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High Density Pond Culture of Silver Perch, *Bidyanus bidyanus*

STUART J. ROWLAND

NSW Fisheries, Grafton Research Centre
Grafton, 2460, Australia

Abstract

Silver perch, *Bidyanus bidyanus*, fingerlings (mean weight 4.6 g) were stocked at a density of 43,000 fish·ha^{-1} in a 0.3-ha static, aerated, pond and fed a 35% protein diet at daily rates up to 168 kg·ha^{-1} for 14 months. Concentrations of total ammonia-nitrogen rose rapidly in summer and remained above 1.0 mg·l^{-1}. There was an outbreak of the mycotic disease, epizootic ulcerative syndrome, following a bloom of *Microcystis* and a rapid rise of pH to 9.4 and un-ionized ammonia-nitrogen to 0.39 mg·l^{-1}. An estimated 18.1% of fish harvested using a boat-mounted electrofisher had spinal damage and internal hemorrhaging. The overall survival rate was 69. 7%, the mean weight 402 g and the food conversion ratio 2.3:1. A production of 12,146 kg·ha^{-1} and a daily pro-duction rate of 27.8 kg·ha^{-1} are the highest yet achieved with silver perch, confirming its potential for intensive culture in ponds with limited water exchange.

Introduction

The Australian native freshwater fish, silver perch (*Bidyanus bidyanus*, Teraponidae), has potential for intensive culture in earthen ponds. There is considerable interest in this species in some Southeast Asian countries, and several million silver perch fry have been sent from hatcheries in Australia to China and Taiwan (Gooley and Rowland 1993). Results of a recent study by Rowland et al. (1995), in which mean annual production rate of fish stocked at a density of 21,000 $fish \cdot ha^{-1}$ in three 0.1-ha ponds was 9,819 $kg \cdot ha^{-1}$, mean food conversion ratio was 1.9, and cost of feeding was US\$1.12 kg^{-1}, demonstrate that silver perch could form a large industry based on high-volume, relatively low-cost production. The authors also suggested that the use of higher stocking densities would not adversely affect growth rates and would lead to much higher production rates.

In the monoculture of other freshwater species such as channel catfish (*Ictalurus punctatus*), common carp (*Cyprinus carpio*) and tilapia (*Oreochromis* spp.), stocking densities up to 30,000 $fish \cdot ha^{-1}$ are used in static, earthen ponds with no water exchange and limited aeration (Rappaport and Sarig 1979; Parker 1988; Visser 1991). As stocking densities and subsequent feeding rates increase, the water quality in ponds deteriorates; in particular, dissolved oxygen (DO) concentrations decrease, and concentrations of total ammonia-nitrogen (TAN) and un-ionized ammonia (NH_3-N) increase (Tucker et al. 1979; Tucker and Boyd 1985; Cole and Boyd 1986). Effluent water from fishponds stocked at a high density can be a source of pollution because of increased levels of nitrogen, phosphorus and organic material resulting from high feeding rates (Boyd 1982). Consequently there are environmental as well as management implications when maximizing stocking densities in static ponds.

The objectives of the current study were: to determine if silver perch could be cultured at 43,000 fish·ha^{-1}, a density higher than is normally used in static ponds; to monitor water quality and disease; and to evaluate the use of a boat-mounted electrofisher as a harvesting technique.

Materials and Methods

The study was conducted in a 0.3-ha pond (maximum depth 2 m) at the Grafton Research Centre, Grafton, Australia. Silver perch fingerlings (mean weight 4.6 g) were stocked at a density of 43,000 fish·ha^{-1} and cultured for 14 months from May (late autumn) through summer to July (winter). Replication was not possible because of limited pond space; however, the study was important because it complimented a concurrent stocking density experiment by Rowland et al. (1995). The pond was aerated using two 1-hp paddlewheel aerators for at least 11 h·d^{-1} between 2100 and 0800 h, and for 24 h·d^{-1} when water temperatures exceeded 25°C. Water was added to the pond every four to five weeks to replace that lost by evaporation and seepage; the pond was not flushed.

Fish were fed the dry, sinking crumbles and pellets of the 35% protein diet of Allan and Rowland (1992). The feeding regime followed that of Rowland et al. (1995), but with a maximum daily feeding rate of 168 kg·ha^{-1}. Approximately 40 fish were sampled monthly, the mean weight determined, the biomass estimated and the ration adjusted accordingly.

Monitoring of water temperature, DO, pH, TAN and NH_3-N followed Rowland et al. (1995). DO was also monitored at 0800 h. Gill and skin tissue from two to five specimens were examined monthly for ectoparasites.

In July of the second winter, a boat-mounted electrofisher (7,500 watt) operated at 340-500 volts, 10-12 amps at 60 pps and 70-90% duty cycle was used to harvest 5,523 fish weighing 2,301 kg over a four-week period. The remaining silver perch were then harvested by draining the pond. A sub-sample of 557 fish (>300 g) was held in 3 g·l^{-1} NaCl for 13 d; each fish was then filleted and examined for internal damage. All fish harvested were counted and bulk-weighed. The survival rate, mean weight, standing crop, production, annual and daily production rates and the food conversion ratio (FCR) were determined. The FCR was calculated by dividing the total weight of crumbles and pellets fed, by the gain in wet weight of fish.

Results and Discussion

A total of 9,054 fish, weighing 3,644 kg was harvested (Table 1). The survival rate of 69.7% is lower than survival rates previously reported for silver perch during the grow-out phase (Rowland 1994; Rowland et al. 1995) and may have been due to predation by cormorants (*Phalacrocorax* spp.) and the darter (*Anhinga melanogaster*) that were seen in the pond irregularly during the first six months of culture.

Table 1. Survival, mean weight standing crop, growth rate, production rates and food conversion ratio (FCR) of silver perch stocked at a density of 43,000 fish·ha^{-1} in a 0.3-ha pond and cultured for 14 months.

Survival (%)	69.7
Mean weight (g)	402.4
Standing crop (kg)	3,644
Daily growth rate (g·fish^{-1})[a]	2.0
Production rate	
kg·ha^{-1}	12,146
kg·ha^{-1}·day^{-1}[b]	27.8
kg·ha^{-1}·year^{-1}[b]	10,147
FCR	2.3

[a]During the "growing season" of October to March when water temperatures exceeded 20°C.
[b]Calculated using a 437-d culture period from day of stocking to the final day of harvest (2 May - 2 August).

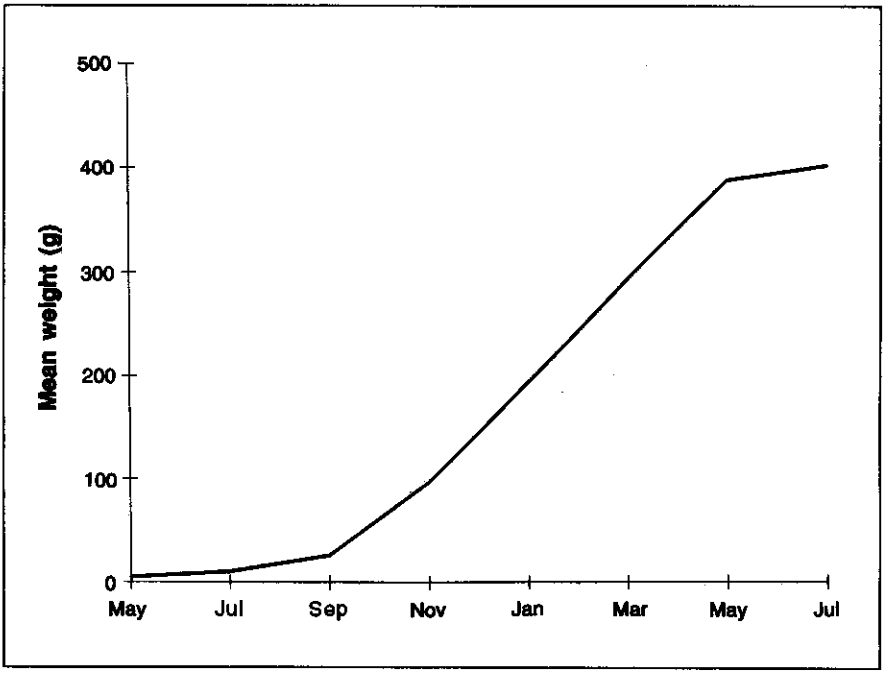

Fig. 1. Growth of silver perch stocked at 43,000 fish·ha^{-1} in a 0.3-ha earthen pond.

The production of 12,146 kg·ha^{-1}, and the daily and annual production rates of 27.8 kg·ha^{-1} and 10,147 kg·ha^{-1}, respectively (Table 1), are the highest yet reported for silver perch. The mean weight of silver perch was 402.4 g (Table 1). However, this is lower than the mean of 434.9 g of fish stocked at 21,000 fish·ha^{-1} and reared for only 10 months (Rowland et al. 1995). In addition, the difference between the annual production rates of fish stocked at 21,000 fish·ha^{-1} as reported by Rowland et al. (1995) and those stocked at a density of 43,000 fish·ha^{-1} in the current study was relatively small (Fig. 2), suggesting a density effect on growth and production.

Growth was slow during the first winter, relatively fast (2.0 g·fish·day^{-1}) from October to April, when water temperatures exceeded 20°C, and then slow during the last two months (Table 1, Fig. 1). The FCR of 2.3 (Table 1) is higher than previously reported for silver perch (Rowland 1994; Rowland et al. 1995). The slower growth and high FCR may have been caused by the inadequate grinding of raw materials for the pellets (Geoff Allan, pers. comm.), the dustiness of the feed (Rowland et al. 1995) and the poor water quality during the second half of the culture period.

Table 2. Range of each water quality variable recorded during the culture of silver perch in a 0.3-ha pond.

Variable	Range
Temperature (°C)	12.5 - 30.3
Dissolved oxygen (mg·l^{-1})	2.2 - 9.7
pH	6.3 - 9.4
Total ammonia-nitrogen (mg·l^{-1})	0.2 - 4.0
Un-ionized ammonia-nitrogen (mg·l^{-1})	0.01 - 0.39

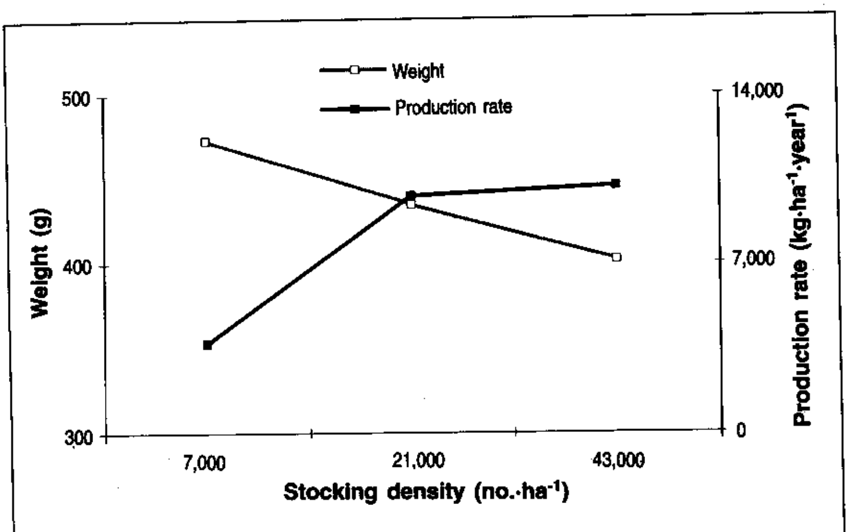

Fig. 2. Mean weights and annual production rates of silver perch in earthen ponds at different densities. Data for 7,000 and 21,000 fish·ha^{-1} from Rowland et al. (1995).

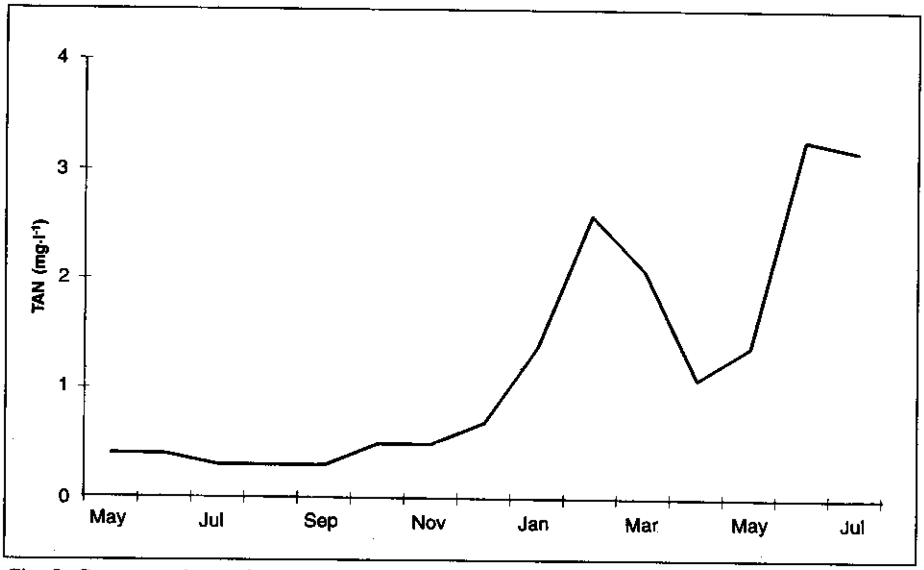

Fig. 3. Concentrations of total ammonia-nitrogen (TAN) in a 0.3-ha pond stocked with silver perch at a density of 43,000 fish·ha^{-1}. Data are mean monthly concentrations.

The range of each water quality variable recorded during the study is given in Table 2. Temperatures ranged from 12.5 to 30.3°C. DO measured in the afternoon ranged from 4.5 to 9.7 mg·l^{-1}, and in the mornings was as low as 2.2 mg·l^{-1} despite aeration. Concentrations of TAN rose rapidly in summer when feeding rates exceeded 70 kg·ha^{-1} and remained above 1.0 mg·l^{-1}with a maximum monthly mean of 3.6 mg·l^{-1} in June (Fig. 3). Similar levels have been found in channel catfish and silver perch ponds during summer when feeding rates exceeded 100 kg·ha^{-1} (Cole and Boyd 1986; Rowland et al. 1995).

Blue green algae, *Microcystis* and *Anabaena*, were present during summer, and a bloom predominantly of *Microcystis* developed in early March, coinciding with a decrease in the concentration of TAN (Fig. 3). During the bloom, there was a rise in afternoon pH values from 7.2 to 9.4 and NH_3-N from 0.01 to 0.39 mg·l^{-1} over a 9-d period. The fish ceased feeding and there was an outbreak of the mycotic disease, epizootic ulcerative syndrome (EUS). No mortalities were recorded and lesions on individual fish remained relatively small (<5 mm) and did not develop into ulcers. Poor water quality, particularly the rapid changes in pH and NH_3-N may have predisposed the fish to EUS in the current study. High concentrations of NH_3-N have been reported to significantly reduce growth in silver perch (Rowland et al. 1995) and rapid changes in water quality are thought to initiate changes to the skin which allow attachment of *Aphanomyces* spores and subsequent invasion of underlying tissue in an ulcerative disease of some Australian estuarine fishes (Callinan et al. 1989; Fraser et al. 1992).

The bloom of *Microcystis*, the deterioration of water quality and the subsequent loss of appetite and disease outbreak probably contributed to the slow growth during the last two months (Fig. 1). Apart from small numbers of *Trichodina*, no ectoparasites were found on the skin and gill tissue of fish sampled throughout the culture period.

Of the 557 silver perch examined internally after harvesting, 101 (18.1%) had hemorrhaging and obvious spinal damage, usually associated with the fourth, fifth or sixth caudal vertebrae. In some specimens, the vertebrae were badly splintered and there was extensive bruising of the muscle tissue, particularly towards the caudal peduncle making these fish unmarketable. This has not been previously seen in processed silver perch and it is presumed that the damage was caused by exposure to the electrofishing unit over the four-week period.

The results of this study confirm that silver perch is an excellent species for intensive culture in static, aerated, earthen ponds, but show that high feeding rates associated with rapid growth and the increasing biomass of fish at a high density during summer will result in a deterioration of water quality and increased susceptibility to disease. Comparison of the results to those of Rowland et al. (1995) clearly demonstrate the need for further research to determine the optimum stocking density of silver perch in static ponds. Future research will include an evaluation of the use of stocking densities from 21,000 up to 60,000 fish·ha^{-1}, the use of water exchange to maintain acceptable water quality, the aetiology of EUS, and the development of appropriate feeding regimes and cost-effective, high quality diets.

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References

Allan, G. and S. Rowland. 1992. Development of an experimental diet for silver perch (*Bidyanus bidyanus*). Austasia Aquaculture 6(3):39-40.

Boyd, C.E. 1982. Water quality management for pond fish culture. Elsevier, Amsterdam. 318 pp.

Callinan, R.B., G.C. Fraser and J.L. Virgona. 1989. Pathology of red spot disease in sea mullet, *Mugil cephalus* L., from eastern Australia. Journal of Fish Diseases 12:467-479.

Cole, B.A. and C.E. Boyd. 1986. Feeding rate, water quality and channel catfish production in ponds. Progressive Fish-Culturist 48:25-29.

Fraser, G.C., R.B. Callinan and L.M. Calder. 1992. *Aphanomyces* species associated with red spot disease: an ulcerative disease of estuarine fish from eastern Australia. Journal of Fish Diseases 15:173-181.

Gooley, G. and S. Rowland. 1993. Murray-Darling finfish current developments and commercial potential. Austasia Aquaculture 7(3):35-38.

Parker, N.C. 1988. Fish culture in the United States. In: Intensive fish farming (eds. C.J. Shepherd and N.R. Bromage), pp. 268-301. BSP Professional Books, Melbourne.

Rappaport, U. and S. Sarig. 1979. The effect of population density of carp in monoculture under conditions of intensive growth. Bamidgeh 31(2):26-34.

Rowland, S.J. 1994. Preliminary evaluation of the Australian freshwater fish silver perch, *Bidyanus bidyanus*, for pond culture. Journal of Applied Aquaculture 4(1):39-48.

Rowland, S.J., G.L. Allan, M. Hollis and T. Pontifex. 1995. Production of the Australian freshwater silver perch, *Bidyanus bidyanus*, (Mitchell), at two densities in earthen ponds. Aquaculture 130:317-328.

Tucker, C.S. and C.E. Boyd. 1985. Water quality. In: Channel catfish culture (ed. C.S. Tucker), pp. 135-227. Elsevier, Amsterdam.

Tucker, L., C.E. Boyd and E.W. McCoy. 1979. Effects of feeding rate on water quality, production of channel catfish and economic returns. Transactions of the American Fisheries Society 108:389-396.

Visser, J.G.J. 1991. Intensive production of *Oreochromis mossambicus* (Peters) with special reference to the relationship between water exchange rate and growth rate. Water South Africa 17(2):139-146.

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