The Effects of Tilapia Introductions on Native Fish Populations of Florida and North America

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More exotic fishes have been introduced and established in Florida than any other state or place in the world. Florida's tropical-subtropical climate coupled with advanced reproductive strategies and the many changes in water-flow patterns (mainly the channelization of South Florida water bodies), has made the establishment of exotics like tilapia possible. Introductions of various tilapia species occurred through escape from aquarium industry ponds and/or the purposeful release from private or state stocks for aquatic plant control. The potential of these fish to affect native species deleteriously has been a major concern of the Florida Fish and Wildlife Conservation Commission for more than 35 years. This concern is warranted, since the majority of published literature focusing on the competition between tilapia and native fish populations. However, exotic fish like tilapia appear to be more symptomatic of problems than the primary cause of them. This review focuses on the limited number of documented interactions between tilapia and native fish of Florida and North America.

INTRODUCTION

More exotic fishes are introduced to and established in Florida than any other state or place in the world (Shafland 1996). Florida's tropical-subtropical climate coupled with advanced reproductive strategies and many changes in water-flow patterns (mainly the channelization of many South Florida water bodies), have made the establishment of exotics like tilapia possible (Shafland 1979). Four species of tilapia, representing three different reproductive strategies of this group are established in Florida. The maternal mouth brooding blue tilapia (*Oreochromis aureus*) has been the most successful tilapia in terms of distribution, primarily because it tolerates lower water temperatures than the other tilapia species present in Florida (Shafland 1996). This species was brought to Florida from Auburn University in 1961 for aquatic plant control experiments and has spread to various parts of the state by escaping from aquaculture or private facilities (Courtenay et al. 1974; Hogg 1974; Kushlan 1986). The Mozambique tilapia (*Oreochromis mossambicus*) is common and successful in South Florida canals, where they have been found to hybridize with the blue tilapia (Shafland 1996).

Introduction has been the result of accidental release from fish farms and the intentional release for aquatic plant control by state and federal agencies (Courtenay et al. 1974; Fuller et al. 1999). The spotted tilapia (*Tilapia mariae*) is also present in South Florida canals, but unlike the mouth brooding tilapias, this tilapia uses substrate for spawning. This species has become abundant because they are able to spawn to some degree year round (Shafland 1996). The blackchin tilapia (*Sarotherodon melanotheron*), a biparental mouth brooder, was the first tilapia to become established in Florida. However, this tilapia as been relatively limited in its distribution, with two separate populations found in both Hillsborough and Brevard/Indian River Counties. Introduction of this species has been the result of one or more aquarium fish farms along waters in these counties (Shafland 1996; Courtenay et al. 1974).

No exotic fish in Florida, including the various tilapia species, has ever caused any native fish to become extinct. Despite this fact, concern for problematic effects is warranted since virtually all foreign species introductions have had objectionable, if not deleterious, consequences. Since it is impossible to accurately forecast the biological effects that tilapia will have on every water body in Florida or the United States, introductions should be based on sound ecological and management practices coupled with public awareness (Shafland 1979; Shafland 1986).

Competition between tilapia and native fishes centers on their more advanced reproductive strategies. Mouth brooding and year-round spawning, coupled with rapid growth, hardiness, and the adaptability to all trophic states of sub-tropical waters has and continues to signify rapid production of these fish (Hubbs 1968). The limited number of documented impacts tilapia have on native fish in Florida and elsewhere in the United

States centers around the effects of overcrowding. The potential for overcrowding can also lead to recruitment/reproductive alterations and competition for food (Courtenay and Stauffer 1984; Fuller et al. 1999; Shafland 1979).

OVERCROWDING EFFECTS

High abundance and densities of tilapia in certain waters has resulted in marked changes in the fish community structure. The apparent displacement of gizzard shad by blue tilapia has been documented in both Florida and Texas. Four years after the introduction of blue tilapia into Lake Parker, Florida, the composition by weight of gizzard shad changed from 60% in 1968 to 5% in 1972 while blue tilapia composition changed from 5% in 1968 to 68% in 1972. The same scenario was found to be true on Trinidad Lake, Texas. Shad populations in this lake declined as the blue tilapia population numbers increased, and after a tilapia die-off due to a cold snap, the shad populations increased (Foote 1977). Fish community structure collections of South Florida canals in 1978 found fewer numbers of native fishes as compared to collections in 1970, when spotted tilapia became the dominant species. In some of these canals, overcrowding by the spotted tilapia also caused a decrease in the population sizes of previously established exotic fishes (Courtenay and Hensley 1979).

RECRUITMENT/REPRODUCTIVE EFFECTS

A decline in the successful reproduction of largemouth bass in some studies has been linked to overcrowding by tilapia. This was found to be true in a Texas power plant cooling reservoir when the standing crop of blue tilapia reached 2,000 pounds/acre. Pond studies in Florida have indicated the largemouth bass failed to reproduce when tilapia densities reached 2,000 pounds/acre, with limited reproduction occurring at densities of

1,000 pounds/acre (Foote 1977). Mean production of Florida largemouth bass fingerlings was found to be 84% less (x = 340) in 0.01-hectare ponds with tilapia densities of (760-1,900 kg/hectare or 1,300-2,500 fish/hectare), as opposed to ponds containing no tilapia (x=2,183) (Shafland and Pestrak 1983).

FOOD COMPETITION EFFECTS

Food competition between tilapia and native fish populations may occur when they both utilize the same limited food resource. A food habit study of blue tilapia, gizzard shad, and threadfin shad in Trinidad Lake, Texas indicated that these species utilized the same food with blue tilapia consuming the largest percentage of detritus (Foote 1977). Dietary overlap between shad larvae and the early life stages of blue tilapia was found to be relatively high in Lake George, Florida. This suggests why dietary competition between early life history stages of these species may contribute to declines in shad populations after blue tilapia introductions (Zale and Gregory 1990).

Growth and survival of young blue tilapia was found to exceed that of young largemouth bass by 50% in tank experiments containing equivalent prey (zooplankton) densities, and fish at equivalent ages. The fish used for these experiments were fry (juvenile) blue tilapia and largemouth bass collected from hatchery ponds. Since blue tilapia and largemouth bass both spawn in the spring, they were able to use fry of both fish at similar ages. Increased growth and survival of the young blue tilapia was attributed to their larger initial egg and fry size, which gave them the ability to be more efficient than young largemouth bass at utilizing zooplankton as food (Zale 1987). In Lake Fairfield, Texas, cages were placed in the water containing both age-0 largemouth bass and blue tilapia to evaluate growth. This cage study allowed the bass and tilapia to

feed on natural food within the lake. When largemouth bass were grown in combination with blue tilapia, it was found that length and weight differed significantly from bass grown alone in separate cages. Adversely, blue tilapia grown in combination with largemouth bass had significantly greater lengths and weights than tilapia grown alone in separate cages. The length and weight differences between the bass grown with tilapia and without tilapia were attributed to competition for similar food resources (Traxler and Murphy 1995).

CONCLUSION

Given the large number of water bodies and aquaculture facilities here in Florida and elsewhere in the United States, wide scale introduction of tilapia species has been and will undoubtedly continue. In order to help deter continued tilapia introductions, state and federal agencies should focus on prevention, assessment, and management. Prevention involves law enforcement, education, and when needed, elimination of localized populations. Assessment of released tilapia is accomplished through continued research programs. Management practices involve minimizing their detrimental impacts while maximizing any intended attributes (Shafland 1986). As evident from this review, there is and continues to exist a limited number of publications on the effects tilapia pose to native fish populations. From what I gathered in talking with biologists who work with non-native fish in Florida, is that they believe competition effects occur, but to what scale these effects have on native fish is truly not understood in a wild system. Since it is impossible to accurately predict the ultimate biological and ecological effects tilapia introductions have on native fish, further purposeful or accidental introductions should be approached with a better understanding of their consequences.

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