Journal of Applied Ichthyology

J. Appl. Ichthyol. 30 (2014), 1016–1027

ISSN 0175–8659

Received: February 23, 2013
Accepted: April 24, 2014
doi: 10.1111/jai.12476

Gillnet selectivity for freshwater fish species in three lentic systems of Greece

By O. Petriki[1], K. Erzini[2], D. K. Moutopoulos[3] and D. C. Bobori[1]

[1]*Laboratory of Ichthyology, Department of Zoology, School of Biology, Aristotle University of Thessaloniki, Greece;* [2]*Centro de Ciencias do Mar (CCMAR), Universidade do Algarve, Faro, Portugal;* [3]*Department of Fisheries and Aquaculture, Technological Educational Institute of Western Greece, Mesolonghi, Greece*

Summary

Gillnet size selectivity was studied for freshwater fish species, based on experimental fishing trials carried out with multi-mesh gillnets in lentic freshwater systems in Northern Greece. Selectivity estimates were based on a large range of mesh sizes, i.e. more than 10 different mesh sizes ranging from 8 to 90 mm bar length. Results showed that the model, in which both mean and standard deviation of the curve were defined as a linear function of the mesh size, revealed the best fit. For seven (i.e. *Alburnus* sp. Volvi, *Aspius aspius*, *Carassius gibelio*, *Lepomis gibbosus*, *Pachychilon macedonicum*, *Squalius prespensis* and *Vimba melanops*) of the 11 studied species and the hybrid (*Alburnus belvica* × *Rutilus prespensis*), gillnet selectivity parameters were estimated for the first time, contributing to the evaluation of gillnet fisheries' impacts on fish species populations and consequently to fisheries management and species conservation.

Introduction

Numerous methods for estimating fixed or static gear size selectivity have been developed. Indirect methods, where selectivity for different fish size classes and gear sizes are obtained simultaneously by fitting an overall response surface, are generally acknowledged to be superior (Kirkwood and Walker, 1986; Wulff, 1986; Erzini and Castro, 1998). In this context, the SELECT model (Millar, 1992; Millar and Fryer, 1999) is widely considered to be the state of the art and is recommended by the ICES. Maximum likelihood estimates of selectivity model parameters can be obtained by using a specialised software such as GILLNET (CONSTAT, 1998), which implements a generalised extension of the SELECT model, or by means of statistical packages with non-linear maximisation capability, such as SAS (SAS Institute Inc., 1988).

The SELECT model has only recently been used for the estimation of gillnet selectivity of European freshwater species (Carol and García-Berthou, 2007). In general, although gill net selectivity has been extensively studied in marine systems (e.g. Erzini et al., 2003), only a few selectivity studies have been addressed in lakes and reservoirs, concerning a limited number of species (Jensen, 1986; Pet et al., 1995; Kurkilahti and Rask, 1996; Booth and Potts, 2006; Psuty-Lipska et al., 2006; Carol and García-Berthou, 2007; Prchalová et al., 2009).

In Greece, information about gillnet selectivity in freshwaters is limited, restricted to *Alburnus belvica* and *Rutilus prespensis* (previously known as *Alburnus alburnus* and *Rutilus rubilio*, respectively; Boy and Crivelli, 1988). Moreover, to the best of our knowledge, apart from *Perca fluviatilis* (i.e. Kurkilahti and Rask, 1996; Psuty-Lipska et al., 2006) and *Rutilus rutilus* (Carol and García-Berthou, 2007) there are no previous studies (at the pan European level) of gillnet selectivity for the rest of the species and the hybrid (*A. belvica* × *R. prespensis*), studied here. In fact, comparative selectivity studies focusing on more than one species (multi-species fisheries) are still lacking for freshwater systems.

The knowledge of gillnet selectivity for European freshwater species is of increasing importance, as this type of fishing gear is recommended by CEN 2005 (European Standard EN 14 757, 2005) for the monitoring of fish populations in lakes and reservoirs, imposed by the Water Framework Directive 2000/60/EC.

The present study aims to: (i) estimate the size selectivity of several fish species caught in three lentic systems, and (ii) provide information essential to inland fisheries management. It is worth noting that this is the first attempt to estimate gillnet selectivity in multi-species Greek freshwater systems.

Materials and methods

Data

Fish samplings were conducted in three lentic, freshwater systems in Northern Greece: Doirani Lake (41°12′0″N, 22°45′0″E) and Mikri Prespa Lake (40°45′58″N, 21°6′2″E), and Kerkini Reservoir (41°12′30″N; 23°8′52″E) (Fig. 1). All systems are large sized (surface area of Lake Doirani is 28 km^2, of Lake Mikri Prespa is 53 km^2, while that of Kerkini Reservoir ranges seasonally from 45 to 72 km^2), shallow (mean depth: 3–4.1 m) and eutrophic.

Fish were sampled seasonally in Kerkini Reservoir (2007–2008), in three seasons in Lake Doirani (spring, summer and autumn, 2006), whereas Lake Mikri Prespa was sampled only once (autumn, 2008). Multimesh monofilament, uncoloured, nylon, bottom gill nets were used, with a hanging ratio of 0.5. For Kerkini Reservoir and Lake Mikri Prespa nets of 10 different mesh sizes (8/0.1, 14/0.12, 16/0.15, 20/0.15, 24/0.17, 30/0.17, 36/0.2, 45/0.2, 55/0.25, 70/0.25; knot to knot/twine

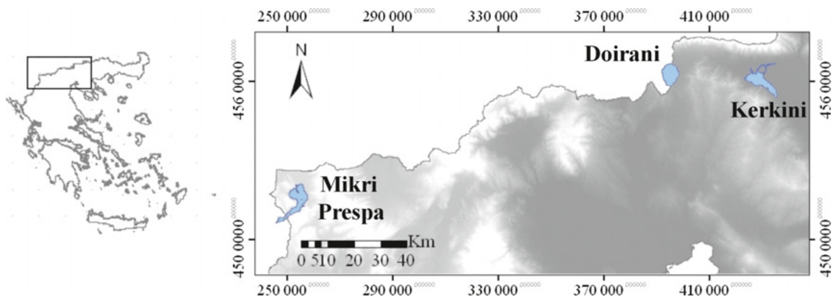

Fig. 1. Map showing the studied systems.

diameter in mm) were used, 25 m length and 3 m height, each. For fish sampling in Lake Doirani the same types of gillnets were used, differing in mesh sizes (14, 18, 22, 26, 30, 40, 45, 50, 65, 70, 75, 80, 90) and dimensions (panels of 14–30 mm were 100 m × 2 m length × height; panels of 40–90 mm were 100 m × 2.2–4 m length × height). The order of the mesh sizes was chosen randomly and a distance of 2.5 m was set between nets to avoid edge effects.

Nets were set before dusk and hauled after dawn, in order to ensure a standard soak time of 12 h, in two stations in Lake Doirani, three stations in Lake Mikri Prespa and four stations in Kerkini Reservoir, in depths ranging from 3 to 6 m. Catches were separated by mesh size and sorted to species level. All specimens were measured for total length (TL) to the nearest mm.

Data of all stations and sampling periods (in Lake Doirani and Kerkini Reservoir) were pooled in order to form large samplings. Datasets of species with small numbers of specimens caught ($n \leq 48$) or low representation in most mesh sizes due to very narrow length ranges were excluded from further analysis. Length frequency distributions (0.5 cm size classes) for all species were then estimated per mesh size. However, the results were restricted to the mesh sizes for which selectivity curves were estimated ($n > 5$). The Kolmogorov-Smirnov test (K-S) was used to compare the length frequency distributions and detect statistical differences (Siegel and Castellan, 1988).

Model descriptions

The model implemented in EXCEL for the estimation of the selectivity parameters was that proposed by Kirkwood and Walker (1986) and Wulff (1986) and is flexible in that no assumptions are required regarding the efficiency of different gillnet sizes. Thus, optimal selectivity is not necessarily the same for all mesh sizes. For instance, the height of the normal selectivity model could also be modelled as a function of gillnet size (Wulff, 1986) if fishing power is considered to vary with mesh size. Additionally, this approach, in which different models are developed, fitted by Maximum likelihood using EXCEL Solver and compared, is recommended for static gear (such as gillnets) selectivity studies. The SELECT model of Millar (1992) also has the same underlying statistical basis and can be considered a special case of the Kirkwood and Walker (1986) and Wulff (1986) model.

Maximum likelihood estimates of selectivity parameters were obtained assuming that the probability of capturing a fish of size j with a mesh size i follows a Poisson distribution and that the selectivity curves for different mesh sizes belong to the same family (e.g. normal, lognormal, or bi-normal probability distributions) (Table A1). Thus, the parameters of the selectivity curve, such as the mean of the normal curve, are a function of gear size (proportional, linear or other relationships). The following likelihood was maximised using EXCEL Solver:

$$\sum_{ij}\left[C_{ij} \times \ln(S_{ij}/\sum_{i} S_{ij})\right]$$

where C_{ij} and S_{ij} are the catches and the normal curve selectivities for size classes j and mesh sizes i:

$$S_{ij} = \exp\left(-\frac{(l_j - \mu_i)^2}{2\sigma_i^2}\right)$$

Five different models (normal selectivity model) were fitted to each dataset:

1. Model 1: $\mu_i = b1 \times m_i$ (i.e. mean proportional to mesh size) and $\sigma_i = b3$ (i.e. standard deviation constant),
2. Model 2: $\mu_i = b1 \times m_i + b2$ (i.e. mean a linear function of mesh size) and $\sigma_i = b3$ (i.e. standard deviation constant),
3. Model 3: $\mu_i = b1 \times m_i$; $\sigma_i = b3 \times m_i$ (i.e. both the mean and standard deviation proportional to mesh size),
4. Model 4: $\mu_i = b1 \times m_i + b2$ (i.e. mean a linear function of mesh size) and $\sigma_i = b3 \times m_i$ (i.e. standard deviation proportional to mesh size), and
5. Model 5: $\mu_i = b1 \times m_i + b2$ and $\sigma_i = b3 \times m_i + b4$ (i.e. both the mean and the standard deviation are linear functions of mesh size).

Each model was fitted and the parameter estimates and maximum likelihoods were recorded. The model fits were ranked based on the maximum likelihood and the best model was used to generate selectivity curves.

Results

Catch composition

A total of 26 species (including one hybrid) were recorded in all catches (Table 1). More specifically, nine species were recorded in Lake Doirani, 11 species (including one hybrid) in Lake Mikri Prespa and 14 species in Kerkini Reservoir. In all cases, catches were dominated (in terms of numbers) by two to three species (Table 1). A total of 34 datasets was formed for each species/lake combination, 16 of which (including 11 species and one hybrid) were used to estimate the selectivity curves. However, 18 of the 34 datasets were not included in further analysis due to the small total number of specimens caught or insufficient number of specimens in more than two mesh sizes (Table 1).

Length-frequency distributions

Length-frequency distributions of the studied species for each lake are shown in Fig. 2. In Lake Doirani for three of the four studied species (i.e. *Pachychilon macedonicum*, *P. fluviatilis* and *R. rutilus*) most individuals (>66% of the total catches) were caught in mesh sizes ≤18 mm (Table A2), with the exception of *Carassius gibelio,* for which most individuals (70%) were caught in mesh sizes ranging between 18 and 26 mm (Table A2). In Lake Mikri Prespa for three of the five studied species (i.e. *A. belvica*, *Lepomis gibbosus* and the hybrid) most individuals (>82% of the total catches) were caught in mesh sizes 14 and 16 mm (Table A3), with the exceptions of *R. prespensis,* for which most individuals (87%) were caught in mesh sizes ranging between 14 and 20 mm, and *Squalius prespensis* for which most individuals (82%) were caught in mesh sizes ranging between 20 and 24 mm (Table A3). In Kerkini Reservoir for four of the seven studied species (i.e. *Alburnus* sp. Volvi, *Aspius aspius*, *L. gibbosus* and *R. rutilus*) most individuals (>76%) were caught in mesh sizes ≤16 mm (Table A4), with the exceptions of *P. fluviatilis* and *Vimba melanops,* for which most individuals (>75%) were caught in mesh sizes ranging from 14 to 20 mm, and *C. gibelio* (85%) mainly caught in mesh sizes ranging from 16 to 24 mm (Table A4).

The mean TL of the captured specimens of all species gradually increased with the increase in mesh sizes (Tables A2, A3 and A4). Mesh size paired comparisons of the length frequency distributions per species/lake combinations showed that most of the distributions (76.15%; 99 of the 130 combinations) were significantly different (K-S, $P < 0.05$). In contrast, the K-S test revealed no significant differences (K-S, $P > 0.05$) in 31 cases (Table A5).

The between-comparisons in Doirani and Kerkini of the length frequency distributions for *R. rutilus* caught by 14 mm, *C. gibelio* caught by 30 mm and *P. fluviatilis* caught by 14 and 30 mm, lead to significant differences (K-S test, $P < 0.05$). In addition, comparisons of the length frequency distributions of *L. gibbosus* in Mikri Prespa and Kerkini revealed significant differences (K-S test, $P < 0.05$) only for mesh sizes of 8 and 20 mm.

Table 1
Relative numerical abundances (%) of species caught in lakes Doirani and Mikri Prespa and Kerkini Reservoir with multimesh gill nets. Scientific names are according to Kottelat and Freyhof (2007)

Species	Doirani	Mikri Prespa	Kerkini
Alburnoides prespensis		0.16[a]	
Alburnus belvica		39.65	
Alburnus macedonicus	45.40[b]		
Alburnus sp. Volvi			30.35
Aspius aspius			0.40
Barbus strumicae			0.002[a]
Carassius gibelio	2.37	1.68[a]	8.21
Chondrostoma prespense		0.96[a]	
Chondrostoma vardarense			0.04[a]
Cobitis strumicae			0.002[a]
Cyprinus carpio	0.16[a]	1.92[a]	0.07[a]
Hybrid (*Alburnus belvica* × *Rutilus prespensis*)		3.36	
Lepomis gibbosus		25.55	1.39
Pachychilon macedonicum	5.38		
Perca fluviatilis	26.05		4.06
Pseudorasbora parva		2.96[b]	1.41[b]
Rhodeus amarus			1.03[b]
Rhodeus meridionalis	15.56[b]		
Rutilus prespensis		20.34	
Rutilus rutilus	4.74		52.10
Scardinius erythrophthalmus	0.25[a]		
Squalius orpheus			0.02[a]
Squalius prespensis		3.36	
Squalius vardarensis	0.10[a]		
Tinca tinca		0.04[a]	
Vimba melanops			0.91

[a]Insufficient number of specimens caught.
[b]Small representation in more than two mesh sizes.

Selectivity curves

Selectivity curves were estimated for mesh sizes: (i) equal to or smaller than 26 mm in eight species/lake cases, (ii) up to 30 mm for six species/lake cases and (iii) up to 36 and 40 mm for *C. gibelio* in Lake Doirani and in Kerkini Reservoir.

The estimated parameters, maximum likelihoods, modal lengths and standard deviations of the curves of the fitted models are shown in Tables 2–4. Model 5 showed the best fit for 14 out of 16 cases. The parameters (i.e. mean and standard deviation) of the selectivity curves estimated by model 5 were linear functions of the mesh size. For *A. belvica* (Table 3) model 2 also gave as equally good a fit as model 5. However, the selectivity curves for the species were estimated by model 5 since it gave the best fit in most cases. For *P. macedonicum* (Table 2) and *R. rutilus* in Kerkini Reservoir (Table 4) models 3 and 4 gave the best fits, respectively. For *P. macedonicum* models 4 and 5 gave unreasonable values for means and standard deviations. In addition, model 4 did not show reasonable fits for either *C. gibelio* or *L. gibbosus* or model 5 for *R. rutilus* in Kerkini Reservoir. The selectivity curves estimated by the best fitted models are presented in Fig. 3. Mean modal lengths estimated by the best fitted models fell within the observed length range in 64 of 71 cases (90.14%) while they were larger in seven of 71 cases (9.86%) (Tables 2–4 and A2–A4).

Discussion

In Greece, gill nets are among the most common fishing gear used in lakes and reservoirs. In this study we estimated the

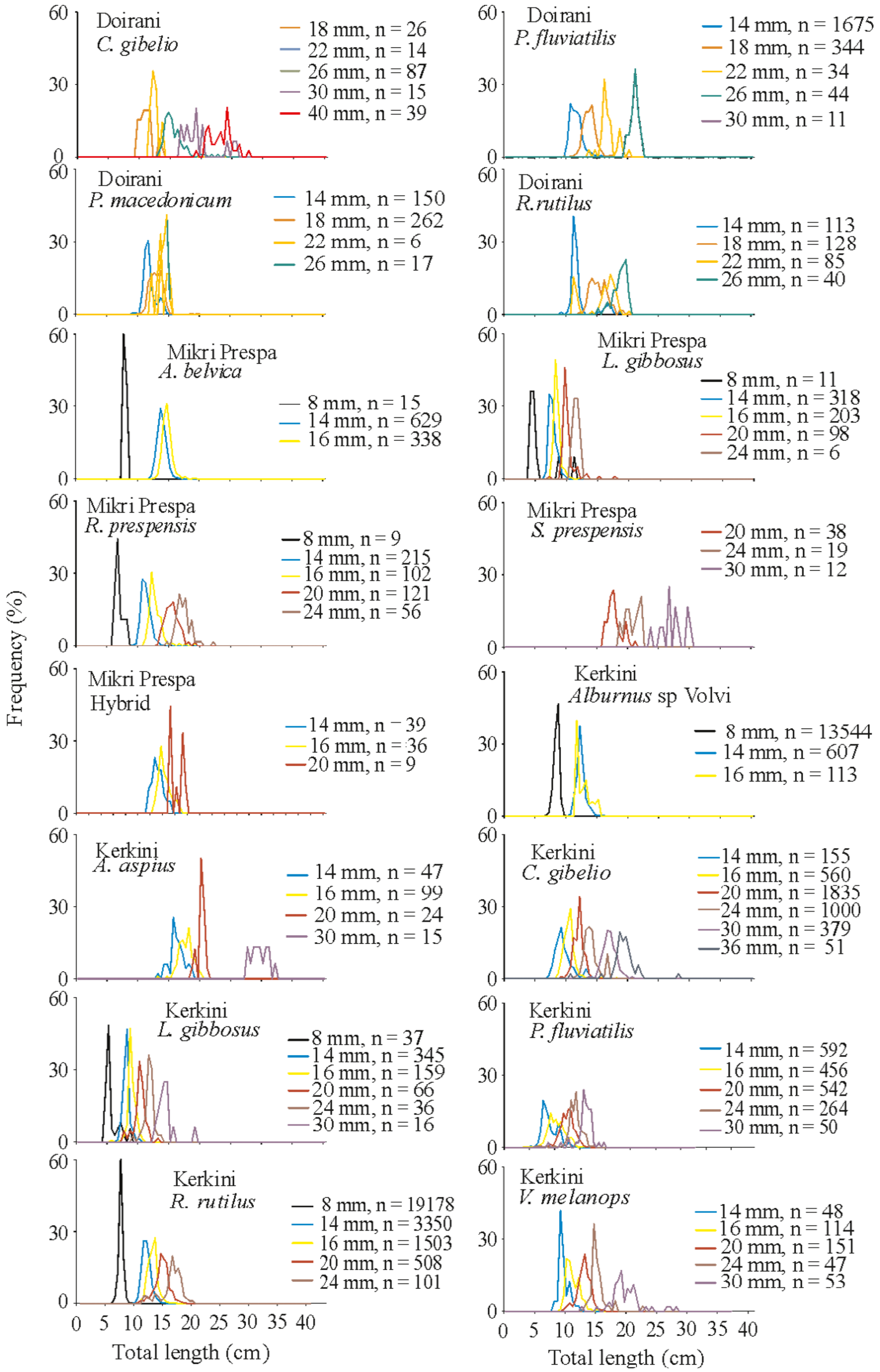

Fig. 2. Length frequency distributions for species caught by multi-mesh gill nets in lakes Doirani, Mikri Prespa and the Kerkini Reservoir.

Table 2
Selectivity model parameters defining mean and standard deviation (SD) of normal selectivity curves, maximum likelihoods (ML), modal lengths (M_p) and spread (SD_p) per mesh size, for gill net captured species in Lake Doirani. m = mesh size; b1, b2, b3 and b4 = estimated model (M) parameters

		Mean = b1 × m + b2		SD = b3 × m + b4			Mesh size (mm)											
							14		18		22		26		30		40	
Species	Model	b1	b2	b3	b4	ML	M_p	SD_p	M_p	SD_p	M_p	SD_p	M_p	SD_p	M_p	SD_p	M_p	SD_p
C. gibelio	1	5.856			1.570	−111.96			10.5	1.57	12.9	1.57	15.2	1.57	17.6	1.57	23.4	1.57
	2	8.203	−5.750		1.825	−104.07			9.0	1.83	12.3	1.83	15.6	1.83	18.9	1.83	27.1	1.83
	3	5.935		0.667		−112.46			10.7	1.20	13.1	1.47	15.4	1.73	17.8	2.00	23.7	2.67
	4	7.688	−4.162	0.730		−106.69			9.7	1.31	12.8	1.61	15.8	1.90	18.9	2.19	26.6	2.92
	5	7.090	−3.320	−0.315	1.915	−65.67			9.4	1.35	12.3	1.22	15.1	1.10	17.9	0.97	25.0	0.65
P. macedonicum	1	7.367			1.855	−365.95	10.3	1.85	13.3	1.85	16.2	1.85	19.2	1.85				
	2	7.518	−0.260		1.886	−365.93	10.3	1.89	13.3	1.89	16.3	1.89	19.3	1.89				
	3	7.614		0.954		−356.65	10.7	1.34	13.7	1.72	16.8	2.10	19.8	2.48				
	4																	
	5																	
P. fluviatilis	1	8.466			1.817	−865.14	11.9	1.82	15.2	1.82	18.6	1.82	22.0	1.82	25.4	1.82		
	2	6.261	3.820		1.591	−838.40	12.6	1.59	15.1	1.59	17.6	1.59	20.1	1.59	22.6	1.59		
	3	8.776		1.081		−919.81	12.3	1.51	15.8	1.95	19.3	2.38	22.8	2.81	26.3	3.24		
	4	9.885	−1.818	1.161		−916.01	12.0	1.63	16.0	2.09	19.9	2.55	23.9	3.02	27.8	3.48		
	5	4.015	7.417	−0.703	2.561	−766.40	13.0	1.58	14.6	1.30	16.2	1.01	17.9	0.73	19.5	0.45		
R. rutilus	1	7.969			2.677	−378.98	11.2	2.68	14.3	2.68	17.5	2.68	20.7	2.68				
	2	7.385	1.148		2.564	−378.58	11.5	2.56	14.4	2.56	17.4	2.56	20.3	2.56				
	3	8.428		1.440		−380.99	11.8	2.02	15.2	2.59	18.5	3.17	21.9	3.74				
	4	8.385	0.080	1.435		−380.99	11.8	2.01	15.2	2.58	18.5	3.16	21.9	3.73				
	5	7.653	0.927	0.530	1.572	−377.43	11.6	2.31	14.7	2.53	17.8	2.74	20.8	2.95				

size selectivity of freshwater fish species from three Greek lentic systems. For seven of the 11 studied species (i.e. *Alburnus* sp. Volvi, *Aspius aspius*, *C. gibelio*, *L. gibbosus*, *P. macedonicum*, *S. prespensis* and *V. melanops*) and one hybrid (*A. belvica* × *R. prespensis*) the gillnet selectivity parameters were estimated for the first time.

Selectivity estimates were based on a large range of mesh sizes, i.e. more than 10 different mesh sizes ranging from 8 to 90 mm bar length, providing the basis of a comprehensive size selectivity analysis of catch data for different static gear sizes.

Although a wide range of mesh sizes was used, the number of fish caught by the larger mesh sizes (>30 mm) was small (n < 5), preventing the estimation of size selectivity for these datasets. The small catches obtained with mesh sizes >30 mm, were indicative of the small size structure of the fish populations in the studied lakes. As mentioned above, the length distributions acquired by multimesh gillnets reflect the most abundant size groups in the study systems. However, some demographic structures may be underestimated (mainly age 0+ specimens) or overestimated (Mehner and Schulz, 2002; Prchalová et al., 2009). Therefore, while assessing the fish population structure, either a combination of fishing gear (Sutela et al., 2008; Erős et al., 2009) or any available selectivity corrections (Prchalová et al., 2009) should preferably be used.

Fish are caught by gill nets through more than one mechanisms (i.e. gilling, wedging and/or tangling) (Hamley, 1975). The combinations of capture mechanisms are reflected in the shapes of the size distributions. The vast majority of the captured fish during this study were mainly caught by gilling and wedging and to a lesser extent by tangling, thus explaining the differences observed in the length frequency distributions (Fig. 2) between mesh sizes. However, in 31 cases no such differences were observed since length distributions were highly overlapping (Fig. 2; Table A5). For 14 and 16 mm mesh sizes (nine cases, Table A5) the overlap was expected due to the small gap (2 mm) between the dimensions of the two mesh sizes. For gaps up to 4 mm (14 cases) and up to 6 mm (eight cases) (Table A5), the observed overlap could be attributed to the high proportions of specimens caught by gilling (larger specimens) and wedging (smaller specimens that penetrate deeper into the net). Moreover, for *C. gibelio*, *L. gibbosus* and *P. fluviatilis*, the observed overlap in length distributions between mesh sizes with a gap of up to 6 mm, could be attributed to entangling effects (triggered by the hard projections in their bodies).

For seven in 71 cases the mean modal lengths were larger than the observed length range (Tables 2–4 and A2–A4); those cases concerned datasets with small size samples (n = 6–40 specimens, with the exception of *Alburnus* sp. Volvi caught by mesh size 16 mm in Kerkini Reservoir: n = 1402 specimens), thus the extracted curves should be considered with caution.

The modal lengths estimated for *P. fluviatilis* for mesh sizes of 24, 26 and 30 mm (Tables 2 and 4) were similar to those estimated by previous gillnet selectivity studies (i.e. Kurkilahti and Rask, 1996; Psuty-Lipska et al., 2006). The modal lengths for the species *R. prespensis* and *A. belvica*,

Table 3
Selectivity model parameters defining mean and standard deviation (SD) of normal selectivity curves, maximum likelihoods (ML), modal lengths (M_p) and spread (SD_p) per mesh size, for gill net captured species, Lake Mikri Prespa. m = mesh size; b1, b2, b3 and b4 = estimated model (M) parameters

		Mean = b1 × m + b2		SD = b3 × m + b4			M_p	SD_p	M_p	SD_p	M_p	SD_p	M_p	SD_p	M_p	SD_p	M_p	SD_p
							Mesh size (mm)											
Species	Model	b1	b2	b3	b4	ML	8		14		16		20		24		30	
A. belvica	1	9.555			1.114	−510.53	7.6	1.11	13.4	1.11	15.3	1.11						
	2	8.225	2.003		1.017	−508.60	8.6	1.02	13.5	1.02	15.2	1.02						
	3	9.623		0.714		−512.44	7.7	0.57	13.5	1.00	15.4	1.14						
	4	10.275	−0.979	0.743		−512.19	7.2	0.59	13.4	1.04	15.5	1.19						
	5	8.207	2.026	−0.020	1.045	−508.60	8.6	1.03	13.5	1.02	15.2	1.01						
Hybrid	1	8.831			1.336	−55.37			12.4	1.34	14.1	1.34	17.7	1.34				
	2	7.654	1.938		1.222	−54.95			12.7	1.22	14.2	1.22	17.2	1.22				
	3	8.980		0.804		−54.75			12.6	1.13	14.4	1.29	18.0	1.61				
	4	8.670	0.497	0.786		−54.73			12.6	1.10	14.4	1.26	17.8	1.57				
	5	8.325	0.981	0.508	0.430	−54.64			12.6	1.14	14.3	1.24	17.6	1.45				
L. gibbosus	1	5.486			0.910	−429.30	4.4	0.91	7.7	0.91	8.8	0.91	11.0	0.91	13.2	0.91		
	2	4.334	1.869		0.737	−414.13	5.3	0.74	7.9	0.74	8.8	0.74	10.5	0.74	12.3	0.74		
	3	5.759		0.759		−516.80	4.6	0.61	8.1	1.06	9.2	1.21	11.5	1.52	13.8	1.82		
	4	4.307	2.251	0.597		−504.32	5.7	0.48	8.3	0.84	9.1	0.95	10.9	1.19	12.6	1.43		
	5	4.319	1.759	−0.299	1.153	−401.55	5.2	0.91	7.8	0.73	8.7	0.68	10.4	0.56	12.1	0.44		
R. prespensis	1	7.702			1.337	−326.30	6.2	1.34	10.8	1.34	12.3	1.34	15.4	1.34	18.5	1.34		
	2	6.250	2.710		1.160	−311.02	7.7	1.16	11.5	1.16	12.7	1.16	15.2	1.16	17.7	1.16		
	3	7.904		0.753		−321.70	6.3	0.60	11.1	1.05	12.6	1.20	15.8	1.51	19.0	1.81		
	4	6.946	1.672	0.693		−316.15	7.2	0.55	11.4	0.97	12.8	1.11	15.6	1.39	18.3	1.66		
	5	6.405	2.474	0.151	0.900	−310.56	7.6	1.02	11.4	1.11	12.7	1.14	15.3	1.20	17.8	1.26		
S. prespensis	1	8.747			1.448	−17.54							17.5	1.45	21.0	1.45	26.2	1.45
	2	7.237	3.457		1.275	−16.83							17.9	1.28	20.8	1.28	25.2	1.28
	3	8.875		0.637		−17.92							17.8	1.27	21.3	1.53	26.6	1.91
	4	7.912	2.169	0.591		−17.72							18.0	1.18	21.2	1.42	25.9	1.77
	5	6.507	4.823	−0.688	2.752	−16.07							17.8	1.38	20.4	1.10	24.3	0.69

Table 4
Selectivity model parameters defining mean and standard deviation (SD) of normal selectivity curves, maximum likelihoods (ML), modal lengths (M_p) and spread (SD_p) per mesh size, for gill net captured species, Kerkini Reservoir. m = mesh size; b1, b2, b3 and b4 = estimated model (M) parameters

		Mean = b1 × m + b2		SD = b3 × m + b4			M_p	SD_p	M_p	SD_p	M_p	SD_p	M_p	SD_p	M_p	SD_p	M_p	SD_p	M_p	SD_p
							Mesh size (mm)													
Species	Model	b1	b2	b3	b4	ML	8		14		16		20		24		30		36	
A. sp Volvi	1	9.189			1.147	−216.22	7.5	1.21	13.1	1.21	14.9	1.21								
	2	8.850	0.436		1.116	−215.65	8.0	1.11	12.9	1.11	14.5	1.11								
	3	9.716		0.877		−200.40	8.0	0.79	14.0	1.39	16.0	1.58								
	4	8.780	1.104	0.791		−198.42	8.5	0.67	13.6	1.18	15.2	1.35								
	5	8.600	1.463	0.939	−0.246	−197.88	8.8	0.43	13.8	1.13	15.5	1.36								
A. aspius	1	10.596			1.261	−87.83			14.8	1.26	17.0	1.26	21.2	1.26			31.8	1.26		
	2	10.621	−0.043		1.263	−87.83			14.8	1.26	17.0	1.26	21.2	1.26			31.8	1.26		
	3	10.745		0.791		−90.45			15.0	1.11	17.2	1.27	21.5	1.58			32.2	2.37		
	4	11.039	−0.487	0.806		−90.36			15.0	1.13	17.2	1.29	21.6	1.61			32.6	2.42		
	5	10.414	0.251	−0.150	1.488	−87.72			14.8	1.28	16.9	1.25	21.1	1.19			31.5	1.04		
C. gibelio	1	5.669			1.075	−1843.41			8.3	1.13	9.5	1.13	11.8	1.13	14.2	1.13	17.7	1.13	21.3	1.13
	2	5.939	−0.542		1.115	−1839.92			8.1	1.19	9.3	1.19	11.7	1.19	14.1	1.19	17.8	1.19	21.4	1.19
	3	5.793		0.622		−2022.73			8.4	0.81	9.6	0.92	12.0	1.16	14.4	1.39	18.0	1.73	21.6	2.08
	4																			
	5	5.880	−0.695	−0.593	2.215	−1781.13			8.1	1.08	9.3	1.11	11.8	1.18	14.2	1.24	17.9	1.34	21.6	1.45
L. gibbosus	1	5.354			0.927	−352.59	4.5	1.03	7.9	1.03	9.0	1.03	11.3	1.03	13.5	1.03	16.9	1.03		
	2	4.564	1.219		0.797	−344.33	5.6	0.74	8.0	0.74	8.8	0.74	10.5	0.74	12.1	0.74	14.5	0.74		
	3	5.731		0.765		−401.26	4.7	0.62	8.2	1.08	9.4	1.24	11.8	1.54	14.1	1.85	17.6	2.32		
	4																			
	5	4.506	1.352	0.086	0.662	−343.53	5.7	0.60	8.1	0.70	8.9	0.73	10.6	0.79	12.2	0.86	14.6	0.96		
P. fluviatilis	1	7.290			2.016	−1682.00			10.9	2.14	12.4	2.14	15.5	2.14	18.6	2.14	23.3	2.14		
	2	6.489	1.515		1.888	−1678.02			11.9	1.70	13.1	1.70	15.5	1.70	17.8	1.70	21.4	1.70		
	3	7.612		1.126		−1688.82			11.5	1.58	13.1	1.80	16.4	2.25	19.7	2.70	24.6	3.38		
	4	7.501	0.199	1.116		−1688.75			12.2	1.30	13.5	1.49	16.1	1.86	18.7	2.23	22.6	2.79		
	5	6.723	1.235	0.320	1.328	−1675.46			12.1	1.53	13.3	1.60	15.7	1.73	18.1	1.87	21.7	2.07		
R. rutilus	1	6.617			1.013	−5783.08	5.3	1.01	9.3	1.01	10.6	1.01	13.2	1.01	15.9	1.01				
	2	6.345	2.620		1.036	−3740.61	7.7	1.04	11.5	1.04	12.8	1.04	15.3	1.04	17.8	1.04				
	3	8.265		0.769		−3669.97	6.6	0.62	11.6	1.08	13.2	1.23	16.5	1.54	19.8	1.85				
	4	5.959	3.512	0.590		−3386.01	8.3	0.47	11.9	0.83	13.0	0.94	15.4	1.18	17.8	1.42				
	5																			
V. melanops	1	8.024			1.403	−249.12			11.2	1.40	12.8	1.40	16.0	1.40	19.3	1.40	24.1	1.40		
	2	7.371	1.251		1.294	−247.38			10.3	1.29	11.8	1.29	14.7	1.29	17.7	1.29	28.0	1.29		
	3	8.247		0.773		−252.85			11.5	1.08	13.2	1.24	16.5	1.55	19.8	1.86	24.7	2.32		
	4	7.732	0.927	0.728		−251.92			11.8	1.02	13.3	1.17	16.4	1.46	19.5	1.75	24.1	2.19		
	5	7.341	1.265	−0.088	1.455	−247.32			11.5	1.33	13.0	1.31	15.9	1.28	18.9	1.24	23.3	1.19		

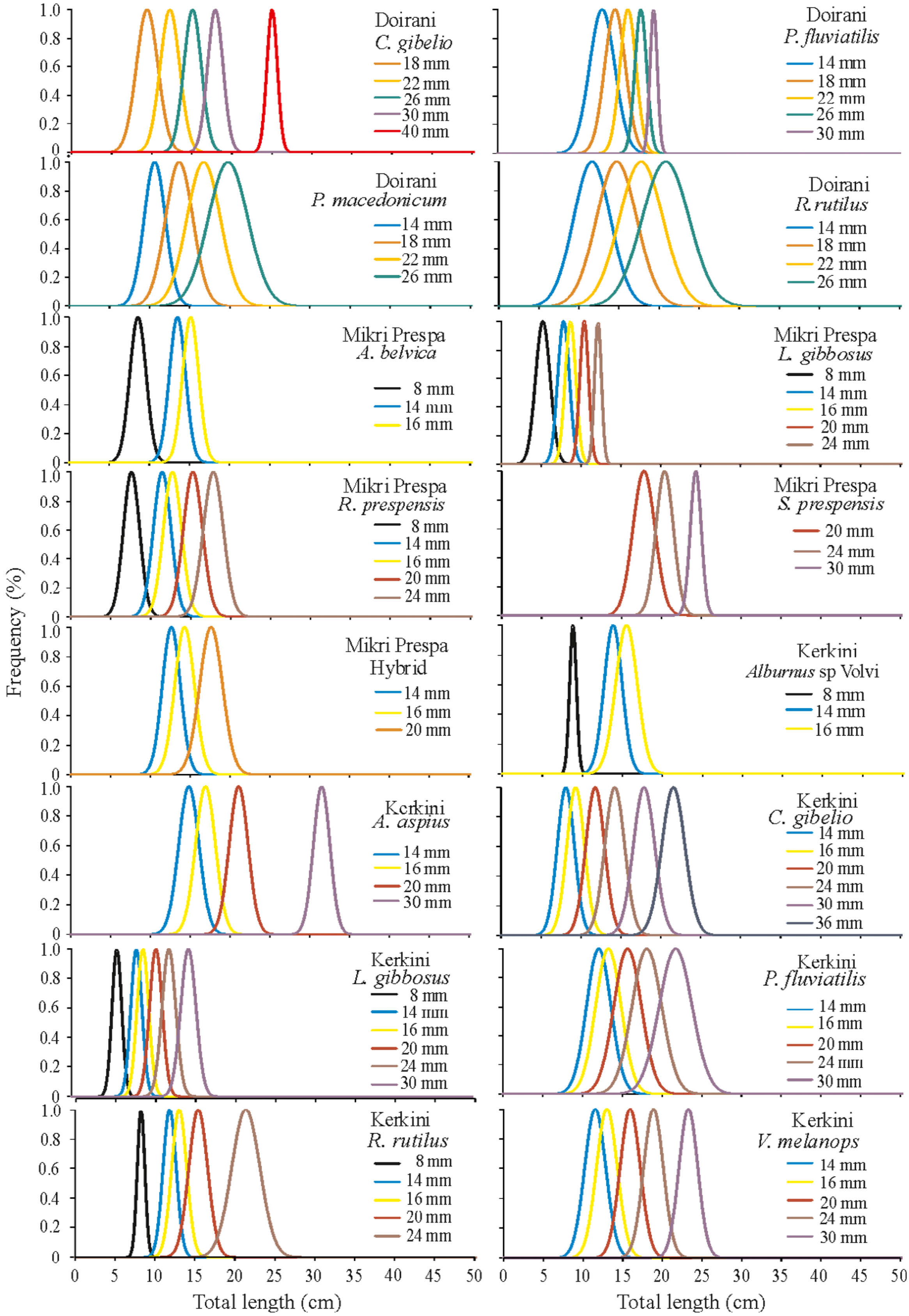

Fig. 3. Selectivity curves for species caught by multi-mesh gill nets in lakes Doirani and Mikri Prespa and the Kerkini Reservoir.

for mesh size 14 mm (Table 3), were slightly larger (≈1 cm) than those estimated by Boy and Crivelli (1988). As the estimates provided by the previous authors refer to fork length, the TL–FL relationships of both species (*A. belvica*, n = 989: FL = 0.996 × TL−0.0335, $r^2 = 0.98$ and *R. prespensis*, n = 508: FL = 0.9964 × TL−0.0307, $r^2 = 0.993$) (D. C. Bobori, unpubl. data) were used for the sake of coherence. Furthermore, the modal lengths estimated for *R. rutilus* for mesh sizes 14, 18 and 26 mm in Lake Doirani (Table 2) and for mesh sizes 14, 20 and 24 mm in Kerkini Reservoir (Table 4), were in accordance to those estimated by similar mesh sizes for Spanish reservoirs (Carol and García-Berthou, 2007), considering that the bar length used in the present study equals half of the stretched length (Hubert et al., 2012) as used by Carol and García-Berthou (2007). Therefore, the best fitted models were adequate for describing the size selectivity of the studied species.

In Greece, gillnet mesh sizes larger than 20 mm can be legally used in inland waters by professional fishermen, except in fisheries targeting: (i) *Cyprinus carpio*, for which the minimum legal mesh size is 55 mm; and (ii) *Alburnus* sp. and *Atherina boyeri*, for which mesh sizes of 15 and 8 mm respectively, can be used. However, our study revealed that the modal lengths estimated for *P. fluviatilis* (mesh sizes 22 and 26 mm in Lake Doirani and mesh size 20 mm in Kerkini Reservoir) and for *C. gibelio* (mesh size 22 mm in Lake Doirani and mesh sizes 20 and 24 mm in Kerkini Reservoir) were all smaller than the minimum landing sizes stipulated by the National Law (18 and 15 cm total length, respectively) and for the length at first maturity for *P. fluviatilis* (16.8 cm) (Froese and Pauly, 2014).

Perca fluviatilis is a native species of commercial importance and among one of the most abundant piscivorous species in Greek lentic systems (Economidis et al., 2000). However, there is a lack of information concerning the fish population status for the establishment of monitoring and management measures with regard to sustainable exploitation of the species. In this framework, a proposed prohibition for the use of mesh sizes smaller than 26 mm for commercial fisheries targeting *P. fluviatilis* should be brought under discussion in order to minimize the impact of overexploitation of specific perch populations.

On the other hand, *C. gibelio* has been introduced in many Greek lentic systems, including the three systems examined here (Economidis et al., 2000), where it has managed to become successfully established due to its environmental tolerance and reproductive traits and to develop large populations in most lakes (Leonardos et al., 2008; Perdikaris et al., 2012). Thus, mass removal of this species has already been proposed (Perdikaris et al., 2012) for management purposes due to its wide impact on the local fish fauna (i.e. omnivorous feeding preferences; Bobori et al., 2013). In recent years, the species catches with gill nets of mesh size >60 mm has been increased due to the market interest for exporting to neighbouring countries. This has probably functioned as an 'involuntary' biomanipulation measure, attributing to the control of the species population (Perdikaris et al., 2012).

The development of methodologies for the determination of optimal gillnet mesh size in multi-species fisheries, similar to the one presented herein, is particularly important. Unlike gear types with logistic type selectivity (e.g. trawls) where methods have been developed for determination of optimal mesh size in multi-species fisheries (e.g. Sinoda et al., 1979; Sainsbury, 1984; Pauly, 1988; Silvestre and Soriano, 1988; Pauly et al., 1989), there is no well-established approach for gillnets or other gear with uni-modal size selectivity. In this context, more information concerning the establishment of specific regulations on the use of gillnet mesh sizes in Greek inland fisheries is required and more studies are needed based on commercial and/or experimental data in accordance with commercial fishing practices.

References

Bobori, D. C.; Salvarina, I.; Michaloudi, E., 2013: Fish dietary patterns in the eutrophic Lake Volvi (East Mediterranean). J. Biol. Res. **19**, 139–149.

Booth, A. J.; Potts, W. M., 2006: Estimating gill-net selectivity for *Labeo umbratus* (Pisces: Cyprinidae), and an evaluation of using fyke-nets as a non-destructive sampling gear in small reservoirs. Fish. Res. **79**, 202–209.

Boy, V.; Crivelli, A. J., 1988: Simultaneous determination of gillnet selectivity and population age-class distribution for two cyprinids. Fish. Res. **6**, 337–345.

Carol, J.; García-Berthou, E., 2007: Gillnet selectivity and its relationship with body shape for eight freshwater fish species. J. Appl. Ichthyol. **23**, 654–660.

CONSTAT, 1998: GILLNET software. Denmark.

Economidis, P. S.; Dimitriou, E.; Pagoni, R.; Michaloudi, E.; Natsis, L., 2000: Introduced and translocated fish species in the inland waters of Greece. Fish. Manag. Ecol. **7**, 239–250.

Erős, T.; Specziár, A.; Bíró, P., 2009: Assessing fish assemblages in reed habitats of a large shallow lake-A comparison between gill-netting and electric fishing. Fish. Res. **96**, 70–76.

Erzini, K.; Castro, M., 1998: An alternative methodology for fitting selectivity curves to pre-defined distributions. Fish. Res. **34**, 307–313.

Erzini, K.; Gonçalves, J. M. S.; Bentes, L.; Lino, P. G.; Ribeiro, J.; Stergiou, K. I., 2003: Quantifying the roles of competing static gears: comparative selectivity of longlines and monofilament gill nets in a multi-species fishery of the Algarve (southern Portugal). Sci. Mar. **67**, 341–352.

European Standard EN 14 757, 2005: Water Quality—Sampling of Fish with Multimesh Gill nets, CEN TC 230, March 2005.

Froese, R.; Pauly, D., 2014: Fishbase. www.fishbase.org (accessed on 19 March 2014).

Hamley, J. M., 1975: Review of gill net selectivity. J. Fish. Res. Board Can. **32**, 1943–1969.

Hubert, W. A.; Pope, K. L.; Dettmers, J. M., 2012: Passive capture techniques. In: Fisheries techniques, 3rd edn. A. V. Zale, D. L. Parrish and T. M. Sutton (Eds). American Fisheries Society, Bethesda, pp. 223–265.

Jensen, J. W., 1986: Gillnet selectivity and the efficiency of alternative combinations of mesh sizes for some freshwater fish. J. Fish Biol. **28**, 637–646.

Kirkwood, G. P.; Walker, T. I., 1986: Gill net selectivities for gummy shark, *Mustelus antarcticus* Günther, taken in south-eastern Australian waters. Austr. J. Mar. Freshw. Res. **37**, 689–697.

Kottelat, M.; Freyhof, J., 2007: Handbook of European freshwater fishes. Kottelat, Cornol and Freyhof, Berlin, 646 pp.

Kurkilahti, M.; Rask, M., 1996: A comparative study of the usefulness and catchability of multimesh gill nets and gill net series in sampling of perch (*Perca fluviatilis* L.) and roach (*Rutilus rutilus* L.). Fish. Res. **27**, 243–260.

Leonardos, I. D.; Kagalou, I.; Tsoumani, M.; Economidis, P. S., 2008: Fish fauna in a protected Greek lake: biodiversity, introduced fish species over a 80-year period and their impacts on the ecosystem. Ecol. Freshw. Fish **17**, 165–173.

Mehner, T.; Schulz, M., 2002: Monthly variability of hydroacoustic fish stock estimates in a deep lake and its correlation to gillnet catches. J. Fish Biol. **61**, 1109–1121.

Millar, R. B., 1992: Estimating the size-selectivity of fishing gear by conditioning on the total catch. J. Am. Stat. Assoc. **87**, 962–968.

Millar, R. B.; Fryer, R. J., 1999: Estimating the size-selection curves of towed gear, traps, nets and hooks. Rev. Fish Biol. Fish. **9**, 89–116.

Pauly, D., 1988: Fisheries research and the demersal fisheries of Southeast Asia. In: Fish population dynamics: the implications for management, 2nd edn. J. A. Gulland (Ed.). John Wiley and Sons Ltd, Chichester, pp. 329–348.

Pauly, D.; Silvestres, G.; Smith, I. R., 1989: On development, fisheries and dynamite: a brief review of tropical fisheries management. Nat. Resour. Model. **3**, 307–329.

Perdikaris, C.; Ergolavou, A.; Gouva, E.; Nathanailides, C.; Chantzaropoulos, A.; Paschos, I., 2012: *Carassius gibelio* in Greece: the dominant naturalised invader of freshwaters. Rev. Fish Biol. Fish. **22**, 17–27.

Pet, J. S.; Pet-Soede, C.; van Densen, W. L. T., 1995: Comparison of methods for the estimation of gillnet selectivity to tilapia, cyprinids and other fish species in a Sri Lankan reservoir. Fish. Res. **24**, 141–164.

Prchalová, M.; Kubečka, J.; Říha, M.; Mrkvička, T.; Vašek, M.; Jůza, T.; Kratochvíl, M.; Peterka, J.; Draštík, V.; Křížek, J., 2009: Size selectivity of standardized multimesh gill nets in sampling coarse European species. Fish. Res. **96**, 51–57.

Psuty-Lipska, I.; Madsen, N.; Draganik, B.; Blady, W., 2006: Gill net selectivity for perch (*Perca fluviatilis*) in the Szczecin Lagoon, Poland. Fish. Res. **80**, 339–344.

Sainsbury, K., 1984: Optimal mesh size for tropical multi-species trawl fisheries. J. Cons. Int. Explor. Mer. **41**, 129–139.

SAS Institute Inc., 1988: SAS/STAT user's guide, Release 6.03 Edition. SAS Institute Inc., Cary.

Siegel, S.; Castellan, N. J., 1988: Nonparametric statistics for the behavioral sciences. Statistics series, 2nd edn. McGraw-Hill, New York, 399 pp.

Silvestre, G.; Soriano, M., 1988: Effect of incorporating sigmoid selection on the optimum mesh size estimation for the Samar Sea multispecies trawl fishery. In: Contributions to tropical fisheries biology. S. Venema, J. Moller-Christensen and D. Pauly (Eds). FAO Fisheries Report 389, Rome, pp. 482–492.

Sinoda, M.; Tan, S. M.; Watanabe, Y.; Meemeskul, Y., 1979: A method for estimating the best cod-end mesh size in the South China Sea area. Bull. Choshi Mar. Lab. Chiba Univ. **11**, 65–80.

Sutela, T.; Rask, M.; Vehanen, T.; Westermark, A., 2008: Comparison of electrofishing and NORDIC gillnets for sampling littoral fish in boreal lakes. Lakes Reserv. Res. Manage. **13**, 215–220.

Wulff, A., 1986: Mathematical model for selectivity of gill nets. Arch. Fish. Wiss. **37**, 101–106.

Author's address: Dimitra C. Bobori, Laboratory of Ichthyology, Department of Zoology, School of Biology, Aristotle University of Thessaloniki, Box 134, GR-54124 Thessaloniki, Greece.
E-mail: bobori@bio.auth.gr

Appendix

Table A1
Selectivity models implemented in EXCEL spread sheets. Parameter numbes to estimate ranges from 2 to 9. Spread sheets can be obtained from one of the authors, K. Erzini: kerzini@ualg.pt.

File Spread sheet	Selectivity Model	Parameters
Normal.XLS		
Normal_1		$m_i = b1 \text{ x } m_i,\ s_i = b3$
Normal_2	$S_{ij} = \exp\left(-\frac{(l_j-\mu_i)^2}{2\sigma_i^2}\right)$	$m_i = b1 \text{ x } m_i + b2,\ s_i = b3$
Normal_3		$m_i = b1 \text{ x } m_i,\ s_i = b3 \text{ x } m_i$
Normal_4		$m_i = b1 \text{ x } m_i + b2,\ s_i = b3 \text{ x } m_i$
Normal_5	$S_{i,j} = \exp\left(-\frac{(l_j-\mu_i)^2}{2\sigma_i^2}\right)$	$m_i = b1 \text{ x } m_i + b2,\ s_i = b3 \text{ x } m_i + b4$
Binormal.XLS		
Binormal_1		$m_{1i} = b1 \text{ x } m_i, s_{1i} = b3; m_{2i} = b5 \text{ x } m_i, s_{2i} = b7; c$
Binormal_2		$m_{1i} = b1 \text{ x } m_i + b2, s_{1i} = b3; m_{2i} = b5 \text{ x } m_i + b6,\ s_{2i} = b7;\ c$
Binormal_3	$S_{i,j} = \exp\left(-\frac{(l_j-\mu_i)^2}{2\sigma_i^2}\right) + c' \text{ x } \exp\left(-\frac{(l_j-\mu_i)^2}{2\sigma_i^2}\right)$	$m_{1i} = b1 \text{ x } m_i, s_{1i} = b3 \text{ x } m_i; m_{2i} = b5 \text{ x } m_i, s_{2i} = b7 \text{ x } m_i; c$
Binormal_4		$m_{1i} = b1 \text{ x } m_i + b2, s_{1i} = b3 \text{ x } m_i; m_{2i} = b5 \text{ x } m_i + b6, s_{2i} = b7 \text{ x } m_i; c$
Binormal_5		$m_{1i} = b1 \text{ x } m_i + b2, s_{1i} = b3 \text{ x } m_i + b4; m_{2i} = b5 \text{ x } m_i + b6, s_{2i} = b7 \text{ x } m_i + b8; c$
Logistic.XLS		
Logistic_1		$b_i = b1 \text{ x } m_i, L50_i = b3 \text{ x } m_i$
Logisitic_2		$b_i = b1 \text{ x } m_i + b2, L50_i = b3 \text{ x } m_i$
Logistic_3	$S_{i,j} = \frac{1}{1 + e^{-b_i(l_j - L50_i)}}$	$b_i = b1 \text{ x } m_i, L50_i = b3 \text{ x } m_i + b4$
Logistic_4		$b_i = b1 \text{ x } m_i + b2, L50_i = b3 \text{ x } m_i + b4$
Logistic_5		$b_i = b1, L50_i = b3 \text{ x } m_i$

Table A2
Length range and mean total length of fish captured per mesh size, Lake Doirani

Species/mesh size	n	Total length (cm) Max	Min	Mean	SE
C. gibelio					
18 mm	26	13.3	9.3	10.65	0.203
22 mm	14	13.1	11.4	12.09	0.145
26 mm	87	23.3	12.9	15.33	0.210
30 mm	15	25.2	16.1	19.38	0.778
40 mm	39	27.3	19.0	22.78	0.297
P. macedonicum					
14 mm	150	14.4	8.9	11.49	0.079
18 mm	162	19.1	9.7	12.59	0.066
22 mm	6	14.5	11.9	13.28	0.372
26 mm	17	15.0	13.2	13.99	0.116
P. fluviatilis					
14 mm	1675	21.9	9.5	11.32	0.030
18 mm	344	22.2	9.2	13.41	0.061
22 mm	34	19.9	13.2	16.44	0.221
26 mm	44	22.6	11.0	18.79	0.258
30 mm	11	21.8	19.1	20.66	0.220
R. rutilus					
14 mm	113	18.2	8.7	11.82	0.184
18 mm	128	18.7	12.0	14.88	0.122
22 mm	85	19.7	10.6	15.10	0.286
26 mm	40	20.0	14.7	18.32	0.181

Table A3
Length range and mean total length of fish captured per mesh size, Lake Mikri Prespa

Species/mesh size	n	Total length (cm) Max	Min	Mean	SE
A. belvica					
8 mm	15	8.0	6.8	7.38	0.085
14 mm	629	16.5	11.8	13.47	0.029
16 mm	338	19.0	12.4	14.35	0.042
Hybrid					
14 mm	39	15.0	11.3	12.77	0.143
16 mm	36	16.3	12.1	13.88	0.164
20 mm	9	17.5	14.6	15.88	0.365
L. gibbosus					
8 mm	11	11.2	4.1	5.55	0.696
14 mm	318	9.7	6.6	7.85	0.032
16 mm	203	12.5	7.7	8.56	0.039
20 mm	98	17.6	7.5	10.28	0.124
24 mm	6	12.1	10.8	11.5	0.203
R. prespensis					
8 mm	9	8.0	5.7	6.46	0.257
14 mm	215	18.2	8.8	10.92	0.063
16 mm	102	18.7	10.8	12.46	0.120
20 mm	121	18.7	13.0	15.12	0.102
24 mm	56	21.8	14.5	16.95	0.166
S. prespensis					
20 mm	38	20.9	15.6	17.49	0.192
24 mm	19	22.0	18.1	20.32	0.279
30 mm	12	29.6	23.2	26.85	0.553

Table A4
Length range and mean total length of fish captured per mesh size, Kerkini Reservoir.

Species/mesh size	n	Total length (cm) Max	Min	Mean	SE
Alburnus sp. Volvi					
8 mm	13544	9.9	6.1	8.08	0.004
14 mm	607	15.6	10.2	11.96	0.030
16 mm	1402	14.7	11.2	12.41	0.100
A. aspius					
14 mm	47	18.2	12.7	15.83	0.173
16 mm	99	19.7	13.0	17.30	0.116
20 mm	24	20.6	18.3	19.78	0.110
30 mm	15	32.0	27.2	29.61	0.348
C. gibelio					
14 mm	155	13.9	7.0	9.21	0.116
16 mm	560	17.9	8.1	10.09	0.044
20 mm	1835	15.5	8.8	11.63	0.019
24 mm	1000	17.9	9.8	13.68	0.040
30 mm	379	20.4	13.1	16.63	0.055
36 mm	51	28.0	10.4	19.06	0.294
L. gibbosus					
8 mm	37	8.4	4.2	5.23	0.183
14 mm	345	10.0	6.5	7.67	0.029
16 mm	159	10.4	5.5	8.55	0.049
20 mm	66	12.8	7.5	9.87	0.116
24 mm	36	13.5	8.7	11.38	0.134
30 mm	16	18.6	12.5	14.03	0.354
R. rutilus					
8 mm	19178	9.8	5.1	6.84	0.003
14 mm	3350	15.1	9.1	11.25	0.013
16 mm	1503	16.2	9.6	12.35	0.021
20 mm	508	17.6	9.8	13.98	0.055
24 mm	101	19.1	10.7	15.60	0.180
P. fluviatilis					
14 mm	592	17.1	7.5	11.60	0.064
16 mm	456	19.3	6.8	13.00	0.080
20 mm	542	19.1	9.5	15.05	0.061
24 mm	264	20.2	9.0	16.57	0.087
30 mm	50	22.1	11.1	18.55	0.243
V. melanops					
14 mm	48	14.7	10.8	12.28	0.120
16 mm	114	17.7	11.8	13.81	0.101
20 mm	151	18.8	12.4	15.65	0.089
24 mm	47	25.2	16.0	17.93	0.211
30 mm	53	30.9	15.1	22.48	0.362

Table A5
Cases where length-frequency distributions of different mesh sizes per Species and System revealed no significant differences (K-S, P > 0.05).

System	Species	Mesh size (mm) combinations
Lake Doirani	*C. gibelio*	18–22
	P. macedonicum	22–26
	R. rutilus	14–18, 18–22
Lake Mikri Prespa	*A. belvica*	14–16
	Hybrid	14–16
	L. gibbosus	14–16
	R. prespensis	14–16, 16–20, 20–24
	S. prespensis	20–24
Kerkini Reservoir	*A.* sp Volvi	14–16
	A. aspius	14–16
	C. gibelio	14–16, 14–20, 16–20, 16–24, 20–24, 24–30
	L. gibbosus	8–14, 8–16, 14–16, 16–20
	P. fluviatilis	14–16, 14–20, 16–20
	R. rutilus	14–16, 14–20, 16–20, 16–24
	V. melanops	16–20