

The brown trout *Salmo trutta* L. populations in the river Lima catchment

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ABSTRACT

All the Lima tributaries are considered to be salmonid Rivers. As a result of intense angling pressure, some tributaries are subject to special angling regulations. However, a correct management of populations of brown trout (*Salmo trutta*) needs to be based on knowledge of these populations. The populations of six tributaries (Vade, Estorãos, Trovela, Labruja, Tamente and Froufe) have been characterised. From September 1995, electrofishing surveys have been conducted every three months in the Rivers Vade (four sites), Estorãos (two sites) and Trovela (one site). One annual sample has been obtained from Labruja, Tamente and Froufe. Brown trout is the only fish species present in all sampling sites, representing more than 50% of total catch in the upstream sites. Brown trout densities varied along the River length and also within the tributaries sampled. Mean values were always greater than 10 ind/100 m², but in some sites more than 20 ind/100 m² were found. Mean trout biomass was 285.5 gFW/100 m², ranging from 23.04 to 727.04 gFW/100 m². Population age-structure showed within-site variation, i.e. 0⁺ and 1⁺ fish were dominant at most sites, although 5⁺ to 7⁺ trout were also captured. The improve conservation efforts of the brown trout needs of more data, related to angling pressure (e.g. number of angler visits and catches) and a more effective control of this.

Key words: *Salmo trutta*, density, biomass, growth, River Lima, Portugal.

RESUMEN

Todos los afluentes del río Lima están considerados como salmoneros. Como resultado de un intensa pesca con caña algunos de los afluentes están sometidos a regulaciones especiales de pesca. NO obstante, la correcta gestión de las poblaciones de trucha, *Salmo trutta*, solo serán posibles si se basan en el conocimiento de estas poblaciones. Desde Setiembre de 1995, se han caracterizado las poblaciones de seis afluentes (Vade, Estoraos, Trovela, Labruja, Tamente y Froufe). Trimestralmente se han realizado una serie de muestreos mediante electropesca en los ríos Vade (cuatro estaciones), Estoraos (dos estaciones) y Trovela (una estación); mientras que en los demás afluentes se ha realizado un muestreo. La trucha es la única especie presente en todas las estaciones, representando más del 50% de las capturas totales en los tramos de río de cabecera. Las densidades de trucha varían a lo largo del río así como en los tributarios muestreados, con valores medios siempre superiores a 10 ind/100 m², pero en algunos puntos se han hallado densidades superiores a 20 ind/100 m². Los valores medios de biomasa de truchas fueron de 285.5 gPF/100m² (oscilando entre 23.04 a 727.04 gPF/m²). La estructura de edades de las poblaciones también muestra variaciones entre estaciones; los peces de 0⁺ y 1⁺ son dominantes en la mayoría de las estaciones, pero también se capturaron truchas de 5⁺ a 7⁺. La conservación de las poblaciones de trucha requiere más datos sobre la presión de la pesca con caña (número de pescadores y capturas) y un control más efectivo.

Palabras clave: *Salmo trutta*, densidad, biomasa, crecimiento, río Lima, Portugal

INTRODUCTION

The brown trout (*Salmo trutta*) is a native salmonid in Portuguese Rivers and is present in most River basins in the North.

The River Lima brown-trout populations support a thriving sports fishery. Intense angling pressure has led to the implementation of special regulations and to a considerable re-stocking effort (Ramos, 1982; Maia-Mendes, 1997). However, the lack of a monitoring programme precludes the evaluation of the efficiency of the management plan, which has been implemented. Thus, knowledge is scarce about brown trout populations and of the recreational fishery in basin of River Lima.

The project aims to evaluate the current status of brown trout populations and the effect angling is having on these.

Estorãos (2 sites), Trovela (1 site), Labruja (1 site), Froufe (1 site) and Tamente (1 site) (Figure 1). All tributaries are similar in length (10-15 km), source altitude (300 to 500 m) and morpho-dynamic features. Froufe and Tamente are upstream of the Touvedo dam, situated on the main River, while the rest are located downstream of the dam. The basin of River Lima is granitic. Climate is oceanic, with typically large inter-annual variability in meteorological conditions. The tributaries have a high slope in the upper reaches, with abundance of riffle habitats and sparse aquatic vegetation. The riverside has trees. In downstream sites the slope decreases, pool habitats predominate over riffle areas, substrate is more diverse and riparian and aquatic vegetation becomes abundant. Surrounding areas in these reaches are largely agricultural.

STUDY AREA

The River Lima is a salmonid River in the Northwest of Portugal. The study was carried out in six of its tributaries, i.e. Rivers Vade (4 sites),

MATERIAL AND METHODS

Electrofishing surveys have been conducted every three months from September 1995, of the Rivers Vade (three sites, V1 to V3, plus an additional site, V4, from February 1997), River

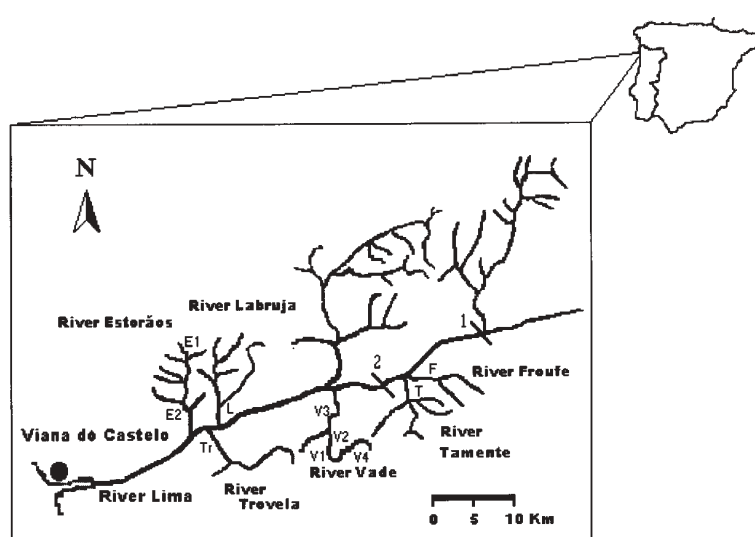


Figure 1. Location of the studied tributaries and the Alto Lindoso (1) and Touvedo (2) dams in the River Lima basin. *Cuenca del río Lima. Situación de los afluentes estudiados, así como de los embalses de Alto Lindoso (1) y Touvedo (2).*

Estorãos (sites E1 and E2) and River Trovela (one site). One sample per year was collected from Rivers Labruja, Froufe and Tamente. Sampling reaches were 100 m in length, closed with stop nets. Two consecutive electrofishing runs were performed, except during unfavourable hydrological conditions. After the second sampling date, reaches 50 m upstream and downstream of each site-length were also fished once. All trout were anaesthetised (ethylenglycol-monophenylether, 2 ml/10 L water) and then measured (fork length, to the nearest cm), weighed (grams fresh weight) and scales taken for age determination (Ombredane & Baglinière, 1991). After recovering from anaesthesia, fish were released in the vicinity of the place where they were caught. Population density was estimated according to Moran-Zippin's method (Youngs & Robson, 1978). Biomass estimates were obtained using Mohand linear relationship (Lobon-Cervia, 1991). Age was determined by scale reading, using the criteria refereed by Ombredane & Baglinière (1991). The length-growth model was expressed by Von Bertalanffy growth curve (Bagenal & Tesch, 1978). The length-weight relationship and the Fulton's condition factor were also calculated (Bagenal & Tesch, 1978).

RESULTS AND DISCUSSION

Diversity and spatial distribution of fish species

Fish species present in the studied tributaries were brown trout (*Salmo trutta*), Iberian chub (*Leuciscus carolitertii*), Iberian roach (*Rutilus arcasii*), Iberian nase (*Chondrostoma polylepis*), Iberian barbel (*Barbus bocagei*), eel (*Anguilla anguilla*), three-spined stickleback (*Gasterosteus aculeatus*) and sea lamprey (*Petromyzon marinus*). All species were found at site E2 (River Estorãos). Trout smolts were caught at only this site, too.

Higher fish diversity was always observed at downstream sites. Brown trout population densities decreased downstream and cyprinids became the dominant fraction of the fish community, similarly to other European mountain Rivers (Lobon-Cèrvia *et al*, 1985; Baglinière & Maisse, 1990; Rodrigues, 1995; Formigo, 1997).

Brown trout was the only species present at all sampling sites (Table 1), representing more than 50 % of the total catch at upstream sites. These results agree with previous work in the Lima basin (Valente, 1990, 1993; Gonçalves, 1996), suggesting that trout is widespread in the basin of River Lima.

Tabla 1. Mean densities (ind/100 m²) of fish species present (brown trout, eel, Iberian chub, Iberian roach, Iberian nase, Iberian barbel, three-spined stickleback and sea lamprey) at selected stretches of six tributaries of River Lima (i.e. Vade, Estorãos, Trovela, Labruja, Tamente and Froufe), caught between September 1995 and 1997. * present but not quantified due to the reduced number of fish caught. *Densidades medias (ind/100 m²) de las especies presentes en las estaciones de muestreo de los afluentes del río Lima, durante el periodo de estudio. *especie presente pero imposible de cuantificar debido al bajo número de peces capturados.*

	Brown trout	Eel	Iberian chub	Iberian roach	Iberian nase	Iberian Barbel	Three-spined stickleback	Sea lamprey
Vade 1	12.58	5.13		*	*			
Vade 2	18.49	4.54	0.36		1.19			
Vade 3	13.57	3.38	0.56	0.22	1.69	0.22		
Vade 4	21.19			137.67				
Estorãos 1	22.28	1.56	17.77					
Estorãos 2	3.37	24.78	15.78	8.15	1.27	1.26	5.00	0.98
Trovela	18.70	5.28	1.50	29.89	2.96		0.29	
Labruja	27.94	2.92	3.58	7.58	3.57	4.12		
Tamente	18.51	13.36	4.32		3.62			
Froufe	7.19	10.11	12.92		16.28	1.51		

Population estimates and biomass

The density of brown trout populations varied considerably within tributaries sampled. Lower densities were observed at site E2 and in the River Froufe, which are located downstream and are sites with a relative abundance of eel and cyprinid populations (Table 1). In the other studied tributaries and upstream of River Vade, mean estimated trout densities were in excess of 20 ind/100 m². Trout occurred in higher numbers in upstream stretches of Rivers Vade and Estorãos (Table 1).

Seasonal fluctuations in density estimates were mainly related to changes in the range of juveniles (Fig. 2) and might be due to higher mortality rates typical during the first year of life (Elliot, 1994).

Except for site E2 (River Estorãos), we always observed that the 0⁺ age group showed the highest density (Fig. 2). During summer and autumn, 0⁺ was the dominant fraction of the brown trout population.

Mean biomass varied between 727.04 gFW/100 m² at site V4 and 23.04 g/100 m² at site E2. Despite the higher trout density estimated for River Labruja and for site E1 in River Estorãos, highest biomass values were observed in the River Vade (Table 2). These results are similar to those obtained for these tributaries in previous studies (Valente, 1990, 1993; Gonçalves, 1996).

Population density and biomass values fall within the range of values observed in other European Rivers (Lobon-Cervia & Penczac, 1984; Lobon-Cervia *et al.*, 1986; Crisp & Beaumont, 1995), and are slightly higher to those observed in Rivers in Northern Spain (García de Jalón, 1988) and in the north of France (Maise & Baglinière, 1991).

Age and growth

Although age structure varied within any site, 0⁺ and 1⁺ fish were the dominant age groups during summer and autumn, as a result of seasonal

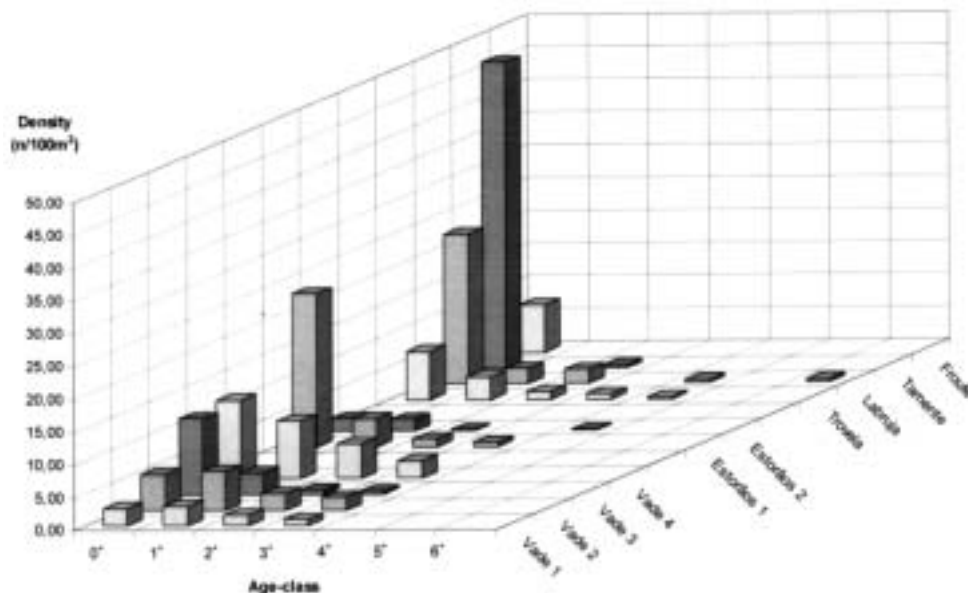


Figure 2. Mean estimated densities of brown trout populations (*Salmo trutta*) in the studied tributaries of River Lima, grouped by age-class. *Densidades medias estimadas de las poblaciones de trucha, agrupadas por clases de edad en los afluentes del río Lima.*

Tabla 2. Mean biomass values (gFW/100 m²) of fish species present (brown trout, eel, Iberian chub, Iberian roach, Iberian nase, Iberian barbel, three-spined stickleback and sea lamprey) in study sites of 6 tributaries of the River Lima, caught between September 1995 and 1997. * present but not quantified due to the reduced number of fish caught. *Biomassas medias (gFW/m²) de las especies presentes en las estaciones de muestreo de los afluentes del río Lima durante el período de estudio. * especie presente pero imposible de cuantificar debido al bajo número de peces capturados.*

	Brown trout	Eel	Iberian chub	Iberian roach	Iberian nase	Iberian Barbel	Three-spined stickleback	Sea lamprey
Vade 1	393.20	261.76		*	*			
Vade 2	661.99	193.91	20.11		56.29			
Vade 3	391.66	174.59	14.56	0.88	42.08	18.38		
Vade 4	727.04			903.11				
Estorãos 1	187.45	50.87	272.84					
Estorãos 2	23.04	165.65	110.61	37.03	56.26	47.43	2.45	10.25
Trovela	355.18	250.66	42.02	190.19	40.70		0.19	
Labruja	617.50	67.85	52.15	56.76	136.96	368.17		
Tamente	132.55	1120.65	75.10		6.71			
Froufe	41.43	560.03	108.65		368.41	57.15		

recruitment. Populations with similar age-structure have been found in other European salmonid Rivers (e.g. Lobon-Cervia *et al.*, 1986; Maise & Baglinière, 1990, 1991; Champigneulle *et al.*, 1991; Elliott, 1994).

Rivers Vade and Labruja presented the widest range in age-classes. Although some 6⁺ and 7⁺ trout were caught, 4⁺ and older individuals were scarce and their presence was detected especially in winter. In Rivers Tamente and Froufe, only

few trout which were 1⁺ and older, were found. As these sites are near the confluence with the Touvedo reservoir and have good spawning areas, these Rivers it is suggested are being used by the older trout present in the Touvedo reservoir (Valente *et al.*, 1995; Cruz, 1998).

Growth was isometric (Table 3) and only small differences were detected between sites. Our data agree with those of other authors in the same streams (Valente, 1993; Gonçalves 1996), in the River Ancora (Formigo, 1997), and in other Iberian Rivers (Lobon-Cervia & Penczac, 1984; Garcia de Jalón *et al.*, 1986; Braña *et al.*, 1992; Rodrigues, 1995; Gonçalves, 1996) and northern European Rivers (Egglisshaw & Shackley, 1977; Moreau & Abad, 1987; Crisp & Beaumont, 1995).

Fulton's condition factor (K) is generally good and shows similarity between all sites (Table 3).

Although growth was slightly higher in River Vade, back-calculation based on scale-reading showed that trout growth may have been slow in all tributaries (Table 4 and Fig. 3). These results are consistent with those obtained for unproductive waters (Lobon-Cervia *et al.*, 1986; Garcia de Jalón *et al.*, 1986; Moreau & Abad, 1987; Maise & Baglinière, 1990; Crisp & Beaumont, 1995; Rodrigues, 1995; Formigo, 1997).

Tabla 3. Length-weight relationship parameters and mean Fulton's condition factor (K) for all fishes (brown trout, eel, Iberian chub, Iberian roach, Iberian nase, Iberian barbel, three-spined stickleback and sea lamprey) present in each of the six studied tributaries of River Lima (i.e. Vade, Estorãos, Trovela, Labruja, Tamente and Froufe). *Relaciones longitud-peso para todos los afluentes del río lima estudiados, así como la media del factor de condicion de Fulton (K).*

	Log a	b	r	N	K
Vade	-4.19	2.92	0.99	1008	1.22
Estorãos	-4.29	2.93	0.99	646	1.25
Trovela	-4.31	2.94	0.99	524	1.19
Labruja	-4.43	2.99	0.99	122	1.16
Tamente	-4.44	3.00	0.99	93	1.17
Froufe	-4.39	2.95	0.99	21	1.13

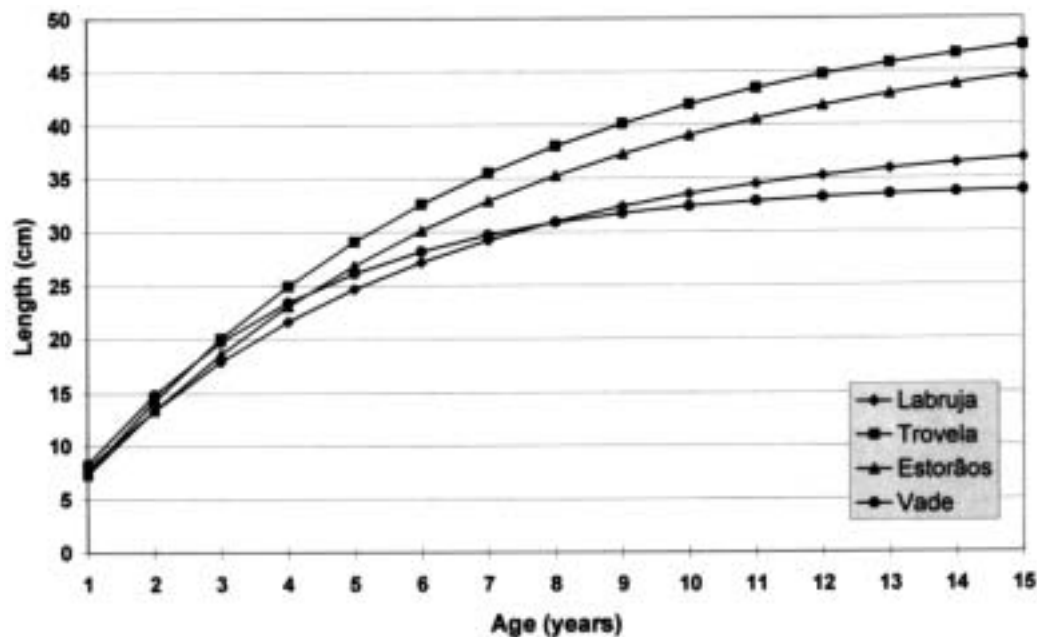


Figure 3. Von Bertalanffy growth curves for brown trout (*Salmo trutta*) populations in studied tributaries of River Lima. *Curvas de crecimiento de Von Bertalanffy para las poblaciones de truchas.*

Tabla 4. Von Bertalanffy growth equation parameters for brown trout populations (*Salmo trutta*) across sites studied. K – growth rate; L_{∞} - maximum size; t_0 - time scaler equivalent to the (hypothetical) starting time. *Parámetros de la ecuación de crecimiento de Von Bertalanffy para las poblaciones de trucha. K – tasa de crecimiento; L_{∞} - talla máxima; t_0 – medida temporal equivalente al tiempo de inicio (hipotético).*

	K	L_{∞}	t_0
Vade	0.290	34.26	0.04
Estorãos	0.157	49.28	-0.03
Trovela	0.169	51.62	0.08
Labruja	0.194	38.91	-0.17

CONCLUSIONS AND MANAGEMENT RECOMMENDATIONS

The brown trout populations in the basin of the River Lima (Northwest Portugal) provide an important recreational fishery (Valente & Alexandrino, 1990). Information is needed on the populations dynamics, growth and production

of this species for its conservation and management (Hellawell, 1976; Welcomme, 1995; Cowx & Welcomme, 1998).

Trout populations in the studied tributaries of the River Lima do not differ markedly from those in other, comparable European areas (Lobon-Cervia *et al.*, 1986; Maisse & Baglinière, 1990, 1991; Gonçalves, 1996; Formigo, 1997). Densities observed here can probably be considered normal of mountain streams.

The studied tributaries of River Lima had good spawning and nursery areas, as evidenced by the high number of 0⁺ and 1⁺ trout present in sampled stretches.

The effects angling is having on brown trout populations were not evaluated. However, preliminary data suggest angling pressure is not having a significantly negative impact on this species. Effective angling surveillance and a more precise catch declaration system are essential to allow correct evaluation of angling pressure and impacts.

Special attention should also be directed to re-stocking actions with a view to the conservation of the native brown trout populations. The effects of re-stocking have not been evaluated yet, either. Recently, genetic analyses of trout populations of the Lima basin (Antunes, 1997), and studies of the movements of the brown trout in the River Vade (Maia, 1998) have suggested that re-stocking is inefficient and that populations of brown trout in the River Vade are self-sustaining.

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