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FULL LENGTH ARTICLE

Initial observations of movement patterns in the apex fish predator, the Nile perch (*Lates niloticus*), in Lake Nasser, Egypt

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Abstract Nile perch, *Lates niloticus*, are top predators in the Nile River's, Lake Nasser, where they support important commercial and recreational fisheries; yet, anecdotal evidence indicates overfishing may be causing declines in population size structure. Little is known about Nile perch population biology, movements, and habitat selection. In 2010, we began a pilot study in Lake Nasser to investigate the Nile perch. One 33-kg Nile perch was successfully implanted with an ultrasonic telemetry transmitter and tracked on two occasions for 12 h each time. Following a "resting" phase, at sunset, the Nile perch crossed several km of pelagic zone to reach the far shoreline of the lake where it spent the night foraging among the aquatic vegetation. Sensor data revealed that the fish's movements covered relatively narrow thermal and depth ranges. Interestingly, the fish's transmitter signal was reacquired 2 months later in the exact GPS location where it was initially caught suggesting seasonally strong site fidelity. Further tracking studies are needed to better understand Nile perch life history and ecology in Lake Nasser in order to protect and conserve this valuable economic resource.

Introduction

The Nile perch, *Lates niloticus*, is native to central, western, and eastern Africa including the major river systems of the Congo, Volga, and Senegal as well as Lakes Chad and Turkana and the Lake Nasser Reservoir of the Nile River (Froese, 2014). It is the largest apex fish predator of Lake Nasser and the Nile River ecosystems reaching sizes over 2 m in length and up to 200 kg in weight. This enigmatic predator has been revered in Egyptian culture since antiquity being immortalized

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by mummification during the reign of Ramses II (ca. 1300 BC) (Nims, 1965). Geologically however, Nile Perch have evolved over millions of years in the Nile River drainage and have achieved a balance with the other species in the fish communities of the Nile River and Lake Nasser (Murray and Attia, 2004). In contrast, it was introduced for commercial fishery development (circa 1954) to the Great African Rift Lakes, where it has adversely impacted Lake Victoria's fish community and caused the extinction of potentially hundreds of endemic haplochromine cichlids that represent one of the great evolutionary examples of adaptive radiations (Goldschmidt et al., 1993). Although the ecological impacts of introduced populations of Nile perch have been well documented on food web dynamics (Ogutu-Ohwayo, 1993; Kitchell et al., 1997), limited scientific information exists about Nile perch ecology in their native habitats. The fishery of Lake Nasser was valued at over US $7 million nearly 30 years ago (Abdel-Latif, 1984) making understanding its ecological role economically important for Egyptian fisheries.

Long term monitoring of the Nile perch population in Lake Nasser is necessary to provide important biological and ecological information about the Nile perch's habitat utilization patterns that will be critical for determining conservation and fishery management measures aimed at maintaining healthy and sustainable populations in Lake Nasser (e.g. possible time/area closures to protect spawning and/or recruitment refugia). Radio telemetry and manual tracking have been used previously to obtain critical information on the movement, habitat use, and distribution of large cichlids in the Zambezi River, Namibia (Thorstad et al., 2012). Thus, the goal of this pilot study was to assess the potential for developing a Lake Nasser Nile perch Research Program using similar tagging and telemetry techniques to improve our limited understanding of population ecology, life history, and essential habitat of this commercially and ecologically important species.

Materials and methods

Study area and tracking events

In 2010, we began a pilot study in Lake Nasser, Egypt (22° 25′ N, 31° 45′ E) with the cooperation of African Angler Safaris to investigate the territory size and habitat selection of adult Nile perch. Fish were captured with hook and line, weighed for mass (g) and measured for total lengths (cm). Fish were implanted with a VEMCO dual sensor ultrasonic telemetry transmitter (V16TP continuous). After consultations with VEMCO engineers and review of the perch's life history (Froese, 2014), a minimum body size of 20 kg was chosen to minimize any deleterious effects of tag implantation and focus the research on movement behaviors of sexually mature individuals. These sensors simultaneously transmit depth and water temperature data which is detected by a directional hydrophone placed in the water and recorded to a VR-100 receiver that identifies the GPS location of the vessel and indicates the fish is within 500 m of that position. After meristic measurements were taken, a small 5 cm incision was made just anterior to the anus and the transmitter was embedded into the body cavity. A suture is then used to close the incision and iodine antiseptic was applied to prevent infection. Implantation surgery generally lasts less than 5 min and no anesthetics were necessary.

Data analysis

The fish's movement within the lake was continuously monitored every 5 min for each 12 h track. Mean GPS positions, depths, and temperatures for each track were determined by averaging those parameters over half hour intervals at the top and bottom of each hour and plotted using ArcView GPS software version 10.1.

Results and discussion

On March 26th (Track 1), one 33-kg Nile perch was captured with hook and line and successfully implanted with the ultrasonic telemetry tag. After implantation, the fish was then immediately returned to the water around mid-day and revived for less than 10 min at which point it was healthy enough to swim away into the depths near the shoreline and allowed to recover. Following a ''resting'' phase subsequent to the tagging event, the fish was tracked for ~12 h until stormy weather forced cessation of tracking. Returning to the GPS location of the original tagging event site on June 6th (Track 2), the fish was relocated and tracked for another ~12 h period. A third tracking expedition was conducted in January 2011 at the same location of Lake Nasser; however, after a 5 km linear search was conducted on each side of the Lake to the north and south of the tagging event site, we failed to relocate the transmitter signal of this focal individual.

During these initial observations, this research was able to successfully monitor the movement patterns of this adult Nile perch for over 24 h across two separate tracking events. Regarding the third expedition which failed to locate the tag's transmitter signal, it is possible the transmitter battery died. However, we believe this to be less likely, since a ten-month activation period is well within the 14-month lifespan of factory specifications. It is more likely that the fish migrated to a different region of the lake for the winter or had been commercially harvested during the seven month hiatus between summer and winter tracking expeditions. Unfortunately, while several other Nile perch were caught during these expeditions, none were deemed to be suitable for the surgical implantation of the V16TP telemetry tags without potentially harmful side effects or loss of the tagged fish to large numbers of commercial fishermen in the certain areas.

Movement patterns and territory size

After the initial acoustic tagging (Track 1), the Nile perch remained motionless at approximately 6 m depth for several daylight hours at a rocky point near the entrance of a small wadi (Fig. 1). At sunset, the fish began to move and swam southeast 3 km in a relatively linear fashion to the far shore of Lake Nasser where we recorded it pacing a shallow island at about 3–4 m depth for several hours. Returning two months later in June (Track 2), the fish's transmitter signal was reacquired, and the fish was found milling about at approximately 10–12 m depth at virtually the exact same GPS position where it was originally caught and tagged. Again, at sunset, the fish began to move and this time traveled west/southwest 1.5 km to a small peninsula with a deep rocky ledge where it appeared to slowly swim a circuit at around 8 m throughout the night (Fig. 1). These two tracks indicated a minimum territory size