Effet of Broodstock Stocking Density on Semi Controlled Reproduction of Black Bass (Micropterus Salmoides) and Fingerling Production In Earthen Ponds Under a Semi Arid Climate. Deroua Fisheries Farm (Fkih Ben Salah, Morocco).

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Abstract— In the present study, several Black bass (Micropterus salmoides Lacepede 1802)reproduction aspects in ponds in a Moroccan semi-arid climate were studied during the 2013, 2014 and 2015 seasons in Deroua Fisheries farm, Fkih Ben Saleh (Morocco). The breeding season begins in late February at a water temperature of 16 °C and ends in early May at a temperature of 27 °C. This study investigated mainly the effect of stocking density on fingerling production. Pairs of male and female brood fish were stocked in the spawning ponds at densities of 1, 2 and 0.75 pairs/100 m². Fingerling production was highly affected by the brood fish stocking densities and the means were 11.06, 7.61 and 4.66 fingerling/pair/m² respectively for densities of 0.75, 2and 1 pairs/100 m².

Résumé — Plusieurs aspects de reproduction de Black bass (Micropterus salmoides Lacépède,1802) dans les étangs sous un climat semi-aride marocain ont été étudiés dans ce travail durant les saisons de reproduction 2013, 2014 et 2015 à la station de pisciculture de la Deroua Fkih Ben Saleh. La saison de reproduction débute fin février à une température d'eau de 15°C et se termine au début de Mai à une température de 30°C. Les résultats obtenus, montre une différence statistiquement significative des moyennes de production des Fingerlings de black bass par couple de géniteurs et par 100 m². En effet les valeurs moyennes obtenus était de 11,06, 7,61 et 4,66 Fingerlings/couple/m2 respectivement à des densités de stockages de 0,75 ; 1 et 2 couple/100m2.

Keywords— Black Bass; Fingerling; Reproduction; Ponds; Density; Semi-Arid Climate.

1 Introduction

The Black bass (Micropterus salmoides Lacepede, pede, 1802) is a native fish of Southeast North American continent. It is a fresh water fish which which prefers marshy areas and the shallow lakes (Lorenzoni et al., 2002). It has become one of the most common fish in the world following it's introductions to several countries during last century (Bruslé et al., 2001) .It was introduced to Morocco in 1934 where it has been acclimatized in the natural lakes of the Middle Atlas (Mouslih, 1987). After its adaptation in these new habitats, samples of brood fish of this species have been introduced successfully into other natural and artificial water bodies of the country. It seems that this strain introduced to Morocco still keeps its genetic originality since there has been no further introductions since 1934 (Droussi, 2007).

Semi controlled reproduction of the black bass has been carrying out in the Deroua Fisheries Station since 1997. Seed production of this species is used to enhance black bass yields in natural lakes and reservoirs dams.

The objective of this study is to establish the biological criteria of seed production of this species in earthen pond under a semi arid climate by studying several aspects related to its reproductive behavior. The ultimate goal of such an approach is to optimize fingerlings production of this species carried out in the nursery ponds of the Deroua Fisheries Station. To achieve this goal, we had to determine the best density of blood fish to be stocked in spawning ponds that would allow the best fingerling productions of this species.

2 Materials and Methods

2.1 Study area

The present study was carried out in the ponds of Deroua Fisheries Station located in a semi-arid climate region, at 25 km west of Beni-Mellal city (central Morocco). The earthen ponds of this station were built on clayey soils originated from limestone formations of the Quaternary mio-Pliocene (Emberger, 1930).The main mission of this station is the production of warm-water fish seeds used to stock Moroccan aquatic environments in order to enhance their productivity and to improve water quality in eutrophic reservoirs by using filter feeding fish such as silver carp and grass carp to control the severe macrophytes development in manmade lakes and irrigation canals.

2.2 Experimental design

This study was conducted from February to May during 2013, 2014 and 2015 seasons. The black bass brood fish were reared in the grow-out ponds of the Deroua Fisheries Station. Ponds used for these experiments (series A, B, C, D and F) have a unit area ranging from 1500 m² to 2000 m² and an average depth of 1.5 m. The water supply is assured from groundwater. These ponds are dried up for more than 10 days and then refilled up to 2/3 of their total volume, a week later the brooders are stocked according to the following experimental design at a sex ratio of 1/1.

TABLE1. DENSITY OF BLACK BASS BROOD FISH PAIRS STOCKED IN THE SPAWNING PONDS

2013			2014			2015		
P	A m²	NB p/ 100 m²	P	A m2	Nb p/ 100 m²	P	A m²	Nb p/ 100 m²
F_5	2000	2	B_2	2000	2	C_1	1500	2
F_4	2000	2	C_4	1500	2	A_4	2000	2
C_3	1500	2	C_3	1500	1	B_4	2000	2
A_2	2000	1	A_1	2000	1	A_2	2000	1
B_2	2000	1	A_4	2000	1	A_5	2000	1
A_4	2000	1	C_2	1500	1	C_2	1500	1
F_1	2000	1	A_2	2000	0,75	C_3	1500	1
			A_5	2000	0,75	F_4	2000	1
						B_5	2000	0,75
						A_3	2000	0,75

P= Pond

Nb p/ 100m²= Number of pairs/ 100m2

A= Aera m²

The selection of the brood fish to be stocked in the spawning ponds was carried out based on their size, health condition and degree of maturity. The selected brood fish had a uniform size and a similar degree of maturity.

The spawning ponds have a similar primary and secondary productivity as they have been receiving the same management techniques since their construction between 1991 and 1994.

During the spawning season which runs between March and April, the water level in the spawning ponds was maintained at over 0.80 m and physical and chemical water quality parameters were monitored on a weekly cycle. The reproductive performance of the brood fish was observed; thus schools of fry guarded by the male around its vital space were easily observed. The observation of the schooling behavior of the fingerlings helps decide when they should be harvested. In fact to avoid cannibalism phenomenon among black bass fingerlings and the effects of other aquatic or semi aquatic organisms, fingerlings should be harvested before the male stops protecting them and leaves them to their fate.

At the end of the rearing period when the fingerlings reach a minimum size of 2.5 cm, the ponds are drained to the catch basin where the brood fish and fingerlings are concentrated. A 22 mm mesh net is used to seine the brood fish before seining the fingerlings using a 5 mm mesh net.

The spawned and non spawned females are counted and transferred to grow-out ponds and fingerlings are counted, loaded and transported in oxygenated tanks to destinations. After the fish harvest the nests prepared by the brood fish in the spawning pond are counted and the distances between them are measured.

3 RESULTAS

The results presented in this study were obtained during three Black bass reproduction seasons in the spawning ponds of the Deroua Fisheries Station. As shown in Table 1, the densities used were 1 and 2 pairs of spawners per 100 m² during the 2013 season and 0.75; 1 and 2 pairs per 100m² during the 2014 and 2015 seasons.

This experimental design allows comparing the effect of the brood fish density on the production of Black bass fingerlings within a single production season and between different production seasons.

The statistical analysis (ANOVA) of the results shows that the brood stock density has a significant effect on the mean production of black bass fingerlings and that the spawning season had no significant effect on this production except for the density of 2 pairs/100m² where means of fingerlings production obtained were statistically different between 2014 and 2015 at a probability level of 0.05.

TABLE2. MEAN VALUES OF THE BLACK BASS FINGERLINGS PRODUCTIONS OBTAINED AT DIFFERENT BROOD FISH STOCKING DENSITIES IN THE SPAWNING PONDS.

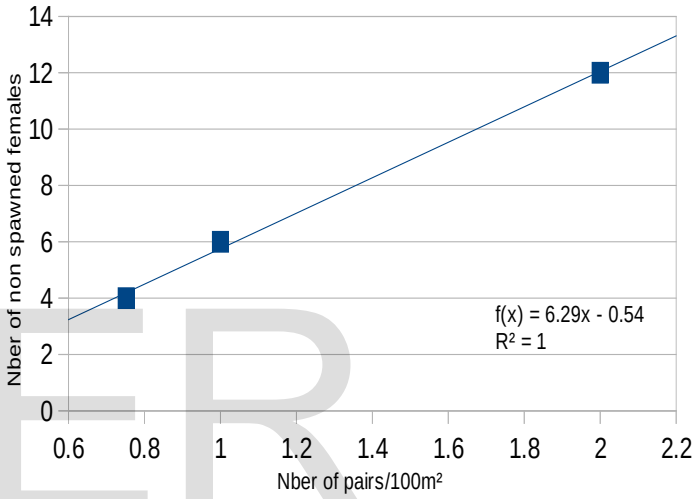
Nb P/100m²	F/P/m² (2013)	F/P/m² (2014)	F/P/m² (2015)	M Mean F/P/m²
2	4,16a	2,66b	2,66b	a
1	8,48b	4,28c	10,06e	b
0,75		10,23d	11,9d	6c

F/P/m² = Fingerling/pair of brood stock / m²

Means in column followed by the same letter are not statistically different

Means in rows followed by the same letter are not statistically different

It comes out from these results that the relationship between the density of brood stock and fingerling production in spawning ponds follows a negative polynomial equation $Y = f(x) = 8.22x - 0.85$ with a coefficient of determination $r^2 = 0.97$ as it is shown in figure


14
12
10
8
6
4
2
0
Nber of non spawned females
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
Nber of pairs/100m²
f(x) = 6.29x - 0.54
R² = 1

4 DISCUSSION

Black bass was introduced to the Deroua Fisheries Station in 1996. This species is well established in this region due the suitable climatic and trophic conditions for its growth and reproduction.

It was observed during this study that, the first maturity of Black bass females and males is reached during the first year of their existence when their total length is 20 to 25cm and their average weight is100 to 300g. In other words, the seeds produced in late spring (June) can spawn in early spring(April) of the following year. Heidinger (1976) has reported that in regions where growth is slow, sexual maturity of Black bass is reached at the age of 3 to 5 years.

At the Deroua Fisheries Station the spawning of Black bass starts by the first week of March at a water temperature of 16 ° C and ends in early May at a water temperature higher than 27 ° C. In Europe, the spawning of the black females runs from April to July at a water temperature between 16 and 18 ° C (Bruslé et al., 2001). The breeding season may be spread over a period of six months in tropical regions where water temperatures are above 20 °C throughout the year (Waters & Noble, 2004).

During this study, the first nests were observed during the last week of February. Males prepare their nest on clean sandy pond bottoms at depths ranging from 0.5 to 0.8 m. This depth is within the preferred range by the Black bass (0,33m to 1,33m) even if it may reproduce at a depth of 5.5m (Miller & Kramer, 1971).Most males build nests at 1 to 2 m from the banks of ponds. Nests prepared in the middle of the ponds are rare. The nest circular form has a diameter of 40cm to60cm with a depth of a few centimeters. The minimum distance between nests recorded was5m observed in the spawning pond with high brood fish density and the maximum distance was 16.5 m observed in low density ponds. The distance between nests is influenced by the territorial and aggressive behavior of males during the breeding season and the stocking density in the spawning ponds. Thus 62% of males in low density ponds build their nests at a distance of 5 to 10 m apart and 37.5% build their nests at a distance of 10m, while for high density ponds, 70% of males install their nests 5 to 10m from each other and only 30% choose a distance greater than 10m.

Spawning and fertilization of eggs of females in the ponds occurs 8-15 days after the preparation of the nest. During these Black bass seed production activities, the first mating of the brood stock was observed during the first week of March at a water temperature of 16 ° C and the first school of fry was observed during the second half of the same month. However, most of the fry appear late March and early April. Females that spawn after this period are rare and are often a ''virgin'' females which reach maturity for the first time late in the breeding season.

The reproduction season is highly influenced by water temperature during the main spawning period of the black bass (late March-early April) in Deroua Fisheries Station when water temperatures range between 18 and 24 °C. These results are similar to those reported by Rodriguez-Sanchez et al. (2009) in Spain and by Lorenzoni et al. (2002) in Italy, which stipulate that the optimal temperatures for the black bass reproduction are ranged between 20°C and 25°C. The difference of more than a month noted between the European breeding seasons and those of North Africa is due to the effect of latitude. It should be also stated that the breeding season is affected by altitude. In Moroccan lake reservoirs located at higher altitude black bass spawning season is relatively late compared to that observed in lake reservoirs located at lower altitude (Droussi, unpublished data).

Black bass fingerling production per pair of male and female brood fish per 100 m² pond surface varies according to stocking densities of the brood fish in the spawning ponds. This production is inversely proportional to the number of stocked brood fish. Black bass fingerling production was 4.66, 7.61 and 11.06 respectively for stocking densities of 2, 1 and 0.75 pair / 100m². These values show that the production of Black bass fingerling improves when low stocking densities of the brood fish are adopted meanwhile the average number of spawned females was 28, 14 and female 11 respectively for stocking densities of 2, 1 and 0.75 pair/ 100m². This result may suggest that the number of the offspring would be proportional to the number of the spawned females and normally the number of seeds obtained should be greater when high densities are adopted. These presumptions will apply to embryonic and larval stages as the number of eggs released by 28 females will be greater than that released by 11 females. However, when the fry start feeding on the zooplankton developed in the pond, a severe competition takes place for the food items and results in food shortage which leads to the elimination of a good proportion of the swim-up fry. Thus the proportion of the fry eliminated in the pond is inversely proportional to their initial abundance during the first stages of their life in the pond.

The inter-annual difference observed in fingerling production will be particularly due to the climate change which may occur between seasons. The 2014 season was marked by a severe water temperature drop during the spawning season which affected the fry survival rates in nursery ponds. Similarly, these inter-annual differences can also be due to the brood fish conditions which may be different from one year to another.

ACKNOWLEDGMENT

This work was conducted in a frame of bilateral agreement between the High Commission of Water and Forest Department and The Faculty of Sciences and Thechnics of Beni Mellal represented by the Laboratory of Valorization and Management of Natural Resources. The authors would like to thank

the High Commission of Water and Forest and the staff of Deroua Fisheries Station for their technical and scientific supports.

REFERENCES

- J. Brusle, ET J.P. Quignard, 2001. Biologie des poissons d'eau douce européens. Editions Tec & Doc, Paris (2èmeédition). 625 p.
- Science advice from a risk assessment of largemouth bass (micropterussalmoides) in britishColumbia. Canadian Science Advisory Secretariat. Science Advisory Report 2010/082
- L. Emberger, 1930. Sur une formule climatique applicable en géographie botanique. Comptesrendues Académie Sciences, Paris. 191. 389-390.
- R.C. Heidinger, 1976. Synopsis of biological data on the largemouth bass Micropterussalmoides (Lacépède) 1802.Synopsis 115: 1–85p.
- M. Lorenzoni, M. Dorr, R. Erra, G. Giovinazzo, M. Merrelli, 2001.Growth and reproduction of largemouth bass, 2001.FeshriesResearsh 56 (2002) 89-95
- K.D.Miller ÄND R.H.Kramer, 1971. Spawning and early life history of largemouth bass (Micropterussalmoides) in Lake Powell,Spec.Publ.Am.Fish.Soc. (8):73-83
- M.DROUSSI, 2007. Rapport sur le Black bass. Centre nationale de pisciculture et d'hydrobiologie, station de la DEROUA. Haut-Commissariat des Eaux et forêts et lutte contre la désertification, 1-20p.
- M.MOUSLIH, 1989. Peuplement ichtyologiques des lacs de moyens Atlas marocain, région d'AZROU. Cybium1989, 13(1) : 13-24
- T.G. Brown, B. Runciman, S. Pollard, AND A.D.A. Grant 2009. Biological Synopsis of Largemouth Bass(Micropterussalmoides). 1-27p
- V. Rodriguez-Sánchez, L. Encina, A. Rodríguez-Ruiz and R. Sánchez-Carmona. 2009. Largemouth bass, Micropterussalmoides, growth and reproduction in Primera de Palos' lake (Huelva, Spain).Folia Zool. – 58(4): 436–446 (2009)
- Waters, D.S., And Noble, R.L., 2004. Spawning season and nest fidelity of largemouth bassin a tropical reservoir. North American Journal of Fisheries Management, 24: 1240-1251.