FOLIA ZOOLOGICA - 45(4): 371-381 (1996)

IS SUPPLEMENTAL STOCKING OF BROWN TROUT (SALMO TRUTTA) WORTHWHILE IN LOW PRODUCTIVE STREAMS?

Rui M.V. CORTES[1], Amílcar TEIXEIRA[2] and Carlos A. PEREIRA[3]

Received September 10, 1995
Accepted October 3, 1996

[1]Universidade de Trás-os-Montes e Alto Douro, Vila Real
[2]Escola Superior Agrária, Bragança
[3]Estação Aquícola do Ave, Vila do Conde

Abstract

The effect of trout stocking was evaluated in two headstreams located in northern Portugal in order to assess the impact on wild trout (*Salmo trutta* L.) and to analyse the success of this operation. The results obtained exhibited the limitation of stocking: 1) the clumped character of the released fishes created a high mortality and limited the increasing of salmonid population to a few weeks; 2) because density-dependent factors seem to prevail in the regulation of salmonid populations, stocking is beneficial only if a population has became scarce, otherwise, the autochthonous fish may be strongly impacted; 3) the relative vulnerability of each age class of the native trouts may vary according with the site.

Key words: stocking, brown trout, impact, fish management

Introduction

Fish stocking is widely used when autochthonous fish populations are reduced or eliminated due to overfishing, or when degradation is so severe that natural recovery of autochthonous fish stocks is no longer possible. This stocking is also used when new water bodies are created, e.g. large reservoirs for water supply or hydroelectricity, resulting in new habitats that may not be colonised by local species (e.g. components of a riverine fish assemblage in a river reservoir). Some stocking programmes may include exotic fish species. In some countries - like the Czech Republic - the additional trout introduced by stocking is used mainly for angling purposes (e.g. transfering the planted fishes into angling grounds after the appropriate period - Libosvárský & Lusk 1974). However, in Portugal, this practise has a more extensive character, because it is not directly linked to angling but it attempts to compensate the severe consequences of the highly variable hydrological regimes (Rodrigues et al. 1994) or of multiple anthropogenic effects.

Supplemental stocking of self - sustaining native populations is a regularly used strategy for brown trout (*Salmo trutta* L.), which represents the most important sport fish in the upland streams of North and Central Portugal, as well as in other parts of Europe. Most of those water courses in Portugal are characterized by low fish productivity, which is related to the low salt content (Cortes et al. 1988). Nevertheless, we must consider that the use of this technique presents several deleterious consequences. First of all, it increases competion for food and space, especially in species with a territorial behaviour, such as brown trout (e.g. Lusk 1977, Elliot 1990), impacting resident trouts and limiting survival of the released fishes. An important negative impact is also the genetic integrity loss of wild stocks (Altukhov 1981).

The aim of the present investigation, which took place in two rivers in northern Portugal, was: 1) to assess the intra-specific effect of trout stocking on the native populations and 2) to determine the success of the stocking programme. This is the first attempt to obtain some information in this country of repopulation programmes.

Study Sites

The Rivers Olo and Sabor are located in north east Portugal, their upper parts running through the Alvão and Montesinho Natural Parks, respectively (Fig. 1). These drainage basins have been subjected to little human impact, which is reflected by a consistent low concentration of dissolved salts and organic matter. This pattern is well exemplified by the maximum year values (corresponding to summertime) for the River Olo: conductivity = 39.6 $\mu S.cm^{-1}$; $N\text{-}NO_3^-$ = 0.6 $mg.l^{-1}$; $P\text{-}PO_4^{3-}$ = 0.05 $mg.l^{-1}$; chlorides = 2.0 $mg.l^{-1}$; SO_4^{2-} = 2.1 $mg.l^{-1}$; COD = 1.42 mg $O_2.l^{-1}$. The River Sabor has a similar chemical composition, and the values reported for the summer period in the chosen site were: conductivity = 32.0 $\mu S.cm^{-1}$; $N\text{-}NO_3^-$ = 0.4 $mg.l^{-1}$; $P\text{-}PO_4^{3-}$ = <0.01 $mg.l^{-1}$; chlorides = 1.3 $mg.l^{-1}$; SO_4^{2-} = 0.9 $mg.l^{-1}$.

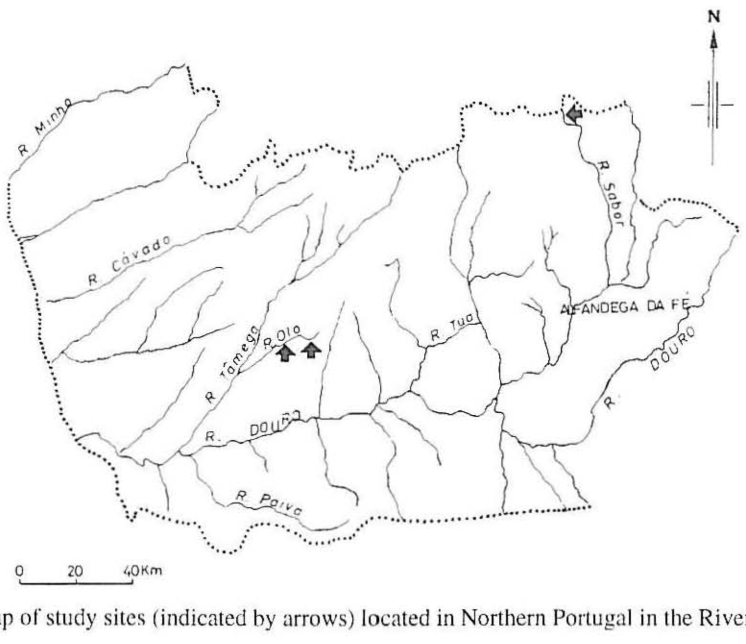


Fig. 1. Map of study sites (indicated by arrows) located in Northern Portugal in the Rivers Olo and Sabor.

The two study sites on the R. Olo were of 3rd and 5th order, about 10 km apart, and one site of 3rd order was considered on the R. Sabor (Fig. 1). The average stream width and water depth were, respectively, 2.5 and 0.2 m for site 1 of R. Olo and 4.5 and 0.45 m for site 2. These physical parameters were 5.5 and 0.55 m for the considered site of R. Sabor. There was no contact between fish assemblages of the two Olo sites because of the natural barrier imposed by a 200m height waterfall.

There is a tremendous flow range, influenced by mediterranean conditions, well exemplified, in the R. Olo near by the downstream point: For a ten years period (1980-1990), the instantaneous flow ranged between 0.01 and 204.34 $m^3.s^{-1}$ (yearly average flow - 2.25 $m^3.s^{-1}$). From June to September, when the present study took place, the average flow for the same period was 0.64 m^3s^{-1}. In R. Sabor, for the mentioned decade, the average summertime flow was 0.83 $m^3.s^{-1}$ (yearly average flow 4.60 $m^3.s^{-1}$).

The study reaches were characterised by a rough boulder-stream bed, steep banks shaded by alder trees (*Alnus glutinosa*), high water velocities and extremely low primary production, which makes these streams energetically dependent on the allochthonous particulate organic matter (C o r t e s et al. 1995).

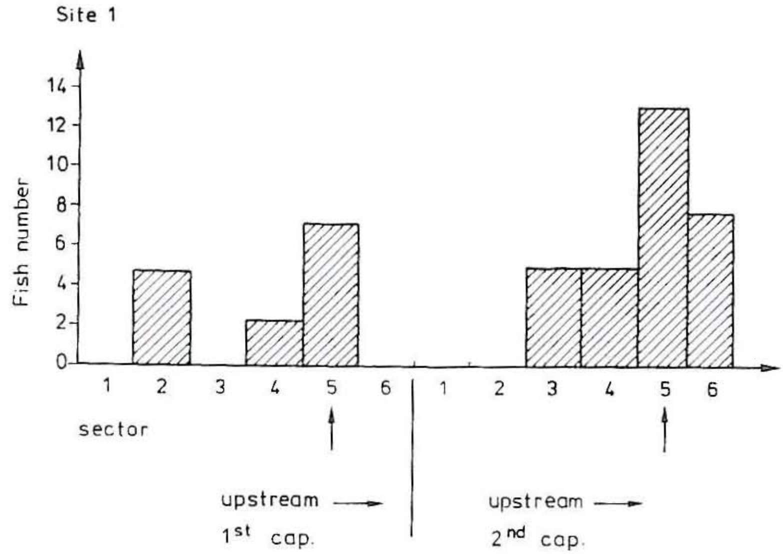
Prior to stocking, only brown trout was present at site one, whereas the fish assemblage at site two was dominated by the cyprinids Iberian nase *Chondostroma polylepis duriensis* and chub *Leuciscus cephalus*, though the brown trout was still well represented, with eel *Anguilla anguilla* relatively scarce. Estimate densites of the first two species in this site, refered to 100 m^2, were 119.5 and 22.3 individuals. Salmonids were dominant in the study stretch on the River Sabor occurring together with few chub (<5.0 individuals/100 m^2).

Table 1. Comparison of lenght structure statistics of native (N) and domestic (D) trouts just prior to stocking in Rivers Olo and Sabor.

	R. OLO			R. SABOR	
	Site 1-N	Site 2-N	D	N	D
Mean	13,3	11,0	17,6	12,5	17,5
Mode	14,5	7,5	21,0	10,5	18,0
Minimum	5,2	5,0	14,0	5,5	12,5
Maximum	30,0	24,6	21,5	22,0	23,4
S. D.	4,2	4,3	2,3	3,9	2,1

Material and Methods

Hatchery-reared trout were stocked as individuals of age 1+. These juvenile fishes were obtained from two fish farms near the study areas (about 25 km from Olo and 2 km from Sabor), which reduced considerably transportation and thermal shock. The fish were reared at a low density (≈2 $kg.m^{-3}$) during the last month, and implantation of visible implant (VI) tags (Fisheagle), in the adipose eyelid tissue, allows the individual identification for a considerable period - see N i v a (1995). This operation was done one week before release to minimise stress effects. The fish were stocked using a spot - planting approach: 109 individuals at one point of site 1 and 126 fish at two points of site 2 on R. Olo, and exactly 500 individuals divided in equal portions at two points on the R.



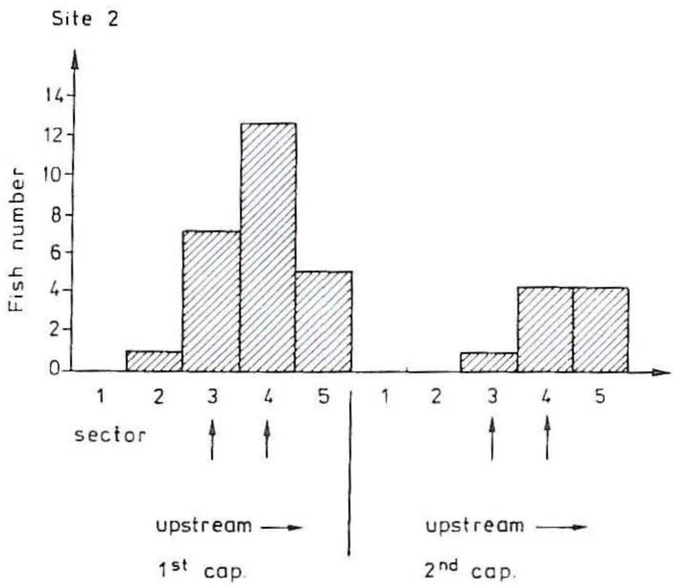


Fig. 2. Spatial distribution of the stocked brown trout along the different sectors of the two sites of River Olo after 1 and 2 months following release (the arrows represent the sectors where stocking took place).

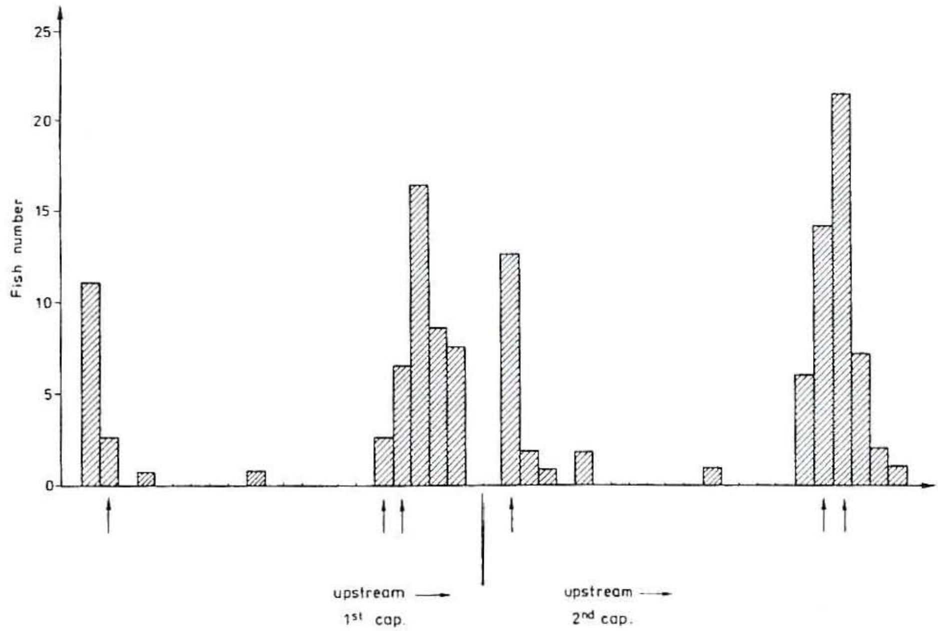


Fig. 3. Spatial distribution of the stocked brown trout along the different sectors of River Sabor after 1 and 2 months following release (the arrows represent the sectors where stocking took place).

Sabor. Stocking took place on the Olo in June 1993 at approximately the same hour at both locations, and in June 1994 on the Sabor. The latter river was considered as a control because angling was prohibited and the area strictly surveyed by the river authority during the study. Table 1 allow us to compare the lenght structure of the released trouts with the one of the existing population. We may observe that the average size of the introduced fishes was somewhat higher, but with a more narrow range.

At exactly one month intervals, in July, August and September of the respective year, sites were surveyed using electrofishing (500 volts DC, produced by a 800 W generator) to determine dispersion of the domestic trout. For this purpose, each site was sub-divided into 40 m (Olo) and 50 m (Sabor) sectors, in which stocked and wild trout were counted and biometric measures taken. Native trout were classed by age (0+, 1+ and ≥ 2+) to detect the differencial impact of stocking by these three year classes. Fish numbers obtained should be considered as semi-quantitative because no block nets were set and only one removal was undertaken, but a constant fishing time was carefully observed in each sector. The objective was to reduce the negative consequences of multiple electrofishings.

To assess the overall results of stocking, quantitative assessments of trout populations were carried out immediately before and three months after fish introduction (i.e. between June and September). For this purpose, it were selected only the sectors chosen for fish release, which were delimitated by stop nets. Therefore, one sector was considered at site 1 and two at site 2 of the River Olo, each of them with 40 m lenght, and two sectors (50 m each) were sampled in the Sabor. We estimated fish density and biomass by the Zippin depletion method using software by Kwak (1992). This design took in account that fish stay generally clumped in places where they are planted and the effects of induced competion between resident and domestic trouts can be more evident. Because fish size is a primary factor influencing the efficiency of electrofishing (Büttiker 1992), estimates were stratified by size class: 5-9.9, 10-14.9, 15-19.9, ≥ 20 cm.

Pearson correlations were calculated between numbers of stocked and of native fish for each of the mentioned three age classes. These calculations were completed to assess the impact of stocking on the resident trout, and they were based on data obtained during the consecutive electrofishings following fish introduction (semi-quantitative and quantitative samplings).

To follow fish condition after release, Fultons' Condition Factor K was calculated for the different surveys on the River Sabor as $K=100w/L^b$ where W and L are the total weight and fork lenght, and b is the exponent of the lenght-weight relationship. K was determined separately for the three lenght classes in which we split the stocked trout (12.5-16, 16.1-19.0, 19.1-23.5 cm) to detect if K varied differently according to size class. The biometric values were taken individually from the tagged trout, because tag retention was considerably high (>90%), and fish without tags were not considered. Comparison of K between classes was undertaken using one-way analysis of variance (ANOVA).

Results

The spatial pattern of reared trouts was relatively uniform at the three sites during the first and second months after release (Figs. 2 and 3). These individuals remained aggregated for a considerable time in the release areas, displaying a little post-stocking movement along the longitudinal course of the river. We also observed an overall coincidence between the modal components of the spatial distribution of the fish and the respective planting points. Note that small weirs represent the upstream boundaries of trout dispersion on R. Olo sites and the downstream one on R. Sabor, imposing thus considerable restrictions to the migration of these fishes.

Trout density and biomass, before and three months after stocking, differed at the two sites on the Olo. At site 1, there was a remarkable similarity between the values (Table 2). However, the 10-14.9 class decreased about 50%, whereas the ≥ 20 class, which was previously absent, contributed largely to the overall biomass. In one of the quantitatively sampled sectors of site 2, density and biomass reflected a pronounced decrease two months after release, because all classes were strongly depleted, mainly the 15-19.9 class. On the contrary, in the other sector, the values remained similar to the previous ones, in spite of stocking, but the 15-19.9 class decreased, whereas the ≥ 20 class increased (Table 2). Note that no stocked fish were captured at site 2 during the latter sampling period.

In the two quantitatively surveyed sectors of River Sabor consequences of stocking appeared more positive: In both cases density nearly doubled and biomass almost tripled after the same period (Table 2). Nevertheless, the higher values of September in the upper stretch also reflect the natural recruitment of native trouts in this area, whereas in the downstream one they are mainly caused by stocking. In this sector, quantitative values of resident fish remained practically unchanged.

Through the Pearson correlations we may conclude that in R. Olo, although there was some effect on the younger age classes, especially at site 1, the oldest age class of native trout exhibited, apparently, a higher vulnerability (Table 3). On the contrary, in R. Sabor the youngest age-class of the autochthonous trouts was the one more obviously impacted by stocking.

Condition of the introduced trout declined progressively (Fig. 4), demonstrating the short-term value of stocking. ANOVA showed that only in July there were significant differences ($P<0.05$) in K between size groups (in June, just prior to the releasing operation no significant differences were noticed for such groups - $P<0.05$).

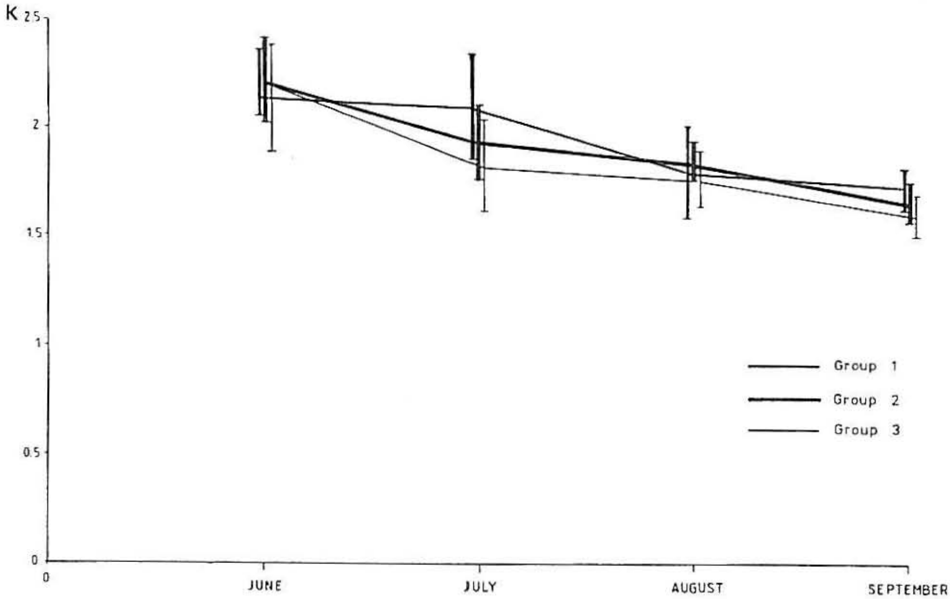


Fig. 4. Month variation of condition coefficient K, for the stocked trouts in R. Sabor from June (trout release) until September, separately for each size class. The vertical lines represent the standard deviation.

Discussion

In the present study it was possible to detect distinct rates of stocking success in the two low-order streams, where abiotic factors are expected to prevail in population regulation (Z a l e w s k i et al. 1985). Populations controlled by density-independent factors are known to be present in lower density in less favourable sites (E l l i o t 1989), and in the present study density-dependent factors became dominant when numbers became higher or exceeded the carrying

Table 2. Total densities (N) and biomass in grams (B) of brown trout populations at the study sectors of the Rivers Olo and Sabor before and three months after stocking. Values are refered to $100m^2$ and are discriminated by size. Numbers between brackets represent exclusively abundances of native trouts (excluding the introduced ones) in the R. Sabor.

Size Class	5-9.9 cm	10-14.9 cm	15-19.9 cm	≥20 cm	All
RIVER OLO					
Site 1					
Before N	5.8	16.2	4.0	0.0	28.7
Before B	14.4	319.3	245.3	0.0	979.7
After N	6.4	8.1	9.4	7.1	25.5
After B	23.6	142.3	399.1	576.7	818.5
Site 2 (upper stretch)					
Before N	65.9	4.6	12.4	2.3	81.7
Before B	441.4	4	231.7	479.6	324.4
After N	10.7	0.1	0.0	0.0	12.6
After B	65.9	8.1	0.0	0.0	110.9
Site 2 (downer stretch)					
Before N	22.0	0.0	9.4	0.0	30.8
Before B	149.0	0.0	371.8	0.0	496.4
After N	20.3	0.0	2.0	2.0	29.0
After B	132.3	0.0	109.2	216.0	54.0
RIVER SABOR					
Upper stretch					
Before N	0.7	9.6	14.0	0.7	9.0
Before B	6.0	154.1	94.5	86.9	303.2
After N	2.7	10.3	9.5	2.1	24.6(16.6)
After B	14.4	214.1	550.8	197.6	975.9(664.7)
Downer stretch					
Before N	1.6	2.3	0.9	0.4	5.0
Before B	16.0	54.8	43.3	36.9	136.2
After N	3.2	4.8	2.0	0.8	10.5(4.3)
After B	10.5	93.4	122.9	81.2	326.7(133.1)

Table 3. Pearson correlation between numbers of stocked trout (D) and numbers of native trout split by three ages classes in the Rivers Olo (2 sites) and Sabor (1 site).

	River Olo (site 1)				River Olo (site 2)				River Sabor			
	D	0+	1+	≥2+	D	0+	1+	≥2+	D	0+	1+	≥2+
D	1				1				1			
0+	0.489	1			0.314	1			-0.238	1		
1+	0.500	0.534	1		0.009	-0.125	1		0.039	0.494	1	
≥2+	-0.013	-0.316	-0.353	1	0.170	-0.249	0.117	1	0.052	-0.162	0.177	1

capacity. The overall values of fish numbers and biomass before and after stocking (Table 2) reveal a higher rate of success precisely where the trout population had previously appeared in lower numbers. This was the case in both sectors of the River Sabor when compared to those of the Olo. In the Sabor there was a lower fish abundance and, consequently, better results were observed following introduction. But even when the River Olo is considered alone, differences are obvious, ranging from absence of significant changes to a clear deleterious effect, this latter situation observed again where higher abundance values of autochthonous trout were found (site 2, upper sector).

In such circumstances, the density - dependent immigration from adjacent areas to fill unoccupied areas may be also delayed by stocking, resulting in a reduced recruitment of native fish (B ø r g s t r ö m 1992). Evidence of intra - and inter-specific competition in salmonids has been found in comparative studies of growth and mortality rates in stocked salmonid alevins where the resident trout populations were removed and where they were not (K e n n e d y & S t r a n g e 1986). Stocked fish placed in the cleared areas had twice as high survival rates as well as greater growth.

The limitations of stocking as a measure to maintain or develop trout populations were apparent due to the clumped character of fish when released (Figs. 1 and 2). Similar situations have been reported elsewhere for other species (e. g. B r y s o n et al. 1975) and for trout (C r e s s w e l l & W i l l i a m s 1982, B e r g & J ø r g e n s e n 1991). Stocking increases competion and it is in part responsible for the progressive lower condition of stocked fish (Fig. 3), earlier growth retardation and, consequently, lower survival. These adverse effects are more notorious where the hiding places are particularly scarce - L u s k 1977. We also concluded that releasing fish with greater size does not increase its capacity of adaptation to the new environment, besides having higher costs.

After stocking, initial periods of very high mortality, lasting 1-2 months, have been reported, continuing afterwards but at a much lower level (J ø r g e n s e n & B e r g 1991). These authors refered that the mechanism governing post-stocking mortality is density-dependent for at least the first two months after release, providing that stocking densities are above the carrying capacity. They also observed that movement became evident two months after stocking. However, this fact may be dependent on other variables, like strains, condition of fish stocked, competition with wild trout, etc., because other studies have reported that movement ceased a few days after stocking (H u l b e r t & E n g s t r ö m - H e g 1983), being this sedentary character particularly present in age classes I and II (L i b o s v á r k ý & L u s k 1976). This latter situation seems also to be the case in the present study.

E l l i o t (1994) synthesizes quantitative aspects of brown trout ecology from numerous works and found that the density of other fish species had no significant effect on the mortality rate of trout, concluding that life cycle is regulated chiefly by density - dependent survival in early life stages. Therefore, we assume that the cyprinids present in some reaches did not interact markedly with the existing and introduced salmonids, and that they rarely affect the stability of this population.

In conclusion, stocking trout has only short-term advantages. C r e s s w e l l & W i l l i a m s (1989) found that reared trout contributed to less than 1% for catch in the season after release, with the main benefits limited to 4-5 weeks. The dilution in time of fish density is even more obvious when stream order increases (Z a l e w s k i et al. 1985). Results obtained on the present and previous studies suggest that some fishery management related to trout stocking should be adapted:

1) First of all, the carrying capacity should not be exceeded, and this is essential in the selection of the reaches where stocking will take place; 2) the

stocking program may need to be extended to the entire area (if it is assessed a pollution abatement and if there is not a deleterious effect on the habitat), because of the limited movement displayed by introduced fishes; 3) for the same reasons, scatter-planting is a more convenient technique than spot-planting; - in this way, besides decreasing the negative effects of competition in those „spots" it helps alleviate angling pressure in the vicinity of the release points; 4) special attention should be given to handling practices, transport and adaptation to the new environment. Schreck (1981) points out the need for appropriate recovery times after each step, because of imposed additive low-level chronic-stress, which affects fish performance in resisting other stresses; 5) it is desirable a previous adaptation to the natural conditions: for instance, unfed fry may be released previously in earthen ponds to feed on natural food, and the domestic fishes must remain during some time in net cages in the places where it was decided to set them free (Hesthangen et al. 1995).

Moreover, stocking should be viewed as a short-term mitigation of fishkills (at a recurring cost), because fish from commercial strains are less adapted to lotic environment and compete less successefully with the existing fish. For instance, resident populations are able to create specific migratory strategies between sites related to genotypic differences (Elliot 1988). In fact, it was found segregation in resource utilization in phenotypically and ecologically different sympatric populations of salmonids (e.g. Ferguson 1986). On the contrary, the non-native brown trout presents a more rigid use of space (Hesthagen et al. 1995). This lack of adaptation to habitat utilization of the non-native stocked brown trout amplifies the shoaling effects and explains the high vulnerability of these fishes, which is also cumulative to the difficulty of feeding on natural food items. Therefore, it is more convenient to perform restocking from indigenous populations, using large numbers of randomly selected wild brood fish. When this is not feasible, a rotational line crossing of broodstock lines should be used to reduce inbreeding, which requires successive generations and also a broodstock management that randomises the selection of eggs and parents throughout the entire spawning season (Dodge & Mack 1994). But even if in this conditions are observed, as Libosvárský & Lusk (1974) warn, a trout stream section may only support an increased trout population if subjected to environmental improvements, being the carrying capacity allways limited by the climatic conditions, mainly the low water discharge of the summer period.

LITERATURE

ALTUKHOV, Y.P., 1981: The stock concept from the viewpoint of population genetics. *Can. J. Fish. Aquatic Sci., 38: 1523-1538.*

BERG, S. & JØRGENSEN, J., 1991: Stocking experiments with 0+ and 1+ trout parr, Salmo trutta L., of wild and hatchery origin - 1. Post - Stocking mortality and smolt yield. *J. Fish. Biol., 39: 151-169.*

BRYSON, W. T., LACKEY, R. T., CAIRNS JR, J. & DICKSON, K., 1975: Restocking after fishkills as a fisheries management strategy. *Trans. Amer. Fish. Soc., 2: 256-263.*

BÜTTIKER, B., 1992: Electrofishing results corrected by selectivity functions in stock size estimates of brown trout (Salmo trutta L.) in brooks. *J. Fish Biol., 41: 673 -684.*

BØRGSTRÖM, R., 1992: Relationship between annual recruitment and density in a lacustrine population of allopatric brown

trout (Salmo trutta). *Can J. fish. Aquat. Sci., 49: 1107-1113.*
CORTES, R. M. V., CARVALHO, L. H. M. & AZEVEDO, J. C., 1988: Produtividade piscícola e estrutura das populações de peixes na Bacia do Rio Tua. *Iberian Meet. Ecol. Aquatic Ecos., Actas Col. Luso-Espanhol Ecol. Bacias Hidrográficas e Rec. Zool., Faculd. Ciências, Porto: 69 - 72 (in Portuguese, with a summary in English).*
CORTES, R. M. V., GRAÇA, M. A. S., VINGADA, J. N. & VÁRANDAS DE OLIVEIRA, S., 1995: Stream typology and dynamics of leaf processing. *Annl. Limnol., 31: 119-131.*
CRESSWELL, R. C. & WILLIAMS, R., 1979: Studies on trout in an industrial river and their management implications. *Proc. 1st British Freshwater Fisheries Conf., University of Liverpool, WK: 285-295.*
CRESSWELL, R. C. & WILLIAMS, R., 1982: Post - stocking movements and recapture of hatchery-reared trout released into flowing waters: effects of time and methods of stocking. *Fish. Mgmt., 13: 97-103.*
CRESSWELL, R. C. & WILLIAMS, R., 1989: Conservation and management of brown trout, Salmo trutta, stocks in Wales Water Authority. *Freshwat. Biol., 21. 111-123.*
ELLIOT, J. M., 1988: Growth, size, biomass and production in contrasting populations of trout Salmo trutta, in two lake district streams. *J. Animal Ecol., 57: 49-60.*
ELLIOT, J. M., 1989: The natural regulation of numbers and growth in contrasting populations of brown trout, Salmo trutta, in two lake district streams. *Freshw. Biol., 21: 7-19*
ELLIOT, J. M., 1990: Mechanisms responsible for population regulation in young migratory trout, Salmo trutta. III: The role of territorial behaviour. *J. Anim. Ecol., 59: 803-818.*
ELLIOT, J. M., 1994: Quantitative ecology and the brown trout. *Oxford Univesity Press, Oxford, 286 pp.*
FERGUSON, A., 1986: Lough Melvin, a unique fish community. *R. Dublin Soc. Occas. Pap. Ir. Sci. Technol., 1: 1-17.*
HESTHAGEN, T., HEGGE, O., SKUDAL, J. & DERVO, B. K., 1995: Differences in habitat utilization among native, native stocked, and non-native stocked brown trout (Salmo trutta) in a hydroelectric reservois. *Can. J. Fish. Aquat. Sci., 52: 2159-2167.*
HULBERT, P. J. & ENGSTRÖM - HEG, R., 1983: Upstream dispersal of fall-stocked brown trout in Canajoharie Creek. *New York N.Y. Fish Game J., 29: 166-175.*
JØRGENSEN, J. & BERG, S., 1991: Stocking experiments with 0+ and 1+ trout parr, Salmo trutta L., of wild and hatchery origin: 2. Post-stocking movements. *J. Fish Biol., 39: 171-180.*
KENNEDY, G. J. & STRANGE, C. D., 1986: The effects of intra-and inter-specific competition on the survival and growth of stocked juvenile Atlantic salmon, Salmo salar L., and resident trout, Salmo trutta L., in a upland stream. *J. Fish Biol., 28: 479-489.*
KWAK, T. J., 1992: Modular microcomputer software to estimate fish population parameters, production rates and associated variance. *Ecol. Freshw. Fish, 1: 73-75.*
LIBOSVÁRSKÝ, J. & LUSK, S., 1974: Some effects of stocking on the performance of a brown trout population. *Acta Sc. Nat. Brno, (8) 5: 1-42.*
LIBOSVÁRSKÝ, J. & LUSK, S., 1976: Spatial stability of brown trout in stream section. *Folia Zool., 26: 61-78.*
LUSK, S., 1977: Fish stock in the middle course of the Svratka River. *Folia Zool., 27: 71-84.*
NIVA, T., 1995: Retention of visible implant tags by juvenile brown trout. *J. Fish Biol., 46: 997-1002.*
RODRIGUES, L. S. B., CORTES, R. M. V. & MONZON, A., 1994: Comparison between population parameters in a low order stream inside and among fish species. *Verh. Int. Ver. Limnol., 25: 2169-2172.*
SCHRECK, C. B., 1981: Stress and compensation in teleostean fishes: Responses to social and physical factors. In: Pickering, A. D. (ed.), Stress and Fish: *295-314.*
ZALEWSKI, M., FRANKIEWICZ, P. & BREWINSKA, B., 1985: The factors limiting growth and survival of brown trout, Salmo trutta m. fario L., introduced to different types of streams. *J. Fish. Biol., 27: 59-73.*

Authors' addresses:

Rui M. V. CORTES,

Universidade de Trás-os-Montes e Alto Douro, Apt. 202, 5001 Vila Real Codex, Portugal

Amílcar TEIXEIRA,

Escola Superior Agrária, Quinta de Sta Apolónia, 5300 Bragança, Portugal

Carlos A. PEREIRA,

Estação Aquícola do Ave, 4481 Vila do Conde Codex, Portugal