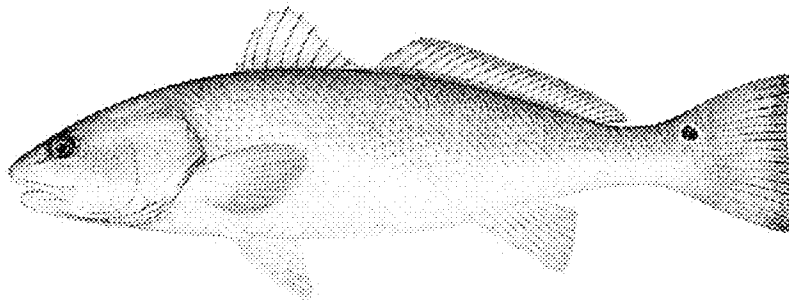
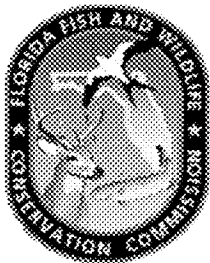


A stock assessment of red drum, *Sciaenops ocellatus*, in Florida: status of the stocks through 2003



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Executive Summary

Since 1990, fishing mortality rates for red drum have slowly increased on both the Atlantic and Gulf coasts of Florida. The number of fishing trips made by anglers catching or seeking red drum reached historical highs on both coasts during the early 2000's. The total harvest of red drum has been stable (Gulf) or slowly increasing (Atlantic) since 1989. Angling success, as measured by total-catch rates, increased in 2003 reversing the downward trend seen since the mid to late 1990s.

The abundance of young newly recruited age-0 red drum declined during the latter half of the 1980's but since then has varied without trend on either coast. Strong year classes (assigned January 1 following hatch) appear in the monitoring data: at the beginning of 1995, 1999, and 2003 on the Atlantic coast and at the beginning of 1996 and 2003 on the Gulf coast. The estimates of absolute abundance for ages 1-3 at the beginning of 2003 was about 0.7 million fish on the Atlantic coast and 1.5 million fish on the Gulf coast. The model-estimated abundance for ages 1-3 did not show an appreciable trend after the mid-1990's on the Atlantic coast but did show a rapid increase after 2000 on the Gulf coast.

Estimated year-class-specific escapement rates were below the Commission's target of 30% between 1986 and 1988 but then increased rapidly to peak values by 1991, probably in response to strict regulations placed on the fisheries during the mid to late 1980's. However, by 1992, increasing fishing effort and harvest began to drive the escapement rates down. In this assessment report we document a persistent decrease in year-class-specific escapement rates through the late 1990's on the Gulf coast and through 2003 on the Atlantic coast. Gulf coast escapement rates appeared to have leveled off, beginning in 1998, at escapement levels near the 30% target.

For 2003, the modal estimate of year-class-specific escapement rate on the Atlantic coast was 34% with a 50% likelihood of falling between 29 and 54%. On the Gulf coast, modal year-class-specific escapement was estimated at 32% in 2003 with a 50% likelihood of falling between 26 and 47%. It appears from these analyses that red drum populations in Florida are likely to be achieving the Commission's management target for red drum of at least a 30% escapement rate through age 4.

Introduction

The red drum fishery in Florida waters has been managed by the Florida Fish and Wildlife Conservation Commission (formerly the Florida Marine Fisheries Commission) since 1985 with a current goal of maintaining fishing mortality rates at low enough levels to allow for at least 30% escapement of red drum from estuarine waters into the near shore adult population. Year-specific escapement rates have been estimated at well below 30% during the early 1980's (Murphy 1994, 1998, 2002). As a consequence of much stricter fishing regulations enacted during the mid 1980's escapement increased dramatically to over 50% by 1988. Although there was considerable uncertainty as to the accuracy of the estimated escapement rates, the observed large influx of young adult red drum into the Gulf of Mexico population beginning in the late 1980's (Murphy and Crabtree 2001) coincided with changes in regulations and support the findings that escapement rates were high during the mid 1980's.

The stock assessments for red drum have changed considerably over time. Early assessments utilized tag-recapture information and assumptions about tag retention and angler reporting rates to infer fishing mortality rates (Murphy *et al.* 1990). These were followed by un-tuned catch-at-age analyses that employed *ad hoc* estimates of terminal-year fishing mortality and selectivity patterns (Murphy 1994). Trends in angler and fishery-independent-monitoring catch rates were first used as indices of abundance in a tuned age-structured assessment (Murphy 1998). Recently, a more flexible age-structured analysis was developed that could potentially capture more of the uncertainty inherent in the analysis (Murphy 2002). However, important information on the sizes of red drum released by anglers was not available in time for the 2002 assessment so its findings were quite equivocal.

This report contains a summary of red drum landings, fisher catch rates, and fishery-independent relative abundance data collected in Florida during the period 1982-2003. Also included are data from an angler log-book program that provided important information on the sizes of red drum released by anglers. All of these data were used to fit a model of red drum population dynamics that could provide age- and year-specific estimates of fishing mortality that are needed to calculate escapement rate.

Fishery Characteristics

Commercial Fishery

There has been no reported commercial harvest of red drum in Florida since 1988. The commercial fisheries' contribution to the overall landings was low during the early-mid 1980's. The only time frame when the commercial fishery was 'active' at the same time that reliable estimates for recreational catch were available is during 1982-86. During this period commercial landings represented only 5-16% of the overall harvest on the Atlantic coast and 14-36% on the Gulf (Table 1, Fig. 1). In this assessment, the term 'harvest' refers to the entire kill of red drum including those that die after release or those that are released dead. While there is information on the number of red drum released by the recreational fishery, there is no information on the release of red drum from the commercial fishery. Therefore, the commercial harvest may have been underestimated if there was a significant discard of dead or dying red drum from that fishery.

Commercial fishing effort, measured since the inception of the Florida Fish and Wildlife Conservation Commission's Marine Resources Information System 'trip-ticket' program in 1985, showed a rapid decline on both coasts until the fishery was regulated out of business in 1987 (Fig. 2). Sizes of red drum sampled from the commercial landings indicated that the landings of red drum were comprised mostly of age-0, age-1 and age-2 fish on both coasts (Table 3).

Recreational Fishery

The recreational fishery's median estimated harvest in Florida during 2003 was about 195,000 red drum on the Atlantic coast and 463,000 red drum on the Gulf coast. Since 1989 when the fishery came under strict regulations there has been a significant increase in harvest on the Atlantic coast (*t*-test, $t = 4.60$, 14 df, $P < 0.05$) but no significant trend in harvest on the Gulf coast (*t*-test, $t = 2.00$, 14 df, $P > 0.05$; Fig. 1). These trends follow the significant upward trends seen for both the numbers of red drum released and the numbers landed on the Atlantic coast (Table 1). On the Gulf coast, the numbers of red drum landed has been relatively stable compared to the significantly increasing numbers of red drum released alive. On both coasts the number of releases increased sharply during 1986 or 1987, such that by the early-mid 1990's the number of releases had increased to about five to seven times the number of red drum harvested.

Since 1987 there has been an increasing trend in the total number of fishing trips made by anglers catching or seeking red drum each year. Prior to this, the estimated number of directed red drum fishing trips made on the

Atlantic coast peaked at about 619,000 in 1984 (Table 1, Fig. 2). Since 1988 the annual numbers of trips made on the Atlantic coast have been variable but with a significant average increase of about 78,700 trips yr⁻¹. After reaching about 1.4 million directed fishing trips during 2000 and 2001, fishing effort appears to have declined more recently to about 1.1 million directed trips. A similar overall pattern since 1982 is seen on the Gulf coast where over 1.5 million trips were made in 1983 and 1984 followed by effort fluctuating but dropping to 439,000 trips by 1988. Since then, the estimated rate of increase on the Gulf coast has been about 93,000 additional trips each year. The number of directed fishing trips made on the Gulf coast reached a high of 2.4 million trips in 2003 (Table 1, Fig. 2).

Standardized coast-wide total-catch rates for anglers fishing for red drum have declined on both coasts since reaching peaks during either the early to mid 1990's on the Atlantic coast or the late 1980's on the Gulf coast. On the Atlantic coast relative angler total-catch rates dropped rapidly after the closed fishery re-opened in 1989, reaching a minimum in 1990 (Fig. 3). Catch rates then rebounded during 1991, peaked in 1994 and slowly declined to levels similar to those last observed in the early 1980's by 1998. On the Gulf coast, total-catch rates have shown a long-term decline since 1988 to a low stable rate during the early 2000's. In 2003 the catch rate increased for the first time since it last increased between 1996 and 1997. Total catch rates for anglers fishing in Everglades National Park have not declined significantly during 1982-2003 (*t*-test, *t* = 1.6, 21 df, *P* > 0.05), and have been especially stable since 1989 when regulations were enacted (Fig. 3).

The size composition of recent recreational landings seen by creel clerks (Marine Recreational Fisheries Statistics Survey (MRFSS) Type A fish) has been bounded, for the most part, by the 18"-minimum and 27"-maximum size limits. On the Atlantic coast, an average of about 1% of the landed red drum (MRFSS creel clerk length samples weighted by landings) during 2002-2003 were less than 18", 88% were 18-27", and 11% were larger than 27". On the Gulf coast, an average of about 3% of the annual length samples were less than 18", 89% were 18-27", and 8% were larger than 27". The compliance with the one-fish bag limit was also high. Fewer than about 1% of the directed trips taken on either coast had landings of more than one red drum per angler (Table 2)

There is no way to accurately estimate the age composition of the recreational harvest without information about the sizes of red drum that are killed but not seen by creel clerks. This unseen harvest comes from red drum that had been disposed of (released dead, used as bait, called type B1 catch in MRFSS) and from the portion of the red drum that had been

released alive that later died, assumed 5% of the number released alive based on unpublished FWC-FWRI data. I assume in this assessment that the type B1 catch size distribution is the same as that of fish seen by creel clerks (Type A). The size distribution of released fish is assumed to be all less than 12" fork length prior to 1986. This reflects the minimum size limit at the time, the relative scarcity of older larger fish in the population, and the consumption-oriented angler ethic. Since 1986 and the advent of stricter fishing regulations, the size structure of released fish was assumed to be the same as the sizes of red drum reported released by randomly chosen anglers who participated in a recent logbook program. Information compiled during this program included length data from red drum released alive during 216 Gulf coast fishing trips and 74 Atlantic coast fishing trips taken during the period September 2002 through September 2004.

Assessment

The goal of this assessment was to estimate escapement for red drum on the Atlantic and Gulf coasts of Florida. Escapement is defined as the ratio of the observed cumulative survival of a group of red drum through age 4 to that same group's potential cumulative survival through age 4 if it hadn't been fished. Escapement can be calculated as an equilibrium value using year-specific estimates of fishing mortalities for ages 0 through 4. This provides a measure of whether overfishing is occurring in a particular year. Another version of escapement is a measure of the cumulative fishing mortality on a year-class over its life while age 0 through age 4. This year-class-specific estimate of escapement is a measure of the current condition of the stock, i.e., whether a year-class is in an overfished state. Since year-class-specific estimates require a series of fishing mortalities on a cohort over five years, the first estimate available in this analysis is for 1986.

An age-structured assessment model was developed for Florida's Atlantic and Gulf coast red drum stocks using AD Model Builder software. This model was used to estimate abundance and instantaneous fishing mortality for ages 0 through 14⁺ over the period 1982-2003. Ages for red drum were assigned on a calendar year, i.e., age-0 fish were about 4-16 months old, age-1 fish were 16-28 months old, and so on. Separate selectivity patterns were estimated for the commercial fishery during 1982-1988, and for the recreational fishery during 1982-1985, 1986-1998, and 1999-2003. Based on unpublished tagging data, I assumed that the selectivity of red drum decreased sharply after age 4; in response to the increasing tendency of red drum to begin frequenting nearshore waters as they approached sexual maturity and, more recently, the protection afforded by the maximum size limit. Selectivity was assumed equal to 0.01 for age-5 and older red drum on the Gulf coast. Red drum behavior on the Atlantic

coast is somewhat different than that observed on the Gulf coast with many adult red drum inhabiting parts of the Mosquito Lagoon/Indian River Lagoon system. Therefore, I assumed that red drum on the Atlantic coast were more available before 1987, with selectivity at age-5 and older set to 0.1, but somewhat protected by the maximum size limit after this, selectivity set to 0.01.

Base model input data included an assumed constant natural mortality rate of 0.2 yr^{-1} on both coasts and 5% release mortality for red drum released alive by anglers. Other coastwide assessments of red drum have used age-specific values of natural mortality with higher mortalities for younger fish (Vaughan and Carmichael 2000; Porch 2000). Sensitivity analyses indicated that estimates of escapement were robust to these different natural mortality rates so the results herein reflect only those analyses under the assumption of constant natural mortality.

Lengths of harvested red drum were converted to ages using a coast-specific age-length key developed from age samples collected during the period 1981-2003. Inadequate sample sizes forced pooling of the data across years and approximation, based on growth curves, of the age composition for very large and very small red drum reported from the harvest. The effectiveness of fishers in harvesting red drum (catchability) changed during the period examined due to gear restrictions and regulations limiting harvest. Estimates of catchability were assumed constant during the period 1982-1988 for the commercial fishery and during the periods 1982-1985 and 1986-2003 for the recreational fishery. Fishery-dependent indices of abundance were used in the analysis: standardized total-catch rates for anglers interviewed by the Marine Recreational Fisheries Statistics Survey (MRFSS) on both coasts and standardized total-catch rates for anglers interviewed during the Everglades National Park's (ENP) boat-ramp survey. Age-one red drum were likely the best represented single age group in these total-catch rates. In addition, fishery-independent indices of relative abundance for red drum were also used in the model to improve the accuracy of the estimates of fishing mortality in the most recent years. These abundance indices were available on both coasts as standardized total-catch rates for young-of-the-year red drum caught in 70' bag seines deployed during the FWC-FWRI Fishery Independent Monitoring group's stratified random sampling program. Young-of-the-year indices for each fall spawning period were assumed representative of the relative abundance of young red drum at the beginning of the following year, i.e., the index calculated using fall 1989 data is referred to in this report as the 1990 index. Historic data (1982-1996) on the relative abundance of age-0 red drum in the Alafia River, Tampa Bay, were used in the Gulf coast analysis. The Fishery-Independent monitoring group also monitors red drum, mostly ages

1 and 2, using 600' haul seines that have been deployed under a stratified random sampling program since 1996 on the Gulf coast and since 1997 on the Atlantic coast. In addition, the relative abundance data for adult red drum ages 6-13, which had been collected for adults sampled during 1996-1998 from off Tampa Bay, were used in the Gulf coast analysis.

Age Structure of the Catch

The age distributions of the landings on both coasts were mostly comprised of red drum that were from 4 to 52 months of age (model calendar ages 0 through 3; Table 3 and 4). On the Atlantic coast, the dominant recreational catch switched from age-0 to age-1 red drum during the period 1986-1989 (Table 4). On the Gulf coast, the estimated catch at age has been fairly evenly distributed between age 1 and age 2 since 1987. Prior to 1987, the dominant age group harvested on both coasts was age 0, with occasional dominance of age 1 fish in the catch.

Trends in abundance

There were few quantitative, fishery-independent observations of the relative abundance of red drum made in Florida prior to 1989. Young-of-the-year abundance estimates are available since late 1981 in the Alafia River, a tributary to Tampa Bay. More widespread fishery-independent sampling of young-of-the-year fishes began in 1989 on the Gulf coast in Tampa Bay and Charlotte Harbor (expanding later to Cedar Key, 1996, and Apalachicola, 1998) and since late 1990 on the Atlantic coast in Indian River Lagoon (expanding to northeast Florida in 2001). Fishery-independent data on the abundance of older age groups has been collected since 1996 on the Gulf coast and since 1997 on the Atlantic coast. Fishery-dependent data, MRFSS angler total-catch rates and ENP angler total-catch rates, are also considered approximate indices of abundance and are available since at least 1982.

Young-of-the-year abundance of red drum declined during the latter half of the 1980's on both coasts of Florida and subsequently has remained relatively steady or increased slowly (Table 4). A decline in recruitment during the early 1980's can be seen in the limited young-of-the-year survey data for Tampa Bay (Fig. 4). Higher recruitment during the early 1980's may have been one of the reasons that age-0 red drum was the dominant age group in the recreational landings during those years (Table 4, Fig. 5). During the 1990's, young-of-the-year abundance indices on the Atlantic coast were fairly consistent during the early 1990's then began to show more variability with occasional high values at the beginning of 1995, 1999, and 2003 (Table 5, Fig. 4). The Gulf coast data for young-of-the-year

