Enhancement of Texas Sciaenids (Red Drum and Spotted Seatrout)

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Abstract

Recreational fishing for two estuary-dependent sciaenids, red drum (*Sciaenops ocellatus*) and spotted seatrout (*Cynoscion nebulosus*), is of vital importance to the economies of Texas (U.S.) coastal communities. The Texas saltwater recreational fishery, with about 1.2 million fishermen, is presently worth US$2 billion per year; of that total economic value, the recreational fisheries for red drum and spotted seatrout - the two major targeted species - are worth $350 and $220 million.

In the 1970s, apparent abundance of red drum in Texas waters reached alarming lows. Stocking red drum fingerlings to enhance the wild population was initiated in 1975, with a large-scale stocking program coming on-line in1983. To date, more than 568 million red drum fingerlings have been hatchery-produced and released into Texas coastal bays. At least partly as a consequence of this enhancement effort, the red drum bay population in Texas waters now has rebounded to near-record levels. Estimates of the contribution made by stocked hatchery fish to total red drum numbers in Texas bays have ranged from 0 to 30%. It is increasingly apparent that the efficacy of the stock enhancement program varies widely, both from year to year and from bay to bay. Yet, it is equally evident that overall, Texas Parks & Wildlife's long-term management plan using hatcheries to supplement natural recruitment, in concert with traditional management tools, has played a crucial role in mitigating and countering the decline of the red drum population.

During the past two decades, managers have had to implement increasingly restrictive fishing regulations for spotted seatrout, prompted by evidence of overfishing, including declines in mean size of fish caught by anglers and also in estimated spawning stock biomass. Beginning in 1993, traditional management was complemented by the stocking of hatchery-reared juveniles. Since then,

more than one million spotted seatrout fingerlings per year have been stocked, with the cumulative total now exceeding 50 million. Currently, the spotted seatrout population is healthy along most of the Texas coast, with management concerns focusing on the middle coast. Evaluation of the success of the seatrout stocking program is ongoing with studies based on the application of genetic markers.

Fishery managers in Texas have taken the often controversial practice of stocking hatchery-produced fish and used it to the apparent benefit of the red drum and spotted seatrout fisheries. In turn, organizations of recreational fishermen have been staunch advocates of the enhancement program, providing not only invaluable political support but also $4 million in direct contributions to operation of the program. The utilization of stocking, combined with traditional management practices, has proved to be a powerful combination in managing Texas natural resources wisely. The objective of this article is to present an overview of Texas' marine stocking program as it has benefited multiple users and stakeholders, including anglers, and coastal communities economically impacted by recreational fishing.

Introduction

Recreational fishing is a high-value business in the United States, with a US$125 billion impact on the nation's annual economy (DOI 2008). Nearly 60 million anglers generate over $45 billion in retail sales each year, and support employment for over one million American workers. Gulf of Mexico recreational fisheries generate $5.4 billion annually in economic benefits. Recreational fishing added 1,000 new jobs a year to the Texas economy from 2001 to 2006 (DOI 2008). Despite the nation's recent economic troubles, recreational fishing has continued to grow. In 2009, fishing license sales rose by 4.7 percent in 12 states (Florida, Indiana, Kansas, Louisiana, Minnesota, New Hampshire, New Jersey, New York, North Carolina, Oregon, Texas and Utah; Southwick Associates 2010). On average, each angler spends $176 a year on fishing tackle and contributes over $40 annually to conservation via license dollars and excise taxes.

The state of Texas ranks first nationally in numbers of sportsmen, outdoors-related expenditures and associated jobs. Some 2.5 million hunters and anglers spend $3.2 billion annually and support 106,000 jobs in Texas (DOI 2008). Saltwater recreational fishing for two estuary-dependent sciaenids, the red drum (*Sciaenops ocellatus*) and the spotted seatrout (*Cynoscion nebulosus*), is extremely important to the local resource-based economies of Texas coastal communities. The Texas saltwater recreational fishery, with about 1.2 million fishermen, is worth $2 billion annually (Southwick Associates 2007); of that total economic impact, the recreational fisheries for red drum and spotted seatrout - the two major targeted species - accounts for almost two-thirds of the more than 15 million saltwater fishing days by residents and non-residents in 2006 (DOI 2008). Economically, this translates into over $530 million in total expenditures (food, lodging, transportation, equipment, and other trip costs) for the two species.

The state's natural resources conservation agency, Texas Parks and Wildlife Department (TPWD), has a stated mission to provide hunting, fishing, and outdoor recreation opportunities for

the use and enjoyment of present and future generations (TPWD 2010). The agency is funded primarily through hunting and fishing license sales, state park entrance and camping fees, and a dedicated portion of the state sporting goods sales tax. Hunting and fishing license sales increased slightly in 2009, with a total of about 1.9 million sold, despite a five percent increase in their cost and a slumping economy. As the state's human population continues to grow, so do pressures on natural resources and the demands of the public to access those resources. One of the agency's central challenges is to remain relevant in today's society where seemingly each new generation is more urbanized and further removed from the great outdoors (TPWD 2010).

Fishery managers in Texas have used stock enhancement in combination with traditional management practices to manage Texas' natural coastal resources wisely. Texas' marine stocking program has contributed to the recovery of Texas' marine fisheries which has benefited multiple users and stakeholders, including anglers and coastal communities economically impacted by recreational fishing. In turn, organizations of recreational fishermen have been staunch advocates of the enhancement program, providing not only invaluable political support but also $4 million in direct contributions to operation of the program.

Texas' Stock Enhancement Program

Matlock's limited recruitment theory proposes that stocking fishes helps to stabilize recruitment by supplementing weak natural year classes, thus mitigating the typical marine scenario of high recruitment in a few years and low recruitment in most years (Matlock et al. 1986). If managers could bypass the high mortality associated with larval recruitment from the nearshore spawning areas into the bays and prevailing environmental conditions were favorable for survival, then effective supplementation might be achieved by stocking relatively few red drum directly into estuaries.

TPWD initiated stock enhancement of red drum in the 1980s in response to substantial declines in red drum abundance and recruitment (Matlock 1984, McEachron et al., 1995); today, the program releases between 20 and 30 million hatchery-raised fingerlings annually into eight different Texas bays and estuaries (Rutledge and Matlock 1986, McEachron et al. 1998, Vega et al. 2003). Efforts to culture spotted seatrout on a large-scale for the purpose of stock enhancement have been made by TPWD marine fish hatcheries since 1993 (Vega et al. 2003). TPWD routinely utilizes stock enhancement to assist in maintaining natural populations impacted by increased recreational fishing pressure (Vega 2003).

Operation of Texas' Marine Hatcheries

Complete details regarding production of hatchery-raised red drum at three TPWD marine fish hatcheries and release of hatchery fish are described in Colura et al. (1990) and Vega et al. (1995). Topics include broodfish maintenance and spawning, egg collection and incubation, and larval and juvenile rearing strategies involving semi-intensive culture methods. Briefly, the present hatchery system consists of spawning/incubation facilities with 39 ha of production ponds. Red drum broodfish are maintained in 13,000-L circular tanks, in environmentally controlled rooms. Each spawning tank contains five to six broodfish (three females and two or three males) ranging in size from 8-18 kg; they are fed shrimp, squid, mackerel and beef liver. Twenty-five percent of the broodfish are exchanged annually with wild fish to maintain genetic diversity. Broodfish are subjected to a 150-day photoperiod-temperature maturation cycle (Arnold et al. 1977, Roberts et al. 1978, McCarty 1990). Spawning occurs at a water temperature of 24 to 27°C, salinity of 30-38 ppt with 11 hours of light per 24-h day. On average, two million eggs are collected each night from March through November. Eggs are transferred to 945-L incubators where they hatch within 24 hours. Within 36 to 40 hours posthatch, larvae have developed mouthparts, distinct eye pigmentation and a complete digestive tract. These first-feeding larvae average 2.7 mm total length.

Culture of spotted seatrout for the purpose of stock enhancement has been conducted by TPWD marine fish hatcheries since 1993 (Vega et al. 2003). Spotted seatrout are similar in nature to red drum and are cultured using methodology patterned on that developed for red drum. The main difference is that each 13,000-L circular spawning tank contains 15 to 20 broodfish (10 females). Spotted seatrout broodfish are subjected to a 150-day photoperiod-temperature maturation cycle. Spawning occurs at a water temperature of 22 to 26°C, salinity of 30-38 ppt with 11 hours of light per day.

Outdoor rearing ponds, filled 5 to 10 days earlier with filtered seawater and fertilized, are stocked with larvae when zooplankton densities reach 250 organisms/L. A combination of chemical inorganic and organic fertilizers applied to rearing ponds produces a rapid phytoplankton bloom that stimulates production of copepods, a primary food for larval red drum. Dissolved oxygen, salinity, temperature, zooplankton densities, and fish growth rates are routinely monitored. Larvae remain in the ponds for 30 days or until they reach a target size of 30-35 mm total length. Once they reach target size, ponds are drained, fish are harvested and they are transferred to mobile distribution tanks for transport and stocking into coastal waters. To date, 568 million red drum fingerlings and 52 million spotted seatrout fingerlings have been hatchery-produced and released into Texas coastal bays.

Contribution of Hatchery-reared Fishes to Wild Stocks

The red drum populations in Texas bays have rebounded to near-record highs at least partly as a consequence of this enhancement effort (Figure 1). The catch rate has remained relatively stable since 1993, presumably reflecting in part the replenishment of the offshore breeding population and a lack of any significant environmental kills since the 1989 Texas coastal freezes. Stocking was one of many actions which may have aided in the recovery of the red drum population and it's specific role in the recovery is undocumented. Estimates of the contribution made by stocked hatchery fish to total red drum numbers in Texas bays have ranged from 0 to 30% (Matlock et al. 1984, Hammerschmidt 1986, Matlock 1990, McEachron et al. 1995, McEachron et al. 1998, Scharf 2000, Karlsson et al. 2008). It is increasingly apparent that the efficacy of the stock enhancement program varies widely in both time and space and may be related in part to season of release and time of recapture. But, it is equally evident that overall, Texas Parks & Wildlife's long-term management plan using hatcheries to supplement natural recruitment, in concert with other management tools (e.g., banning nets, declaring red drum a gamefish, and traditional regulatory changes), has played a crucial role in mitigating and countering the decline of the red drum population. Genetics studies have been used to complement other TPWD methods (long-term fishery independent monitoring) to assess the stocking program (e.g., bag seine and gill net sampling) via estimations of relative abundances of sub-adults. Since 2004, genetic markers such as microsatellite DNA have been used to assess the contribution that hatchery-reared red drum are making to the population. Results to date confirm successful enhancement of red drum in Texas waters, measured as the proportion of hatchery-released fish among fish sampled at random from the wild. Karlsson et al. (2008) described a recent study where a total of 30 hatchery-released fish were identified among 321 red drum (>1 year of age) gill net sampled from Galveston Bay, while a total of 11 hatchery-released fish were identified among 970 red drum (>1 year of age) gill net sampled from Aransas Bay. The total proportion of fish of hatchery origin was 8.5% in Galveston Bay and 1.1% in Aransas Bay. Additional genetics analysis of stocking effectiveness is underway for other Texas bays. Evaluation of the success of the seatrout stocking program is ongoing, with studies based on the application of similar genetic markers.

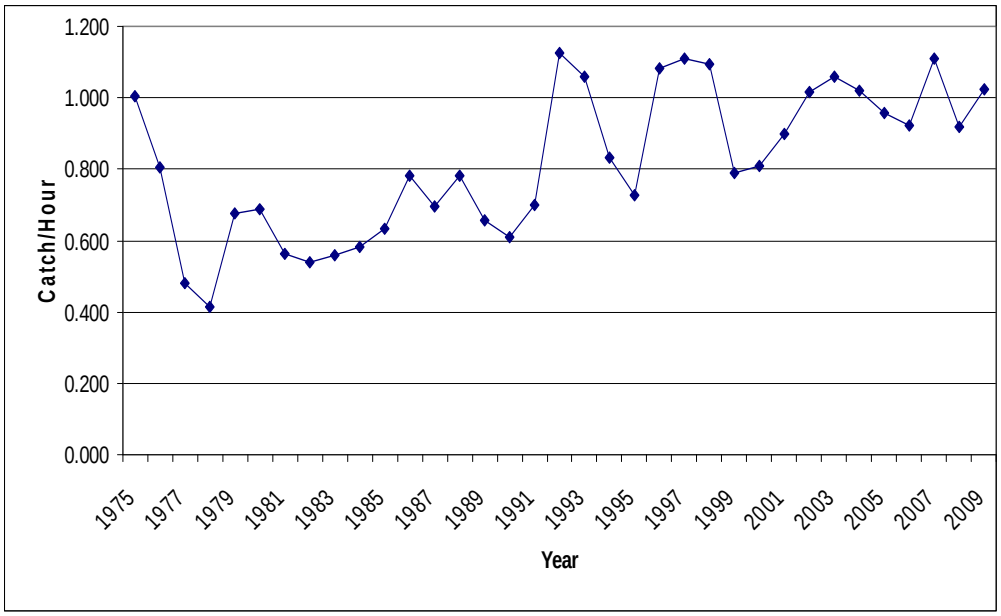

Figure 1. Gill net mean catch rate (catch/hour) of red drum collected coastwide from Texas bays during 1975 - 2009.

Conclusions

Release of hatchery-raised juveniles into the wild to augment exploited marine species has increased substantially over the past few decades; in fact, such stock enhancement is a key strategy for restoring depleted stocks of fish, worldwide (Blankenship and Leber 1995, Munro and Bell 1997, Leber 2002, Stickney and McVey 2002, Bell et al. 2006, Kitada and Kishino 2006, Bell et al. 2008). TPWD fishery managers have used several different techniques to assess the success of hatcheries in enhancing populations (Rutledge and Matlock 1986, McEachron et al. 1993, McEachron et al. 1995, McEachron et al. 1998, Karlsson et al. 2008). The answer to the question of hatchery success is very complex with many components to address. All that is really known is that sometimes stocked fish survive to enter the recreational fishery, sometimes they do not. Are the stocked fish actually enhancing the natural population or is it a replacement issue? Additional research is needed to address this question more precisely. It has taken the TPWD nearly 30 years to reach the present stage in development of its stocking and recovery program. To date, over 600 million fingerlings have been stocked. Although controversial, fishery managers in Texas have used the release of hatchery-raised fish to augment the red drum and spotted seatrout fisheries. The innovative use of stocking, combined with traditional management practices, has proven to be a powerful combination in managing Texas natural resources wisely. Wild stocks of red drum seemed to have been enhanced

through stocking to provide improved fishing success. However, the degree of improvement depends on such factors as the carrying capacity of each system, the number of wild fish present before stocking, fishing pressure, harvest restrictions and climatic events. TPWDs long-term management plan utilizing hatcheries and stocking to supplement natural spawning has played a role in maintaining the red drum population during the last three decades, and serves as a tool to ensure that Texas' fishery resources are wisely managed, and that the recreational saltwater fishing industry in Texas continues to contribute prominently to the state's economy.

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