Is Mass Removal an Efficient Measure to Regulate the North American Catfish *Ameiurus melas* Outside of Its Native Range?

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ABSTRACT

The black bullhead (*Ameiurus melas*) is a North American species that has successfully established populations throughout Europe. The main management policy to regulate its population in France is systematic mass removal by fishers, but the efficiency of this measure has not been evaluated. In the Grande Brière Motièrre marsh (northwest France), this species currently dominates the fish assemblage. We sampled this black bullhead population with trap nets and by electrofishing. The non-commercial fishery was also surveyed. Length-frequency distributions were significantly different between trapped individuals and those sampled by electrofishing, suggesting a size-selectivity of trap nets. Abundance of black bullhead was negatively correlated with the fishermen activity, measured at variable locations of the study site. The young-of-the-year / adult ratio was constant at each site, suggesting that black bullhead might not compensate for fishing mortality with increased recruitment.

INTRODUCTION

During the two last centuries, many fish species have been introduced in Europe, notably from North America, with variable success of naturalization (review in Copp et al. 2005). The black bullhead (*Ameiurus melas*), an ictalurid fish native to North America, is an example of a non-indigenous fish species that has successfully established populations throughout Europe (Wheeler 1978) and particularly in France where it was introduced in 1871 (Boët 2001). Whereas this species is well studied in its native range (e.g., Hanchin et al. 2002a, Brown et al. 1999), few studies have been conducted in its non-native range in Europe (but see Boët 1980).

Despite its classification as a "species liable to cause biological disequilibrium" by French legislation (article R. 232-3 Code rural, see Guevel 1997), few management measures have been undertaken in the country to limit its increasing populations. One such measure is the obligation for fishers to eliminate all captured individuals. Recently, Louette and Declerck (2006) experimentally showed that trapping may potentially be a cost-effective tool for the mass removing of brown bullhead (*Ameiurus nebulosus*). Nevertheless, the efficiency of this measure to limit black bullhead population size has never been assessed outside of its native range to our knowledge (but see Hanson et al. 1983).

The objective of this study was to investigate the effect of the trap-net fishery on the black bullhead population in a man-made wetland (Grande Brière Mottière marsh, northwest France). First, we compared the length-frequency distributions of black bullhead from the trap-net fishery with electrofishing to evaluate the size-selectivity of the gears. Then, we investigated whether black bullhead abundances were related to variable fishermen activity to assess the efficiency of this management tool.

METHODS AND MATERIALS

Study area and fishermen activity survey

The Grande Brière Mottière (Fig. 1) is a 7000 ha freshwater marsh located on the Loire River drainage in northwest France (47°22'N, 02°11'W) with a water regime regulated

by a sluice at the outlet. The area is composed of a complex web of permanently flooded ditches within a patchwork of temporary flooded habitats mainly composed of reed beds (*Phragmites australis*) and grasslands (Poaceae; see Eybert et al. [1998] and Carpentier et al. [2004] for details). Based on traditional habits, the study site is divided into eight zones where fishing is permitted (mean area of land cover = 905 ha ± 366 S.D.). The two protected areas (250 and 700 ha, respectively), where fishing is totally prohibited, were not included in the study. The study site supports a traditional fishery composed of non-commercial fishers that target the European eel (*Anguilla anguilla*) and large piscivorous fish such as northern pike (*Esox lucius*) and pikeperch (*Sander lucioperca*). The black bullhead, introduced in 1929 (Maillard 1972) and currently dominating the local fish assemblage (authors, unpublished data), is principally captured by eel fishers that use modified trap nets (i.e., eel pots). In 2005, we questioned 28 fishers using eel pots (i.e., 58% of the fishers using this gear) to evaluate the fishermen activity in each of the eight zones of the Grande Brière Mottière marsh. Fishermen activity was calculated as the number of eel pots per kilometer of ditch in each zone.

Black bullhead sampling

The black bullhead population was sampled in 2004 using trap nets and electrofishing. Trap nets, which have already proven their efficiency to monitor black bullhead population (Hanchin et al. 2002b), were used to establish the size-class distribution of

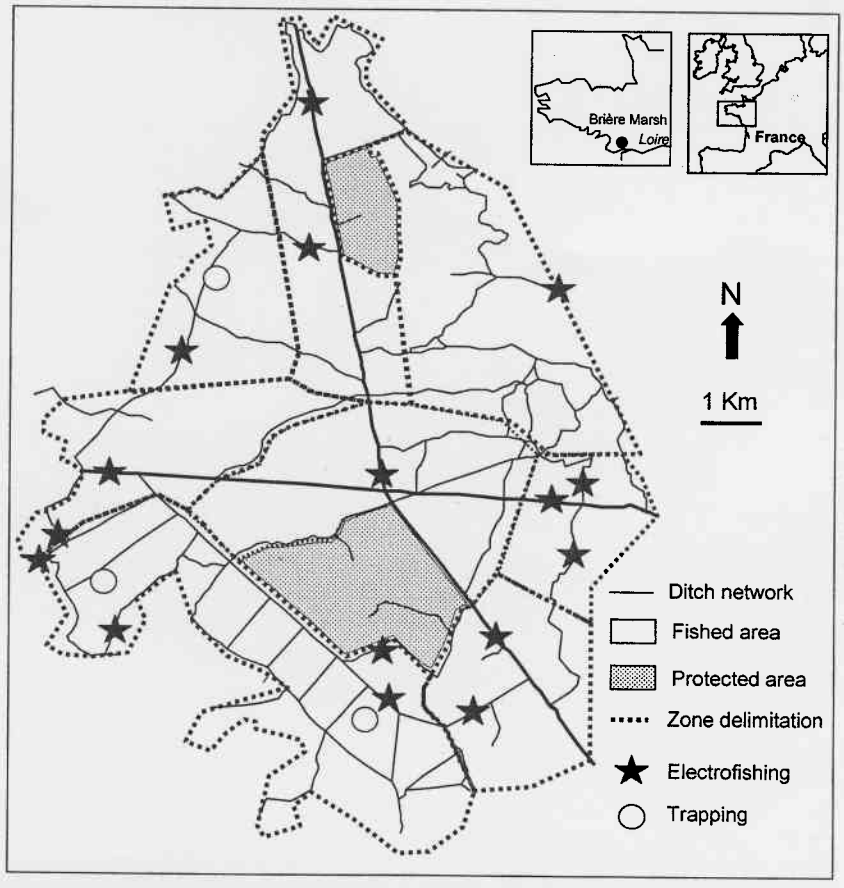

Figure 1. Map of the Grande Brière Mottière marsh ditch network and location of trapping surveys and ditches sampled by electrofishing in 2004.

black bullhead caught with this gear. Eight trap nets (i.e., fishermen eel pots, 1.5 m long with 1.0 x 0.4 m frames and 10 mm mesh) were randomly set at three locations in the study area from May to August, representing a trapping effort of 242 net-nights.

Electrofishing was used to assess spatial variations in the black bullhead abundance in the whole study area (7, 000 ha) and to define the population length-frequency distribution. The point abundance sampling method (PAS, see Nelva et al. 1979) was used because it is an efficient and cost-effective method for assessing fish abundance (expressed in catch per unit effort [CPUE] = number of individuals·PAS^{-1}) and provides reproducible and quantitative samples allowing for within- and between-site comparisons (e.g., Copp 1989). Furthermore, this method is effective for capturing all species and most life stages in shallow waters. The sampling design (PAS number per site) was defined in accordance with Copp and Garner's (1995) recommendations. The sampling operations were conducted using an EFKO F.E.G. 8000 electrofishing apparatus (30 cm anode diameter, 400-600 V and 6-10 A) and consisted of throwing the anode from a boat to a distance of 5 to 10 m to limit fish escape, each PAS being separated by a minimum distance of 50 m (e.g., Persat and Copp 1989). Sixteen ditch sections were sampled in August (i.e., after the spawning period of this species) totaling 401 PAS (mean = 25.1 ± 3.2 S.D. per ditch). In total, 5,084 fish were caught, and a minimal sub-sample of 100 individuals was measured to the nearest mm in each ditch section. From the inspection of length-frequency distributions, we used a 70 mm total length threshold to distinguish young-of-the-year (YOY) from adults, this threshold being in accordance with results of Hanchin et al. (2002a). Because YOY are not caught by fisher trap nets as a consequence of eel pot mesh-size, they were removed from the data set collected by electrofishing to compare length distributions. Black bullhead abundance (CPUE) was $\log_{10}(x+1)$ transformed to conduct the statistical analyses.

RESULTS AND DISCUSSION

The length-frequency distributions of black bullhead > 70 mm (Fig. 2) was different between trap nets and electrofishing (two-sample Kolmogorov-Smirnov test, KS = 0.170, $p < 0.001$). This global difference in size-classes mainly involved the selectivity by eels pots of individuals between 70 and 100 mm (i.e., certainly age-1 individuals [Hanchin et al. 2002a]).

Black bullhead abundance was negatively related with fishermen activity (linear regression, n = 16, $R^2 = 0.609$, $p < 0.001$, Fig. 3), indicating that trap-net fishers likely had an effect on bullhead density. A major concern in mass removal is whether or not increased recruitment would negate the benefits of population reduction (Hanson et al.

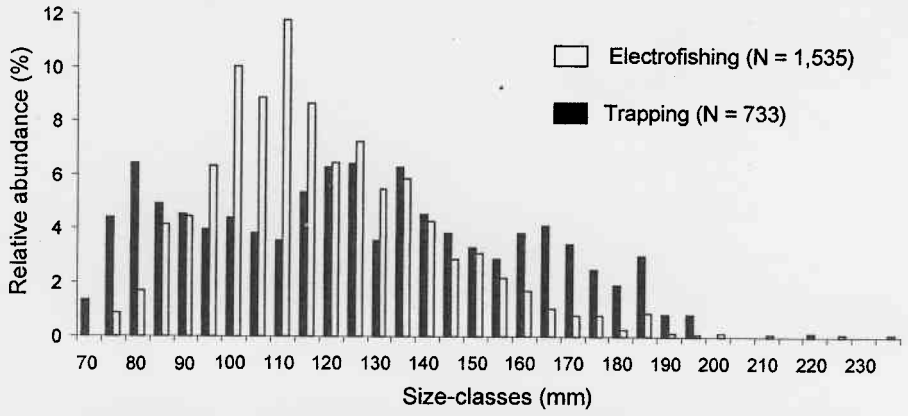

Figure 2. Size-frequency distribution for *Ameiurus melas* sampled by trap nets and electrofishing in the Grande Brière Mottière marsh in 2004.

1983). In the studied black bullhead population, YOY / adult ratio did not vary in relation to the adult abundance (linear regression, n = 16, $R^2 = 0.03$, p = 0.503), suggesting that black bullhead might not compensate for fishing mortality with increased recruitment, at least under these metrics. This result is surprising because mechanical control methods are generally temporary since the remaining fishes exhibit compensatory survival, increased growth, and increased fecundity, all of which result in a rapid resiliency of populations (Wydoski and Wiley 1999). Nevertheless, Hanson et al. (1983) did not observe any significant increased recruitment in their black bullhead population. In our population, the absence of a significant relation between YOY / adult ratio and adult abundance might indicate that fishing mortality affects black bullhead density but not sufficiently to activate regulatory mechanisms.

The systematic mass removal by fishermen seems to be partly successful in limiting the abundance of black bullhead in the Grande Brière Mottière marsh. Nevertheless, the black bullhead is still the dominant species in the local fish assemblage. Consequently, the use of this single management measure currently is not sufficient to regulate the population. Recent works have shown that alternative measures are efficient for limiting the establishment of non-native fishes. In the Grande Brière Mottière, the invasion of natural habitats (grasslands) by reed beds during the last century has substantially altered ecosystem function (Eybert et al. 1998). This habitat modification is

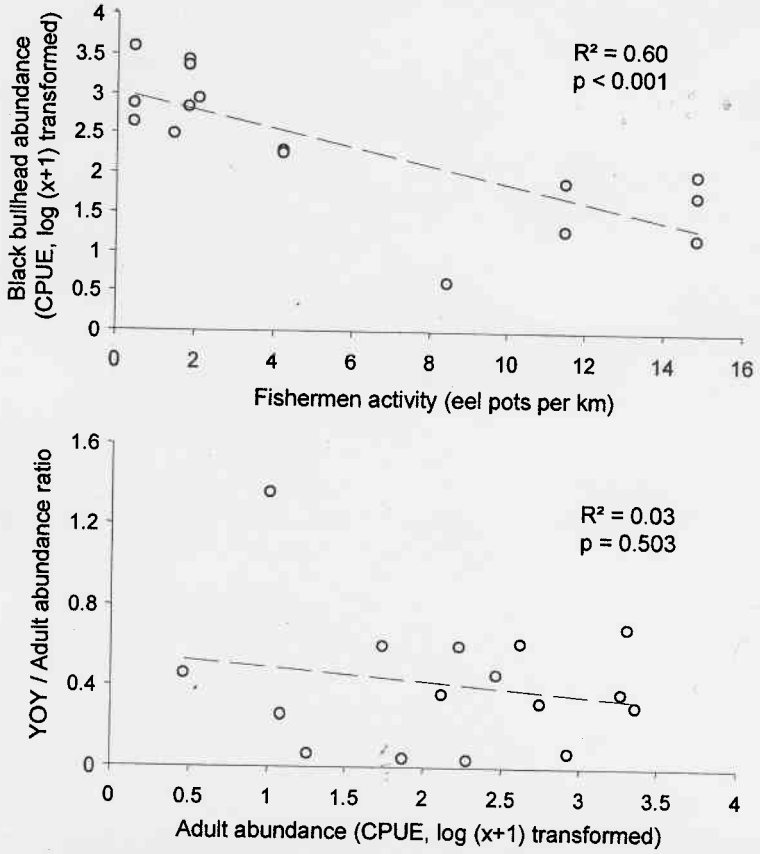

Figure 3. Relationship between total black bullhead abundance and fishermen activity and between young-of-the-year / adult ratio and adult black bullhead abundance in the Grande Brière Mottière marsh. Abundance (CPUE) values were $\log_{10}(x+1)$ transformed.

certainly one of major cause for the domination of the fish assemblage by the black bullhead. Recently, Scoppettone et al. (2005) demonstrated that habitat restoration could be valuable to control non-native fish species. Consequently, we propose that managers continue the systematic mass removal but in conjunction with natural habitat restoration to more efficiently regulate the black bullhead population in the Grande Brière Mottière marsh.

ACKNOWLEDGMENTS

We are grateful to J.-P. Damien, E. Le Mitouard, V. Thoby and the numerous persons who participated in the field work. We acknowledge D.W. Willis and two anonymous referees for valuable comments on an earlier draft. We thank the Parc naturel régional de Brière for logistic and the PnrB, FEDER, DIREN, Région Pays de la Loire and Agence de l'Eau from Loire-Bretagne for financial support.

LITERATURE CITED

Boët, P. 1980. L'alimentation du poisson-chat (*Ictalurus melas* Raf.) dans le lac de Créteil. Annales de Limnologie 16: 255-270.

Boët, P. 2001. Le Poisson-chat *Ameiurus melas* (Rafinesque, 1820). *In*: Keith, P. and J. Allardi (eds.), Atlas des poisons d'eau douce de France. Patrimoines naturels, MNHN, Paris, 47: 222-223.

Brown, M.L., D.W. Willis, and B.G. Blackwell. 1999. Physicochemical and biological influences on black bullhead populations in eastern South Dakota glacial lakes. Journal of Freshwater Ecology 14: 47-60.

Carpentier, A., J.-M. Paillisson, E. Feunteun, and L. Marion. 2004. Fish community structure in temporary lowland flooded grassland. Bulletin Français de la Pêche et de la Pisciculture 375: 1-14.

Copp, G.H. 1989. Electrofishing for fish larvae and juveniles: equipment modifications for increased efficiency with short fishes. Aquaculture and Fisheries Management 20: 453-462.

Copp, G.H. and P. Garner. 1995. Evaluating microhabitat use of fish larvae and juveniles with point abundance sampling. Folia Zoologica 44: 145-158.

Copp, G.H., P.G. Bianco, N.G. Bogutskaya, T. Eros, I. Falka, M.T. Ferreira, M.G. Fox, J. Freyhof, R.E. Gozlan, J. Grabowska, V. Kovac, R. Moreno-Amich, A.M. Naseka, M. Penaz, M. Povz, M. Przybylski, M. Robillard, I.C. Russell, S. Stakenas, S. Sumer, A. Vila-Gispert, and C. Wiesner. 2005. To be, or not to be, a non-native freshwater fish? Journal of Applied Ichthyology 21: 242-262.

Eybert, M.-C, J.-Y. Bernard, P. Constant, E. Feunteun, J. Hédin, and S. Questiau. 1998. Réhabilitation des prairies inondables dans les marais briérons: évolution de la flore, des poissons et des oiseaux. Gibier et Faune sauvage 15: 999-1016.

Guevel, B. 1997. La loi pêche (Code Rural) et l'introduction des espèces piscicoles. Bulletin Français de la Pêche et de la Pisciculture 344/345: 43-51.

Hanchin, P.A., D.W. Willis, and M.J. Hubers. 2002a. Black bullhead growth in South Dakota waters: limnological and community influences. Journal of Freshwater Ecology 17: 65-73.

Hanchin, P.A., D.W. Willis, and T.R. St. Sauver. 2002b. Comparison of concurrent trap-net and gill-net samples for black bullheads. Journal of Freshwater Ecology 17: 233-237.

Hanson, D.A., B.J. Belonger, and D.L. Schoenike. 1983. Evaluation of a mechanical population reduction of black crappie and black bullheads in a small Wisconsin lake. North American Journal of Fisheries Management. 3: 41-47.

Louette, G. and S. Declerck. 2006. Assessment and control of the non-indigenous brown

bullhead *Ameiurus nebulosus* populations using fyke nets in shallow ponds. Journal of Fish Biology 68: 522-531.

Maillard, Y. 1972. Poissons et problèmes piscicoles du bassin du Brivet. Penn ar Bed 71: 386-399.

Nelva A., H. Persat and D. Chessel. 1979. Une nouvelle méthode d'étude des peuplements ichthyologiques dans les grands cours d'eau par échantillonnage ponctuel d'abondance. Comptes Rendus de l'Académie des Sciences 289: 1295-1298.

Persat, H. and G.H. Copp. 1989. Electric fishing and point abundance sampling for the ichthyology of large rivers. Pages 197-209 *In* Cowx, I. (ed.), Development in electric fishing. Oxford: Fishing New Books, Blackwell Scientific Publications.

Scoppettone, G.G., P.H. Rissler, C. Gourley, and C. Martinez. 2005. Habitat restoration as a means of controlling non-native fish in a Mojave desert oasis. Restoration Ecology 13: 247-256.

Wheeler, A. 1978. *Ictalurus melas* (Rafinesque, 1820) and *I. nebulosus* (Lesueur, 1819): the North American catfishes in Europe. Journal of Fish Biology 12: 435-439.

Wydoski, R.S. and R.W. Wiley. 1999. Management of undesirable fish species. Pages 403-430 *In* Kohler, C.C. and W.A. Hubert (eds.), Inland fisheries management in North America. American Fisheries Society, Bethesda, Maryland.

Received: 1 May 2006

Accepted: 12 August 2006