Culture Trials of Nile Perch Juveniles in Cages and Earthen Ponds

N.O. Outa and E.O. Ogello

The fishery for Nile perch *Lates niloticus* has been one of the most economically viable fisheries of Lake Victoria since introduction of the species in the 1950s (Cowx *et al*. 2003). The main aim of the introduction was to convert native bony haplochromines in the lake into more economically useful biomass for food and trade (Goudswaard *et al*. 2008). The value of Nile perch at the beach level is estimated to be more than US$400 million, with an export value of US$240 million (World Bank 2010). The contribution of Lake Victoria fisheries to the GDP of the riparian countries is Kenya 2.0 percent, Tanzania 2.8 percent and Uganda 3.0 percent, of which 78 percent is contributed by Nile perch (LVFO 2013).

By 2012, there were 4,156 fishing boats operating on the Kenyan side of Lake Victoria, of which 3,240 were mainly targeting Nile perch (LVFO 2012). Due to the economic viability of Nile perch, the catch per unit effort in Lake Victoria has been progressively declining. The decline of the Nile perch fishery has been accelerated by various ecological challenges that have occurred in the lake (Ogello *et al*. 2013).

Other perches, such as Eurasian perch *Perca fluviatilis*, Asian sea bass/barramundi *Lates calcarifer* and yellow perch *Perca flavescens* have been cultured successfully in Spain, some Asian countries and the USA, respectively (Acerete *et al*. 2004, Paterson *et al*. 2003). However, successful captive breeding and culture trials of Nile perch are scanty in the Lake Victoria region, despite the importance of Nile perch to the economies of the riparian countries. Although culture trials at the Kajjansi Aquaculture Research and Development Centre in Uganda demonstrated that Nile perch grows exponentially from 10 to 550 g in seven months (Gregory 2006), more data are needed across the East African region to authenticate the culture potential of Nile perch. Indeed, with the deteriorating ecological conditions of Lake Victoria, there is need for other alternatives of Nile perch production to ensure a steady supply to fish markets.

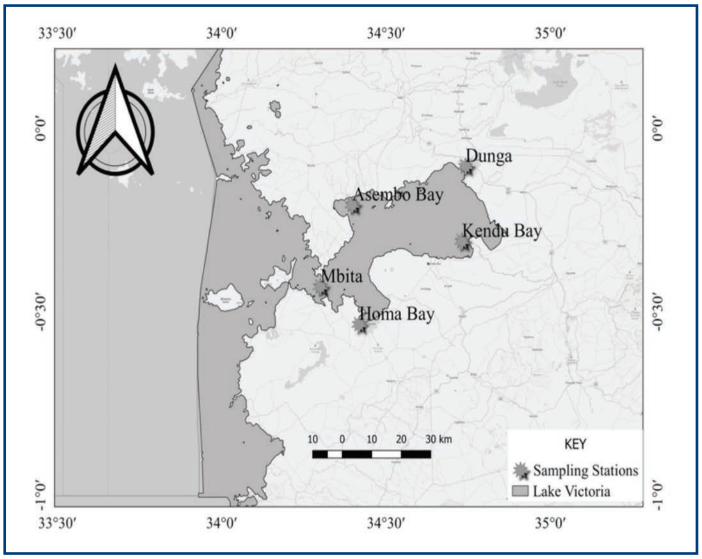

FIGURE 1. *Map of Winam Gulf, Lake Victoria, Kenya: the red stars represent beaches where sampling was done during the experiment.*

> The fishery for Nile perch *Lates niloticus* has been one of the most economically viable fisheries of Lake Victoria since introduction of the species in the 1950s. The catch per unit effort in the lake has been progressively declining, accelerated by various ecological challenges that have occurred. With the deteriorating ecological conditions, there is need for other alternatives of Nile perch production to ensure a steady supply to fish markets.

This article describes a study to generate data on handling, transport, feeding and captive culture of Nile perch to bridge some knowledge gaps in evaluating the aquaculture potential of this economically important fish.

Study Area

Fish were sampled around Winam Gulf (0° 15' S, 4° 35' E) (Fig. 1). The Gulf stretches about 100 km east to west and 50 km north to south and has about 550 km of shoreline. The Gulf is rather shallow, with an average depth of 6 m and a maximum depth of 37 m (Okely *et al*. 2010). Surface water temperatures range between 23.5 and 29.0 C. The area is sheltered from strong winds and serves as the breeding zone for many fish, including Nile perch (Campbell *et al*. 2003).

Density during Transport

Fish were obtained from Asembo Bay, Dunga, Kendu Bay, Homa Bay and Mbita beaches around Lake Victoria using beach seines (<10-mm mesh). Fish were sorted by size and stocked into hapa nets, each measuring 3 m × 3 m × 1 m, placed under papyrus shade near the lakeshore overnight, about 12 hours. This was meant to enable the fish to evacuate gut contents before transportation. Fish were packed into 10-L polyethylene bags containing 5 L of lake water at densities of 40, 80 and 100 g/L. Bags were oxygenated with medical-grade oxygen from a compressed gas cylinder to 100 percent saturation.

Each density was replicated in three bags. Packed bags were placed in a plastic tank (1 m × 0.8 m × 0.35 m) lined all-round with a mattress to maintain the temperature at 25 ± 1 C, which was loaded into an air-conditioned automobile. Fish were transported by road for four hours from Homa Bay (0° 31' S, 34° 27' E) to the Kenya Marine and Fisheries Research Institute, Kegati station (0° 41' S, 34° 46' E).

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TABLE 1. Mortality and survival of Nile perch fingerlings after four hours transport and after five days.

Fish size (cm)	Stocking density (g/L)	Mortality during transport (%)	Mortality after 5 days (%)	Survival after 5 days (%)
2-4	40	63±15	8±10	28
	80	70±21	3±3	27
	100	57±34	4±5	30
5-7	40	15±5	0	74
	80	11±10	0	88
	100	24±14	7±4	64
8-15	40	0	0	100
	80	7	5±7	88
	100	3±2	3±4	94

In the laboratory, each bag with fish was placed in a 1-m^3 tank containing 500 L of rainwater and opened after fish had acclimatized to the tank water temperature. Mortality was determined by counting the number of dead fish in each tank. Mortality in each tank was monitored for 5 days and was then added to the mortality immediately after transport to obtain the cumulative mortality. Mortality of smaller fish (2-4 cm) was significantly greater during transport and after five days compared to larger fish (Table 1).

FIGURE 2. *Experimental cages for Nile perch culture at Mageta Island.*

Prior to sealing bags, water pH, dissolved oxygen (DO) concentration and temperature were measured with a multi-parameter meter (YSI PRO 2030). Three water samples were collected from each bag and stored in ice for laboratory analysis of initial total ammonia nitrogen (TAN). Upon arrival pH, DO and temperature in each bag were determined and other water samples collected for TAN analysis. TAN was analysed in the laboratory using standard method (AOAC 2005).

The TAN concentration after four hours of transport was significantly greater than the initial value of 0.11±0.01 mg/L. The TAN concentration reflected density, with the lowest concentration (0.21±0.01 mg/L) at 40 g/L, intermediate concentration (0.43±0.07 mg/L) at 80 g/L and highest concentration (0.69±0.78 mg/L) at 100 g/L.

Growth Trials in Cages and Ponds

Feeding of Nile perch started one day after stocking. Fish were fed with live feeds (catfish and tilapia fry) maintained at 10 fry/L in the culture tank for two weeks before transfer to cages and ponds. Catfish fry were obtained by artificial induction, fertilization and hatching using standard procedures previously established in the KMFRI laboratory and tilapia fry were obtained from KMFRI nursery ponds. Fish for cage trials were transported to the cage site in aerated tanks.

Fish cages (Fig. 2) measuring 10 m × 5 m × 2.5 m were located in Mageta island (0° 7’ 59” N, 34°0’ 51” E). Cages were made with a steel frame holding a 5-cm mesh net at the bottom and located in an area sheltered from strong winds. Cages were placed 200 m from the lakeshore for ease of access and management and at a depth of about 5 m.

Three cages were used for the experiment. Each cage was stocked with 2,000 fish, each with an average initial weight of 20 g. Fish were fed daily with live foods consisting of haplochromines and other small fishes obtained from the lake, dams and abandoned fish ponds. To maintain diet throughout in the cage, a solar lamp was fitted on the cage at night to attract wild fish fry and insects for the cultured Nile perch.

Nile perch were stocked into three ponds at 1000 fish per pond. Ponds measured 30 m × 10 m × 2.2 m and were located at the KMFRI-Kegati station. Ponds also had 1000 mixed-sex tilapia that produced approximately 5000 fry per week that served as food for Nile perch in addition to haplochromines and small fish. The pond was fitted with solar lamps to allow fish to feed at any time as was the case with cages. Tilapia in ponds were fed formulated feeds with 40 percent crude protein.

Biometric data on length and weight was collected weekly for the six-month culture period. At the end of the experiment, the specific growth rate (SGR) and survival rate (SR) were calculated for both fish in cages and ponds using the formulae:

SGR= [ln (final weight) – ln (initial weight) ×100]/ number of days of the experiment;

SR= (Number of fish at stocking / number at harvesting).

The growth rate (SGR) of Nile perch in cages (0.83 percent/d) was significantly greater than that in ponds (0.52 percent/d) (Fig. 3). Survival was 100 percent in both environments.

Water Quality in Cages

Water quality parameters, dissolved oxygen, temperature, pH, and TAN and total phosphorus were tested biweekly throughout

TABLE 2. Ranges and averages (in parentheses) of water quality parameters in the open lake and Nile perch cage during the culture period.

Parameters (mg/L)	Open water	Inside the cage
TAN	0.29 - 0.40 (0.30±0.04).	0.31- 0.41 (0.35±0.04)
NO_2	0.33 - 0.42 (0.37±0.05)	0.29 - 0.41 (0.36±0.05)
NO_3	0.51- 0.61 (0.57±0.04)	0.49 - 0.60 (0.56±0.04)
PO^4	0.16 - 0.20 (0.17±0.01)	0.16 - 0.19 (0.17±0.02)

the culture period in and out of the cages. The average water quality parameters before the culture experiment were 0.36±0.14, 0.29±0.16, 0.53±0.03 and 0.16±0.01 for NH_4, NO_2, NO_3 and PO_4 respectively. Water quality was not different between the open lake and the fish cages as well as before and during culture (Table 2).

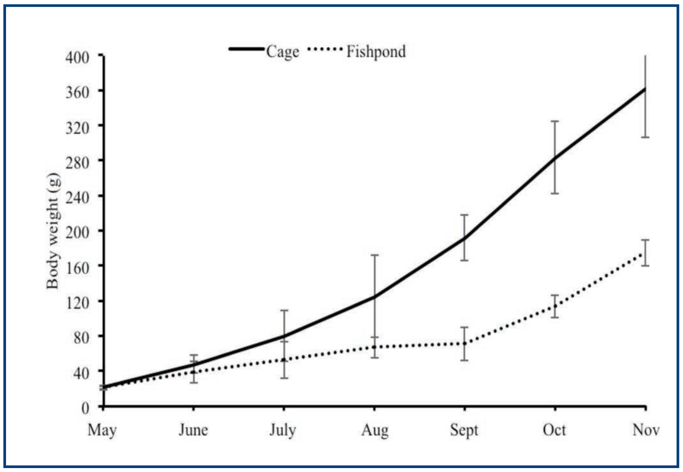

FIGURE 3. *Monthly growth rate of Nile perch in cages and ponds.*

Nile perch has been considered as an unconventional aquaculture fish and its culture has not been practiced, particularly in Kenya. This study demonstrated that Nile perch can withstand handling and transport, indicating the capacity of Nile perch to quickly adapt to packing conditions. The growth rate of Nile perch in cages was significantly greater than that in ponds.

Discussion

Aquaculture can help improve food security in Kenya. This depends on research and scientific knowledge available on the fish considered for culture. Nile perch has been considered as an unconventional aquaculture fish (Kigbu *et al*. 2014) and its culture has not been practiced, particularly in Kenya. Knowledge of the feeding behaviour of fish is important to formulate feeds during culture in captivity. Nile perch is a predatory fish that feeds predominately on fish and shrimp (Kishe-Machumu *et al*. 2012, Dadebo *et al*. 2005, Mhitu and Chande 2004).

Successful and economical handling and transportation of fish fingerlings from the source to the culture centres or facilities is important in the fish production chain (Bui *et al*. 2012). Any fish for aquaculture should be able to withstand handling stress during sampling and transport (Acerete *et al*. 2004). Transport experiments have been conducted for most of the important aquaculture species in Kenya like *Labeo victorianus*, *Oreochromis niloticus* and *Clarias gariepinus* (Orina *et al*. 2014, Oyoo-okoth *et al*. 2011) but not for Nile perch because this species has not been transported and cultured effectively.

This study demonstrated that Nile perch can withstand handling and transport, indicating the capacity of Nile perch to quickly adapt to packing conditions. Because of the lack of data on optimal packing densities, handling and transport of Nile perch, mortality related to cannibalism and transport stress was a challenge during preliminary transport experiments. The procedure of fish handling is important in determining the stress level during packaging for transport. To reduce stress, fish were scooped before the net was hauled into the boat and transferred to a basin for sorting and packing. Because Nile perch is highly piscivorous, size sorting is necessary before packing to reduce cannibalism inside transport bags.

Fast growth is a desirable characteristic in any fish considered for aquaculture (Maithya *et al*. 2003). Culture methods and systems should therefore be designed to encourage and promote fast growth. Fish growth is affected by diet, water quality and handling stress.

Water quality challenges experienced in pond systems are reduced in cages due to the constant flushing of wastes and remnants of feed by water currents. This encourages faster growth in fish reared in cages compared to pond environments (Huchette and Beveridge 2003). Mwachiro *et al*. (2012) recorded a significantly higher growth rates in *Oreochromis jipe* reared in cages in Lake Jipe than in ponds. They attributed this to the higher dissolved oxygen in the cage due to water currents and the better water quality compared to conditions in ponds.

Cage aquaculture in Kenya is at its formative stages and there is very little technical support to farmers venturing into this culture method. In the current study, the size of fish at the end of culture period was homogenous with few smaller Nile perch.

The problem faced in culture of Nile perch is the predatory nature since it preys on live fish (Outa *et al*. 2016). Trial experiments in Uganda showed considerable potential for aquaculture. The most promising results were obtained from raising the fish in trash-fish fed net cages sited in ponds. The growth of wild-caught Nile perch

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resulted in exponential growth from 10 to 550 g in seven months. No incidences of mortality or cannibalism were recorded in this experiment and the fish did not appear to be overly sensitive to low dissolved oxygen and constant sampling (Gregory 2006). Nile perch will accept trash fish, strengthening the possibilities of its captive culture. During the current experiment, fish in cages were fed on small trash fish consisting of *R. argentea* and haplochromines bought from fishermen.

The impact of cage fish farming on the aquatic environment by the release of nutrients that affect water quality can bring about conflict with multiple water users and also have a negative feedback effect on the caged fish. This can be due to algal blooms which can lead to reduced oxygen causing fish mortality (David *et al*. 2015, Degefu *et al*. 2011, Hallare *et al*. 2009). There were no such effects recorded in this study because no artificial diet was fed to the fish in the cages.

Cases of theft, fish poisoning and cage breakages by strong waves have been reported in Malawi (FAO 2007). Site selection and security are therefore important factors to consider while setting up cage culture facilities. Cages occupy space on the surface of water bodies and, if poorly positioned, may disrupt navigation or diminish the scenic value of the water body. Because of overfishing within the lake, captive culture of Nile perch can be useful in reducing fishing pressure on the wild stock while providing cheap and high-quality protein to the people around the lake region.

Boutique Fish Farms, a research project funded by World Bank and conducted by the University of Jerusalem has sought to establish aquaculture systems for local communities to boost fish supplies in Uganda. Nile perch aquaculture was one of ventures considered by the project (Hebrew University of Jerusalem 2010). Although the results of the project are not explicitly available, it highlights the possibility of captive culture of Nile perch.

The results showed that Nile perch can be transported and reared in ponds and cages. Cage aquaculture of Nile perch can be adopted as a measure to reduce pressure on the wild stock occasioned by high exploitation pressure and environmental degradation. There is need for further studies on the ecology, biology and potential of this fish in aquaculture. This article lays a foundation for future research.

Notes

N.O. Outa* and E.O. Ogello

Department of Fisheries and Natural Resources, Maseno University, P.O. Box Private Bag, Maseno, Kenya

* Corresponding author: nichouta@gmail.com
Tel: +254 723 052 865

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