cm frame, mesh size 300 µm). Complementarily, macroinvertebrate drift samples were taken with the same mesh size net in a riffle at the upper section of each segment, respecting the same 4-h intervals. All captured organisms were preserved in formalin (5%) until subsequent laboratory treatment. Individual stomach contents and macroinvertebrate samples (from benthic and drift) were examined in the laboratory using a binocular dissecting microscope. Food items were counted and identified to the lowest taxonomic level possible (generally to family and, when feasible, to genus or species). The wet weight of each sample was measured to the nearest 0.0001 g on a micro-precision balance.

Frequency of occurrence (%FO) and percentage prey number (%N) were calculated for each size-class of wild and stocked trout. Prey diversity (Shannon-Weaner H' index) of diets was determined and the Manly-Chesson index (Chesson 1978,1983) was calculated to evaluate prey selection. The index formula is:

$$\alpha = (r_i / p_i) / \sum (r_i / p_i), i = 1, 2, \dots, m,$$

with r_i = the proportion of food item i in the diet and p_i = the proportion of food item i in the environment and m = the number of food items in the environment. If $\alpha = (1/m)$, it means that a prey is consumed in proportion to abundance in environment, whereas $\alpha > (1/m)$ indicates preference and $\alpha < (1/m)$ indicates avoidance.

The diet overlap between the different size classes of wild and stocked trout was determined by the Schoener percent overlap index (S) (Schoener 1970):

$$S = 100 (1 - 0.5 \sum |p_{x,i} - p_{y,i}|)$$

where $p_{x,i}$ is the frequency of the i th food category for species x , and $p_{y,i}$ is the frequency of the i th food category for species y . The overlap was considered biologically significant when S assumes values greater than 60% (Wallace 1981). The analysis of consumption was estimated by the fullness index: F.I. = weight of fresh stomach content/weight of the

fish (mg.g⁻¹) (Frankiewicz et al. 1993). This index was used in order to avoid the bias caused by differences in trout size and weight. Kolmogorov-Smirnov K-S tests were used to evaluate significant differences of F.I. between the sampling diel periods defined. The package STATISTICA 7.0 © (Statsoft 2004) was used to achieve these tests.

Based on the data of prey composition (log transformed), a non-metric multi-dimensional scaling (n-MDS) analysis was applied to explore the relationship between the wild and stocked trout diets. This technique relates diet composition through a matrix of Bray-Curtis similarities. Multivariate analyses of similarities- one-way ANOSIM tests, as a nonparametric randomization approach, was then applied to the Bray-Curtis similarity matrix to assess the differences in diet similarities taking into account three factors: fish size groups, river reaches and study years. All these analyses were performed using the package PRIMER 5 (Clarke & Gorley 2001).

Results

Diet composition

A total of 3 646 stomach contents of stocked and wild trout of Baceiro and Sabor streams were examined and identified, which included 54 316 organisms distributed by 124 different

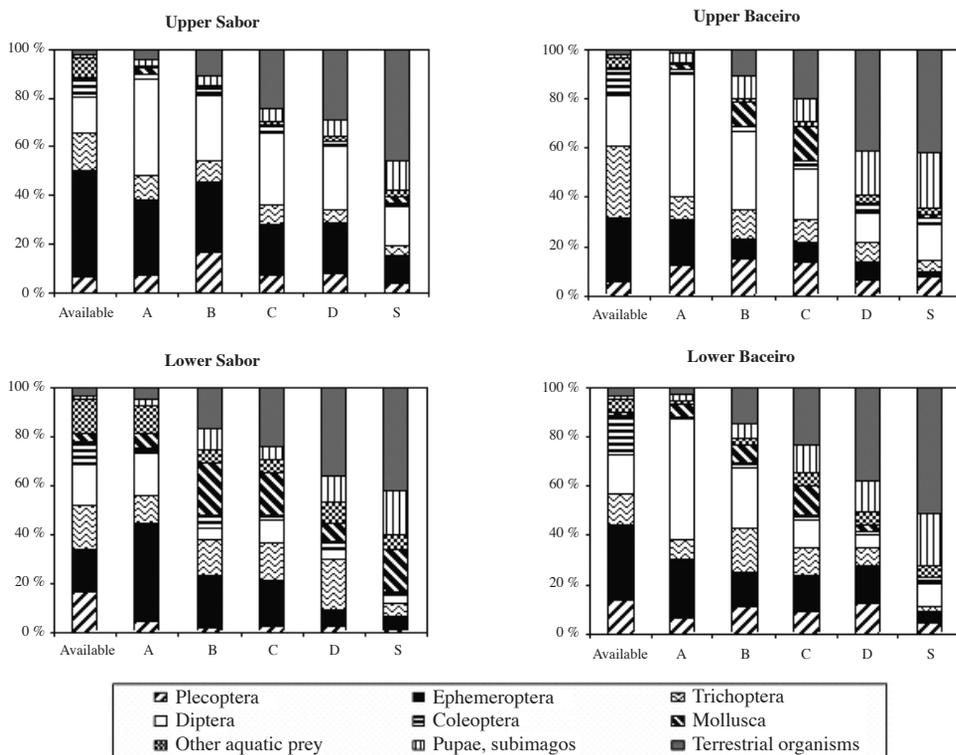


Fig. 1. Relative abundance of food items in environment (available aquatic and terrestrial invertebrates) and diet composition of stocked (S) and wild size-class (A<10.0, B-10.1-15.0, C-15.1-20.0, D>20.0 cm) trout in the Upper and Lower reaches of the Sabor and Baceiro streams (2000 to 2002).

categories, with a wide range of abundance. In general, wild and stocked trout fed almost exclusively on arthropod invertebrates of aquatic and terrestrial origin, but other prey (molluscs, annelids, microcrustacean, cyprinid fishes and small amounts of mineral and plant particles) were also found in the diet composition. Stocked trout displayed a remarkable homogeneity on feeding behaviour, with the majority of food resources based on land-based preys (%FO- 82.5 to 93.0 %) arising from the dense riparian gallery present or by pupae and subimagos that continuously emerged from the bottom of the stream (Fig. 1). On the contrary, the diet of the young-of-year (YOY) wild trout was clearly dominated by instream sources, dominated by benthic aquatic insects like Diptera larvae (mostly Chironomidae and *Simulium* sp.), Ephemeroptera (especially *Baetis rhodani* but also *Epeorus sylvicola*, *Ecdyonurus* gr. *venosus* and *Habrophlebia fusca*) and Plecoptera (*Euleuctra geniculata*, *Leuctra* sp.) nymphs. Aquatic invertebrates were always present in the diet of trout populations, but the input of organisms of exogenous origin, like terrestrial insects falling into the water, became an important food item, especially for adult wild trout during the summer season. These distinctive patterns between wild and domestic trout were found in both reaches of Baceiro and Sabor streams, considering the mean relative abundance for the three sampling periods (Fig. 1). Although the importance of terrestrial prey on the diet of wild trout increased with size, it was also recorded that the consumption by dominant trout (Class D) included other type of aquatic prey taxa characterized by larger dimensions, such as cased caddis larvae (e.g. *Allogamus ligonifer*, *Calamoceras marsupus*, *Sericostoma* sp.), which were not taken by the smaller trout. The values obtained for the number (Fig. 2) and diversity (Fig. 3) of prey taxa captured by stocked fishes were consistently lower than for adult wild trout. On the other hand, each size class of wild trout exhibited a wide range of variation, regarding quality and quantity of food items.

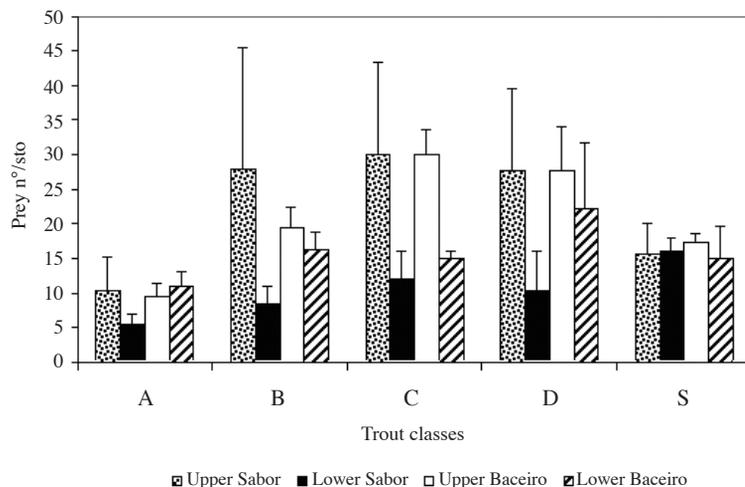


Fig. 2. Mean \pm Standard Error (SE) values of prey number per stomach of stocked (S) and the four size classes of wild (A < 10.0, B-10.1-15.0, C-15.1-20.0, D > 20.0 cm) trout feeding on aquatic and terrestrial invertebrates in the Upper and Lower reaches of the Sabor and Baceiro streams, for all sampling periods (2000 to 2002).

The n-MDS ordination produced a reasonable good representation (Fig. 4) of diet similarities of trout classes in a two-dimensional space (stress value= 0.15, Clarke & Warwick 1994) showing a clear separation between YOY and the other size classes of wild and stocked trout. Complementally, the ANOSIM one-way analyses tested the

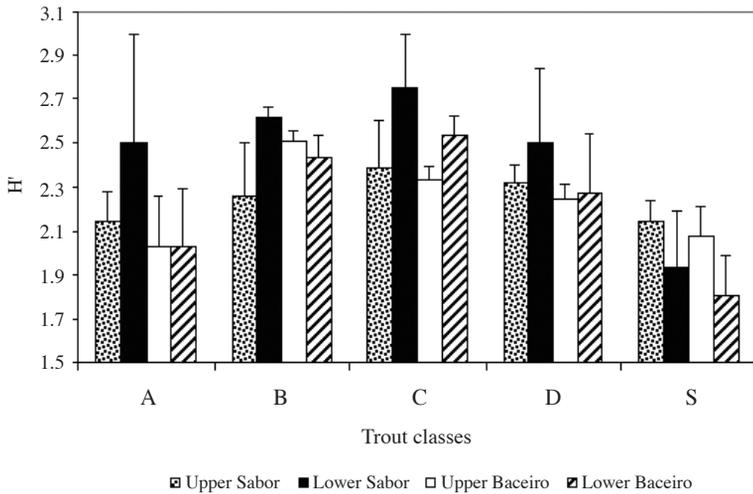


Fig. 3. Mean \pm Standard Error (SE) values of prey taxa diversity (Shannon-Weaver H' index) for the stocked (S) and the four size classes of wild (A < 10.0, B-10.1-15.0, C-15.1-20.0, D > 20.0 cm) trout in the Upper and Lower reaches of the Sabor and Baceiro streams, for all sampling periods (2000 to 2002).

statistical significance of the ordination results. While the overall test of differences across all stocked and wild size classes was highly significant ($P < 0.001$), the pairwise tests indicated significant differences ($P < 0.001$) between YOY and all remainder groups and between stocked and smaller wild adults (B and C classes). Moreover, significant differences ($P < 0.05$) were found between all reaches except for the Upper and Lower Baceiro, although the Lower Sabor registered the most significant differences ($P < 0.001$). Finally, significant differences ($P < 0.001$) were observed between the years of 2000 and 2002.

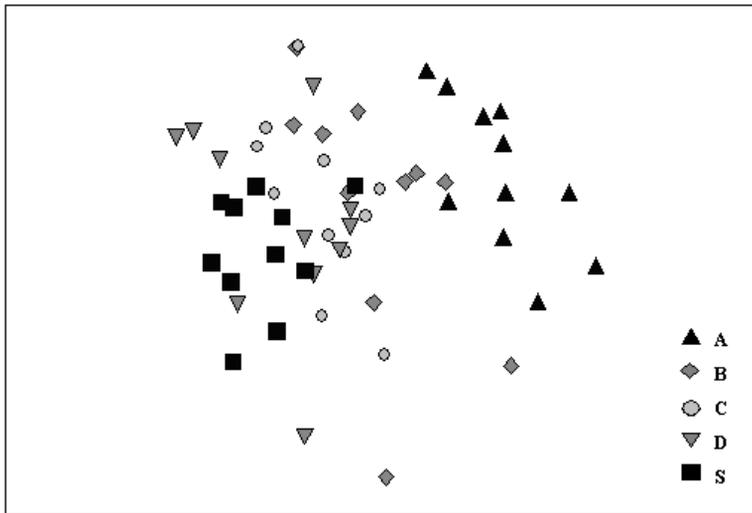


Fig. 4. n-MDS ordination of diet similarities of stocked and wild size-class trout in Upper and Lower reaches of the Sabor and Baceiro streams for the three summer seasons (2000 to 2002). Symbols for wild trout: ▲ = A (< 10.0); ◆ = B (10.1-15.0); ● = C (15.1-20.0); ▼ = D (> 20.0 cm) and stocked trout ■ = S.

Prey selection

Schoener's index showed a significant overlap ($S > 60\%$) between stocked and wild adults (class D and, in less extent, C) (Table 1). Additionally, it was confirmed a tendency to a diet overlap between successive size classes of wild trout for all reaches.

Manly-Chesson (α) index pointed out for the preference of stocked and all wild trout by terrestrial arthropods (Fig. 5). However, the preference or avoidance by aquatic prey *taxa* changed with size-class of wild trout. YOY and juvenile wild trout usually also preferred Baetidae nymphs, Simuliidae and Uenoidae (*Thremma tellae*) larvae, and molluscs (*Ancylus fluviatilis*), which were prey taxa captured in the benthic zone or on the macrophytes. In all reaches, despite the benthos availability, the Trichoptera larvae (e.g. *Calamoceras marsupus*, *Allogamus ligonifer*) were always not taken by YOY trout but not by adult wild fishes. By contrast, with exception of molluscs, this index also showed the preference of stocked trout by food items captured near the water surface.

Diel variation

No significant differences ($P > 0.05$, Kolmogorov-Smirnov tests) were detected between the three daylight periods (morning vs. afternoon, morning vs. evening and afternoon vs. evening) for stocked trout regarding the quantity of food items. Otherwise, significant differences ($P < 0.05$) were calculated between mornings vs. evening for YOY and juvenile trout (A and B classes) in Upper Sabor and for wild adults (C and D classes) in lower reaches of Sabor and Baceiro streams. Moreover, in the Upper Sabor significant differences for wild adults were also found, on afternoon vs. evening (C and D classes) and morning vs. afternoon (D class) tests ($P < 0.05$).

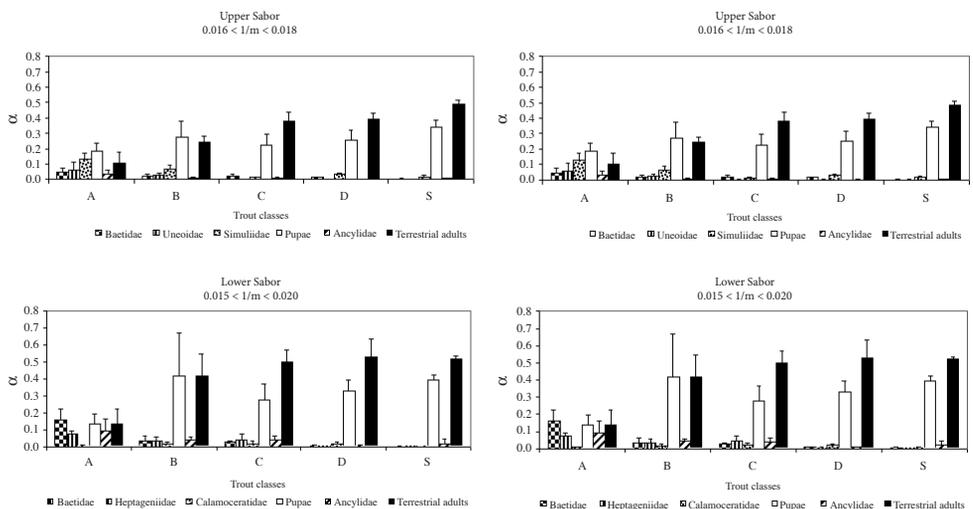


Fig. 5. Manly-Chesson's alpha (α) index (mean \pm SE) for stocked (S) and wild size-class (A<10.0, B-10.1-15.0, C-15.1-20.0, D>20.0 cm) trout feeding on the main aquatic and terrestrial invertebrates in the upper and lower reaches of the Sabor and Baceiro streams. The reciprocal of the number of prey types in sampling reaches (1/m) represents neutral selection. Values $> 1/m$ indicate positive selection and values $< 1/m$ indicate avoidance. The index was computed for each sampling period and reach and then pooled for the three sampling periods.

Table 1. Diet overlap (Schoener index) between stocked (S) and wild size-class trout (A < 10.0, B- 10.1-15.0, C- 15.1-20.0, D> 20.0 cm) in the Upper and Lower reaches of Sabor and Baceiro streams, during three sampling periods (2000 to 2002). Significant values ($S > 60\%$) identified with an asterisk (*).

	Upper Sabor			Lower Sabor			Upper Baceiro			Lower Baceiro		
	2000	2001	2002	2000	2001	2002	2000	2001	2002	2000	2001	2002
A vs. B	71.9*	73.6*	38.9	-	47.5	27.6	41.1	57.3	64.6*	32.5	67.3*	69.4*
A vs. C	64.2*	50.9	59.0	-	36.1	46.4	28.1	37.4	56.1	27.2	35.6	53.8
A vs. D	76.3*	47.7	59.9	-	23.9	29.4	17.7	31.1	42.1	15.5	27.4	52.0
A vs. S	26.1	30.5	54.0	-	22.6	22.5	18.2	31.8	42.5	26.4	24.7	24.1
B vs. C	87.2*	66.3*	35.6	-	84.5*	59.7	75.2*	73.5*	78.2*	57.7	61.1*	73.2*
B vs. D	76.3*	60.1*	42.0	-	54.2	52.5	47.4	49.5	48.3	35.4	53.0	60.7*
B vs. S	42.2	42.6	35.3	-	45.6	46.2	45.0	46.8	51.3	37.5	40.4	47.7
C vs. D	77.4*	76.0*	71.1*	-	63.6*	62.5*	62.9*	53.3	49.8	60.7*	79.2*	63.7*
C vs. S	48.0	65.3*	75.3*	-	50.9	45.4	60.5*	50.9	55.9	59.7	60.4*	47.1
D vs. S	45.1	69.5*	75.3*	-	72.6*	58.7	82.7*	80.7*	71.4*	77.0*	66.8*	51.8

When the analyses were reported to the fullness index (F.I.) values (Fig. 6), significant differences ($P < 0.01$, K-S tests) were registered for stocked trout between morning vs. afternoon and morning vs. evening, but only in the Lower Sabor. In this reach, significant differences were also noticed between the smaller adults (C class) in the morning and YOY trout (A class) in the evening in relation to all other trout groups for the same day period. In the Upper Sabor, the F.I. did not differ significantly for each size class. However, significant differences ($P < 0.05$) were observed for the YOY trout, at evening, when compared to other classes. In the Upper Baceiro F.I. did not significantly differ between day periods for each of the defined trout groups. However, in the Lower Baceiro F.I. were significantly higher for the juvenile wild trout (B group) ($P < 0.001$).

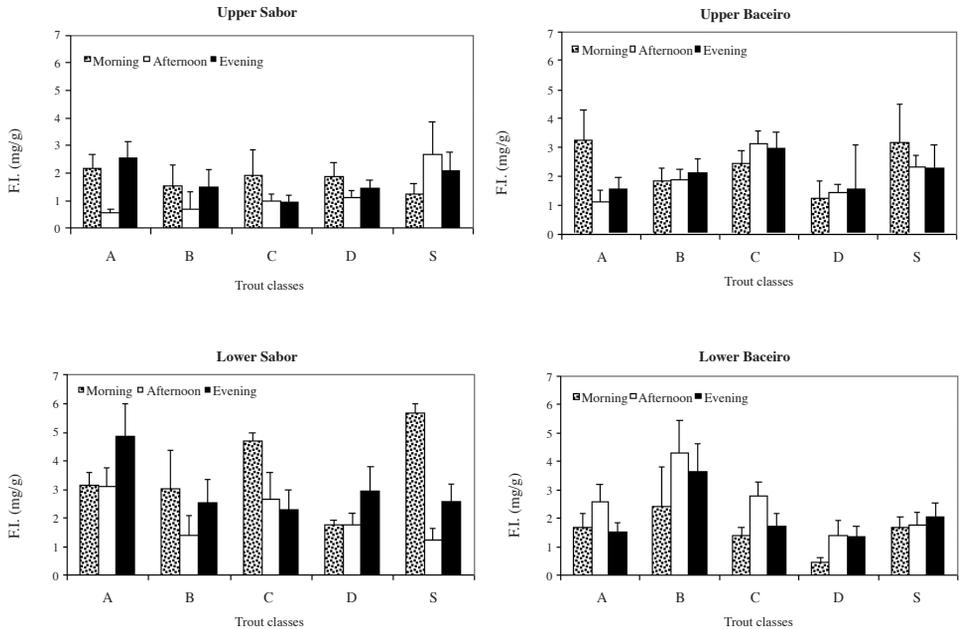


Fig. 6. Diel Fulness Index (F.I.) variation (mean \pm SE) of stocked (S) and wild size-class (A<10.0, B-10.1-15.0, C-15.1-20.0, D>20.0 cm) trout in Upper and Lower reaches of the Sabor and Baceiro streams, considering three sampling diel periods (morning 08.00-12.00; afternoon 12.00-16.00; and evening 16.00-20.00) and summer seasons (2000 to 2002).

Discussion

It has been pointed out that stocking introduces a marked competition increase for resources and, consequently, negative ecological interactions are often described (White et al. 1995, McMichael et al. 1999). For example, Abbott & Dill (1989) found that stocked fishes behaviour could reduce the feeding opportunities of wild fishes. However, this study showed, based on the n-MDS ordination (Fig. 4) and the ANOSIM analyses, a separation of foraging strategies between stocked trout and the different size classes of wild trout, more evident for YOY (< 10.0 cm) group. These differences arose from the fact that stocked trout presented a highly dependent diet of terrestrial insect inputs, which was also reported by other investigators (Sosiak et al. 1979, Johnson et al. 1996, Maynard et al. 1996), whereas YOY fed almost exclusively on benthic aquatic insects. Additionally, the

diversity and selectivity Manly-Chesson index confirmed the high preference of stocked fish for terrestrial organisms and, conversely, low preference for benthic invertebrates, with exception of molluscs (*Ancylus fluviatilis* and *Lymnaea peregra*), especially in Lower Sabor. It is possible that the shape of the molluscs colonizing the coarse substratum may be confounded with the artificial food deposited in the raceway tanks. This feeding behaviour is probably related to specific characteristics displayed by stocked trout, such as the near-surface swimming and the lack of overhead fright, observed during snorkelling surveys (Teixeira, pers. observation) in both streams. Weber & Fausch (2003) suggest that the high densities and the scramble-for-food environment, typical in hatcheries, contribute to inefficient foraging behaviour. Furthermore, the excessive aggression of stocked trout reduces the time available for food search and the energy expended in agonistic contests or simply the intense swimming activity results in a decline of their condition and subsequent lower survival rates (Ersbak & Haase 1983, Olla et al. 1994).

The diet of wild trout populations in the Baceiro and Sabor streams was similar to various other studies of salmonids in the Iberian Peninsula (García de Jalón & Barceló 1987, Suárez et al. 1988, Valente & Heland 1990) and other locations (Elliott 1967, Bridcut & Giller 1993, 1995, Klemetsen et al. 2003). It was based on aquatic macroinvertebrate arthropods and, especially during the summer season, terrestrial organisms captured nearby or dropped onto the stream surface. Generally, the consumption of food items was proportional to its availability in environs, except for reduced consumption of cased caddis larvae less, but a specialised behaviour was also identified in some individuals such as the preference for specific species like the plecopteran nymph (*Perla madritensis*) in a particular habitat (riffles in Upper Sabor). Nevertheless, the piscivorous regimen found in some trout populations (Elliott 1994, L'Abée-Lund et al. 2002) was not a strategy detected in the studied streams (prey number < 1%), in spite of high densities of cyprinid populations in the lower reaches. Simultaneously, remarkable changes were also detected in the feeding patterns among size classes of wild trout. Benthic aquatic taxa, predominant in diet of YOY trout, were gradually decreasing with fish size-class and replaced in terms of abundance on stomach contents by terrestrial arthropods. Apparently, this pattern suggests an ontogenetic variation in the capacity of exploring feeding resources. Despite the competition for terrestrial and pupae prey taxa, adult wild trout also exhibit a preference and specialisation for benthic prey with superior size like caddisflies larvae. This gradual increase of larger prey consumption by adult trout has been quoted (Rincón & Lobón-Cerviá 1999, Steingrímsson & Gíslason 2002). However, all wild trout exhibited a high prey selection by terrestrial arthropods (Manly-Chesson index, Fig. 5). This is also reported in other surveys (Rincón 1993, Wipfli 1997, Bridcut 2000, Hilderbrand & Kershner 2004). Although a higher prey selection of terrestrial and pupae food items was registered for YOY trout, the percentage consumed was low (<1%). Caddisflies larvae (Trichoptera), with exception, in certain cases of *Thremma tellae*, had little significance on the YOY diet composition and a negative selection was found. Comparing the foraging strategy observed, the juvenile and smaller adult fishes (B and C classes) displayed more opportunistic behaviour in order to explore all the aquatic environments, which are confirmed by the diversity index (Fig. 3). Significant differences were observed especially for the YOY and also for other wild group trout in Sabor and Baceiro streams, but the available data only related to the sunlight hours. There are various studies reporting a peak of feeding behaviour during the day period (Angradi & Griffith 1990) or at dusk (Elliott 1973). However, according to Fraser &

Metcalf e (1997) and Metcalf e et al. (1999) the salmonids feed more efficiently at daytime light levels, maximizing the growth rate in this period. On contrary, the nocturnal foraging activity occurs, in most situations, because of the predation risk and subsequently to maximize the survival.

In conclusion, the results suggested that no evident signals of competition for food resources were detected between stocked and wild trout, even if significant overlap diets (Schoener index, Table 1) were calculated for the D class. Since the wild trout occupies a dominant status in social organization and takes advantage of a better knowledge of wild environment when compared with stocked fish, it is expected that positions energetically favourable related to food availability and refuge had been preserved. Therefore, the negative impact of supplementation stocking programs resulting from the competition for food between stocked and wild trout populations were not registered in Sabor and Baceiro streams. Probably, if biotic interactions occurred at feeding resources level did not seem limiting, the establishment of stocked populations in a natural environment can be controlled by the abiotic factors present in the oligotrophic systems of north-eastern Portugal. On the other hand, the low introgression rates verified (Santos 2004) confirmed the adaptation and breeding incapacity of these trout. Therefore, we believe that stocking, even if it is inappropriate, as a measure for recovery of the natural population in this type of streams, has limited impact on resident populations, in what concerns food depletion, because of the lack of adaptative strategies of stocked trout.

After all, should we conclude that stocking does not disrupt wild trout populations? We believe that a greater care should be played in relation to the multiple aspects involved, namely the following issues for the studied streams: 1) stocking programs should be used only when natural populations do not have the capacity of recovering the carrying capacity of aquatic system; 2) if stocking is decided as the best management tool, stocked trout should originate from indigenous population captured in the same stream and reared in improved hatchery conditioning specifically prepared for stocking. Furthermore, rigorous monitoring programs should be defined to evaluate, carefully, the ecological risks and the costs and benefits of stocking; 3) more protective regulations should be applied to salmonid streams, as a means to guarantee the natural recruitment, through, for instance, a self-sustainable mature stock of reproducers and 4) adequate habitat improvement techniques should be developed in order to increase, whenever possible, the fisheries.

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