THE DEMISE OF NORTH CAROLINA'S COASTAL FISHERIES RESOURCES & THE PUBLIC'S RIGHT TO FISH

Truncated Age Structure in Public Fish Stocks

The title of this series is "The Demise of North Carolina's Coastal Fisheries Resources and the Public's Right to Fish." In the first three papers in this series, we have examined the history of coastal fisheries management in North Carolina, the tragedy of the commons as it applies to coastal fisheries resources, and the public's legal right to fish under the public trust doctrine and the North Carolina Constitution. Now we will examine the overwhelming evidence of demise—the evidence that our public-trust fisheries resources are overfished to a state of decline and in need of rebuilding and restoration.

There are many indicators that provide empirical evidence of the demise of North Carolina coastal fisheries resources over the last half century. Those indicators include measurable, biological changes in fish populations, like fishery age truncation. They also include stock declines indicated by management data, such as reduced commercial landings over time. Finally, they include factors that are the result of stock demise, such as declining public harvest limits and the poor overall status of public-trust "stocks" when they are objectively assessed. Those indicators will be discussed in this and the next several series installments.

As a first indicator of the status of coastal fisheries resources, the moderate to severely truncated population age structures exhibited by many fish species or stocks[1] historically important to the fishing public is a very significant biological indicator of the dire condition of our public-trust fisheries resources. Age truncation refers to the removal of older aged individuals from a fish population, most often through fishing. It makes perfect sense that fishing is the cause of age truncation, since many fishery management strategies impose regulations that tend to protect smaller, younger fish, while allowing the lawful removal of older fish from the population for consumption or sale.

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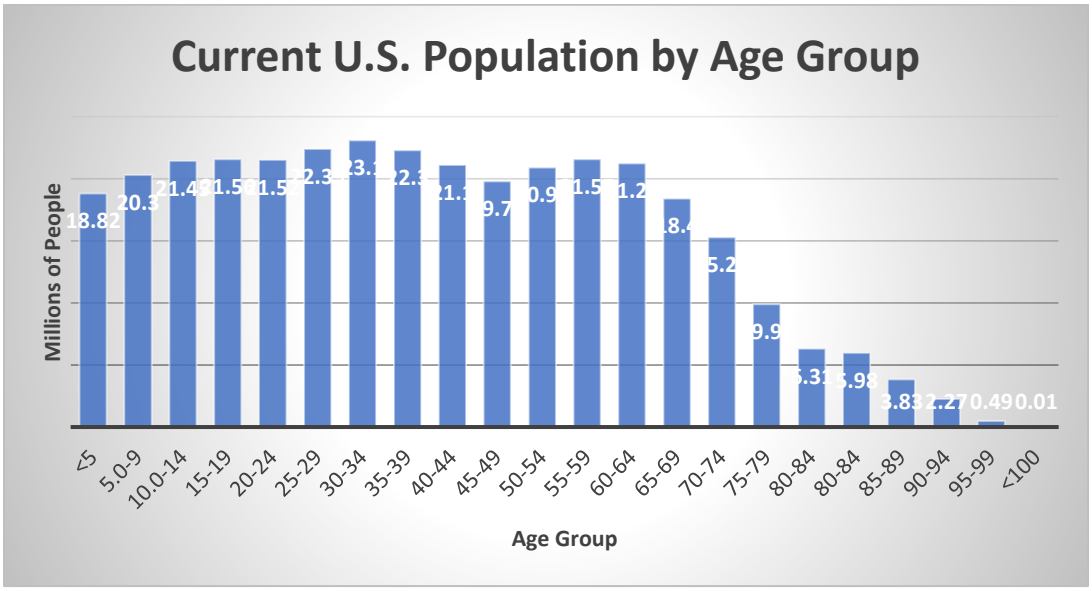
[1] This series of papers refers to North Carolina's coastal fisheries resources both in terms of "species" and "stocks." "Species" is a biological unit; it is the scientific designation for an interbreeding population, or 'kind" of fish—for example, Southern flounder. "Stock," by contrast, is simply a management term—that is, it is a fisheries resource unit designation useful for management purposes. A single fish species may have more than one management unit, and, therefore, more than one stock. For example, a future paper will be dedicated to the management history of North Carolina estuarine striped bass. In that paper, we will discuss the species "striped bass," as well as the two primary North Carolina management stocks of striped bass—a northern stock and the central/southern stocks—within that species.

Because stock is an artificial management unit rather than a biological unit, it may also include more than one fish species. For example, a separate paper in this series will discuss the history and management of river herring in our state. The North Carolina "river herring" stock actually consists of two species—the blueback herring and the alewife—that live and travel together in mixed groups. For that reason, it makes sense to treat the two species as one group for management purposes. By convention, where a single fish species is also managed as a single stock, the terms "species" and "stock" are often used interchangeably in describing that species.

Population age structure is a well-established, scientific indicator of population health and viability. For example, the United States population shows a "healthy," widespread age distribution of people from age 0 (infants) to centenarians (those over 100), as follows:

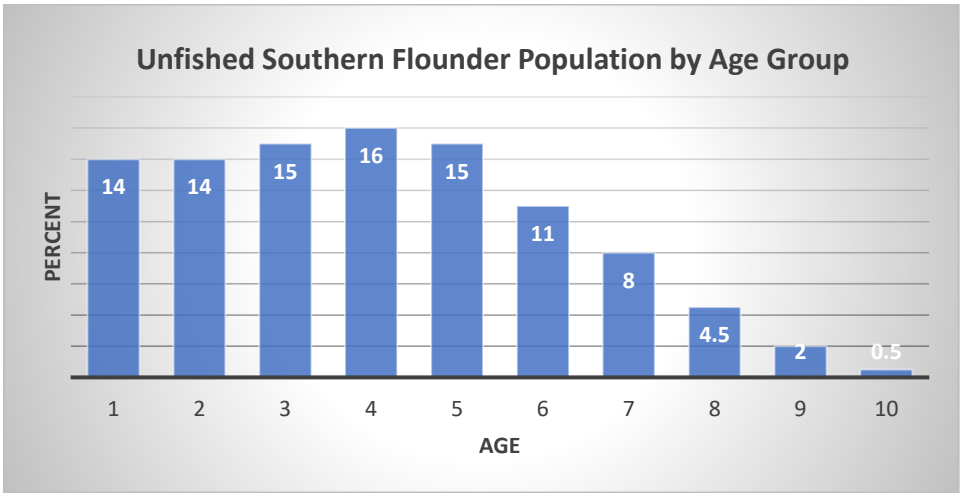


Note from the graph that, in general, populations show many younger and intermediate-aged individuals, but that after a certain point, the number of older-aged individuals in the population begins to decline due to the age-related deaths of older individuals in the population. That is expected. Nevertheless, that decline in older-aged individuals is normally gradual, as shown above. There are, however, many factors that have significantly affected the number of individuals in one or more of the above age groups throughout the history of the nation, significantly altering the age-distribution chart for that time period. For example, from 1941-1945 during WWII, more than 400,000 United States soldiers were killed in military action, most in the 20-year-old to 24-year-old and the 25-year-old to 29-year-old age groups. As another, more recent example, in 2020 and 2021, Covid infections killed almost 277,000 U.S. citizens 85 years of age and older, about four percent of that population group.

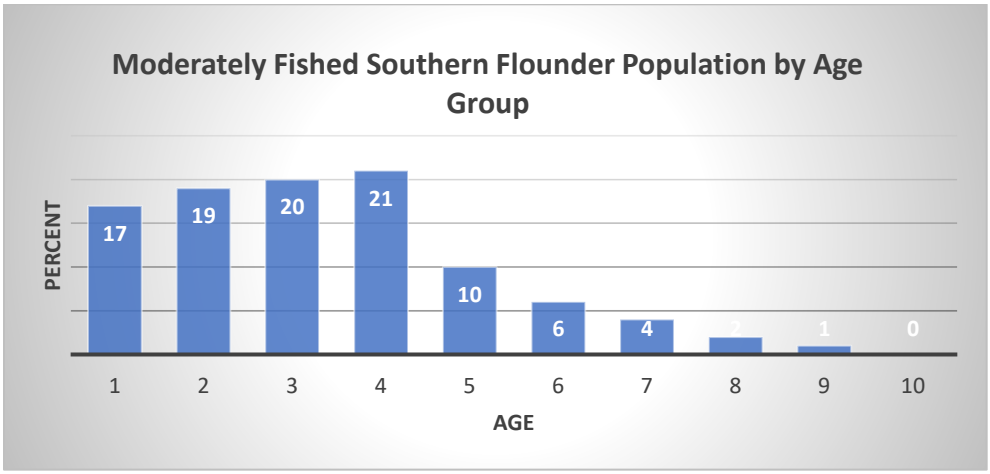
The same holds true for fish stocks. Significant changes in population age structure result from factors that cause the death and removal of large numbers of individuals from one or more age classes. Fishing mortality is the prime example of such a factor. At this point, it is useful to briefly talk about terminology as an aid to understanding age truncation in fish populations. A "population" is a group of individuals of the same species or stock that occupy a specific area over a certain period of time. "Population dynamics" refers to how populations of a species or stock change in size and structure over time. "Year classes" in a fish population or stock refer to the number of individuals in a population that are of the same age, *e.g.*, the number of one-year-old fish in the population, the number of two-year-old fish, the number of three-year-old fish, and so on. As we will see, the way in which those year

classes are distributed in a fish population is an important factor in determining the overall stock health.

Applying that terminology to age truncation, a healthy population age distribution for a fish stock (as would typically occur in an unfished stock) exhibits mostly individuals of young to "average" age, with gradually decreasing numbers of older fish in each stock year-class within the species' lifespan. For example, because Southern flounder were historically known to live to be about 10 years old, the graph of age structure in an unfished Southern flounder population might be expected to look like this:

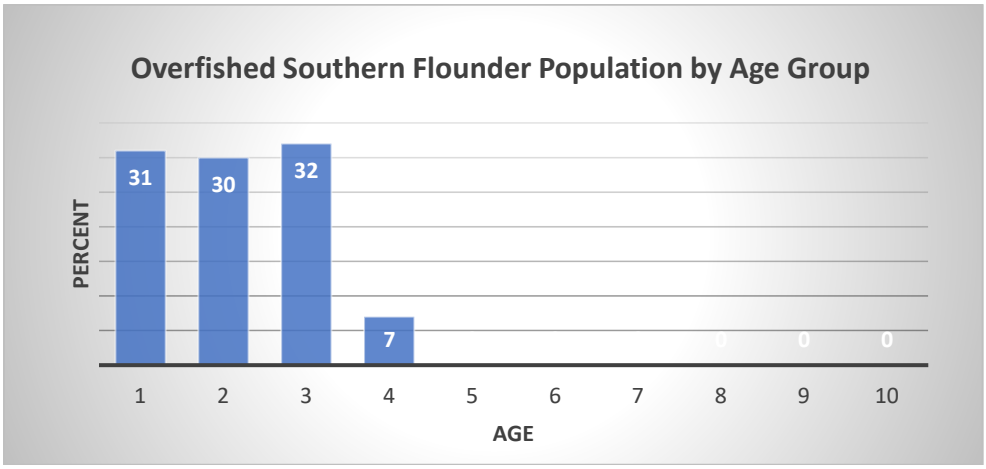


When a species or fish stock is targeted for human harvest, the older-aged (larger) individuals in the population are typically the first to be removed by that harvest. Accordingly, the removal of those older fish changes the stock age structure from its normal, unfished distribution. That is acceptable to a point, and the stock can remain healthy so long as not too many of the older fish are removed from the population. A moderately fished Southern flounder population might look like this:



But the continued removal of older-aged fish will eventually result in a year-class distribution where the stock is dominated by juvenile and other younger-aged fish,

and the older-aged year classes expected in a normal population distribution are increasingly "cut off," leaving the year-class distribution moderately to severely truncated. So, that same theoretical Southern flounder stock, in an overfished condition, might look like this:



Indeed, this hypothetical graph is close to what we currently see in North Carolina—a stock that has been continuously overfished for at least a third of century—where fish in the one to three-year-old range dominate, four-year-old fish are rare, and fish older than four years of age have completely disappeared from the population.

The removal of older-aged fish through overfishing has a number of adverse effects on fish stocks historically important to the fishing public. Age truncation has been shown to reduce stock productivity and negatively affect population and community stability. Reduced stock productivity resulting from age truncation is extremely significant in stocks that are either excessively depleted or have collapsed[2]—like North Carolina Southern flounder, striped bass, spot, Atlantic croaker, weakfish (gray trout), Atlantic sturgeon, and river herring—and are in dire need of rebuilding and restoration. Studies have shown that fish stock age-class structure is a main major factor affecting stock abundance, because older females, in comparison to younger sexually mature females in the stock, produce immensely greater numbers of eggs[3] with greater genetic fitness and viability.

Moreover, the absence of larger and older fish reduces the availability of those fish for public harvest or to the consumer through commercial harvest. For example, the North Carolina Division of Marine Fisheries ("Division") maintains a citation

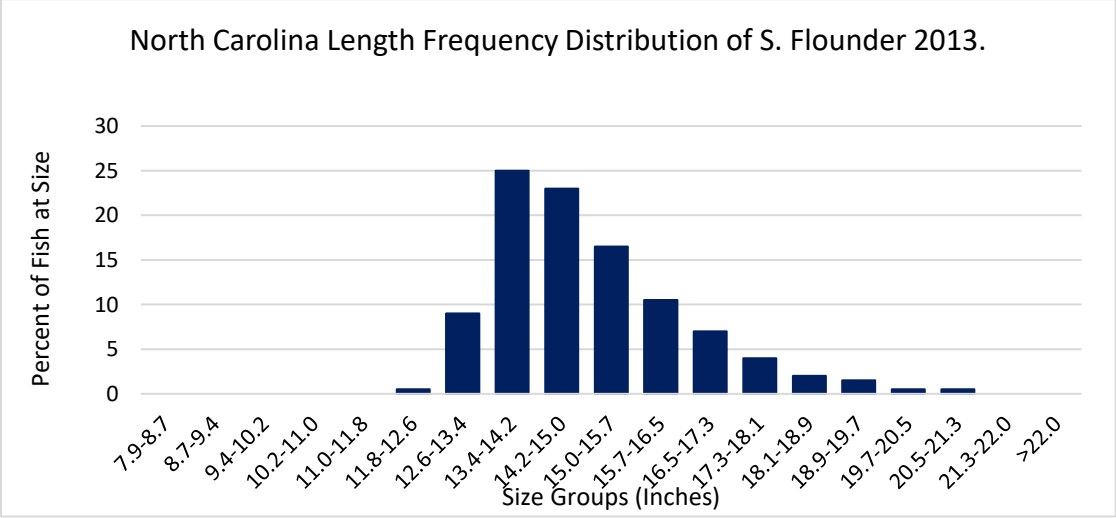
[2] Depletion caused by overfishing cannot continue indefinitely. At some point stock abundance will diminish to the point that there are too few mature female spawners producing eggs to allow the stock to recover to levels that can sustain harvest. This was the fate of North Carolina river herring, and is the likely condition of North Carolina striped bass stocks in the Tar, Neuse and Cape Fear River systems.

[3] For example, in striped bass, it is estimated that an average 4-year-old female produces about 400,000 eggs annually, while an average 14-year-old female may produce as many as 4,500,000 eggs per year, more than an eleven-fold increase.

program to recognize catches or releases of large fish by public anglers. The frequency and number of citations issued by the Division has declined across numerous fisheries in recent decades. The decline in the number of these citations issued for numerous species supports the biological data that indicate the decline in number or complete disappearance of older-aged individuals in many—if not most—public-trust fish stocks.

Southern flounder—which the state admits have been overfished for more than three decades—serve as a reasonable example of stock age truncation due to overfishing. Based on Division data, we know that Southern flounder historically lived to age ten or greater. However today, with prolonged overfishing, it is uncommon to find a fish older than age four in North Carolina waters, and current harvest of Southern flounder in North Carolina is fish that are two to three years old, most of which are sexually immature fish. Observed truncation in age structure is direct evidence that the Southern flounder stock is in trouble.

The plight of Southern flounder was illustrated in the complaint CCA NC and 86 citizens filed against the state for public trust fisheries mismanagement in November 2020 by looking at flounder length frequency (size) distributions over time for all fish caught (both commercially and publicly harvested) in North Carolina.[4] Using that example, we start with the 2013[5] graph showing the percent of Southern flounder harvested by each size group:

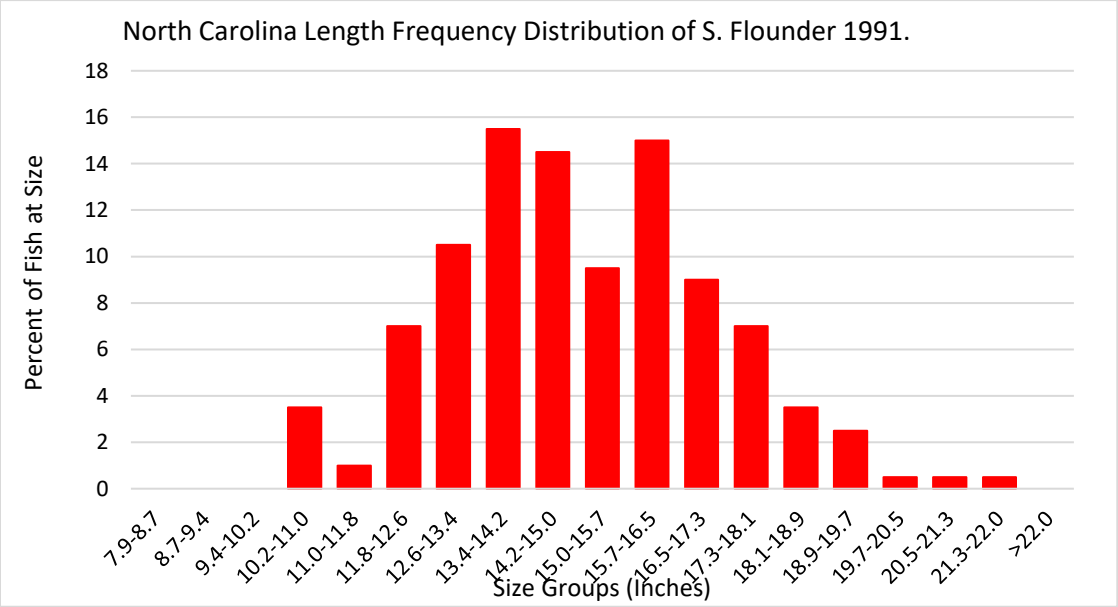


The assumption for the graph is that larger (longer) fish are older fish, and that general assumption is supported by a large body of anecdotal and scientific data. The 2013 graph clearly shows the truncated nature of the stock with respect to larger fish, with most harvested fish being less than 16 inches in length, and no

[4] The data used here are taken from the Division's 2015 "Southern Flounder Stock Assessment."
[5] 2013 was the last year for which Southern flounder harvest data were available to the plaintiffs before the complaint was filed in 2020. Due to continued overfishing on the Southern flounder stock in every year since 2013, it is quite certain that the stock age-class structure has not improved, and has likely worsened.

harvested fish larger than 22 inches in length. The fact that there were no harvested fish greater in length than 22 inches is especially significant. The size at which all Southern flounder are sexually mature is 22 inches or greater in length, and the absence of such fish in the graphs indicate that North Carolina harvest consists almost exclusively of juvenile fishes that have never spawned prior to harvest!

Now consider the earlier, 1991[6] graph of percent of Southern flounder harvested by size group:



As compared to 2013, the 1991 graph shows that Southern flounder length distributions are somewhat more widespread, with more reasonable representation of harvested fish from many length classes for that stock, including older fish. While larger fish comprised a greater proportion of harvested fish in 1991, fish larger than 22 inches still made up less than one percent of the catch, clearly an unacceptable number based on sexual maturity. While the Southern flounder age distribution shown in the 1991 graph perhaps more closely approximates unfished distribution for a naturally occurring species population than does the age distribution shown in the 2013 graph, it is only minimally so—in both graphs there should be many more fish greater than 22 inches in length. That result is hardly surprising since, as noted in footnote 5, North Carolina Southern flounder were already substantially overfished prior to 1991.

Striped bass is another example of a fish stock historically important to the North Carolina fishing public that now exhibits severely truncated age structure. Striped

[6] The 1991 data are the oldest harvest data available from Division stock assessments for Southern flounder. However, it is important that the 1991 data do not reflect the "natural," unfished condition of Southern flounder, since that stock was already overfished in 1991, and thus stock age truncation was already well underway.

bass may live up to thirty years of age, so in a "normal" population year-class distribution for that species one would expect to find a large body of middle-aged individuals, with decreasing numbers of older fish, but still some survivors in most older-aged year classes. What is actually found in most North Carolina estuarine striped bass populations, however, is an extremely truncated year-class structure, where almost all the older fish have been removed from the stock, leaving only the younger fish—typically ages 1 to 3. Striped bass more than 10 years of age are extremely rare in North Carolina estuarine waters. That is far from a normal population year-class distribution, and provides clear evidence of both a management problem and a likely non-viable stock in the long-term, typical for an overfished species.

But Southern flounder and striped bass are not alone. There are numerous other species of North Carolina coastal fish stocks historically important to the fishing public that exhibit unduly truncated age structure[7] because of either commercial overfishing or resource wastage through the use of "highly efficient" commercial gears allowed or promoted by the state. Those stocks include spot, weakfish, Atlantic croaker, American shad, river herring, Atlantic sturgeon and bluefish, all of which exhibit moderate to severe age truncation as a result of overexploitation.

The State has long known about age truncation as an indicator of the overfished status and poor health of North Carolina fish stocks, but it has minimized or ignored the problem, failing to address its implications for either long-term stock viability or public fishing rights. The only way to improve population age distribution in public-trust fish stocks is to reduce excessive fishing mortality.

In summary, the moderate to severely truncated year-class structure that is typical of an overfished species and characterizes many North Carolina coastal fish stocks is clear evidence of both a management problem and an unsustainable fishery. Long-term stock viability is the "benchmark" for coastal fisheries resource management set by the state, the trustee of public-trust fish stocks. But for now, long-term viability is simply a "paper target" for most public-trust fish stocks historically important to the fishing public, given age truncation and other evidence of public fisheries in precipitous decline. It will remain so until citizens demand that state government takes seriously its role as trustee for public-trust fisheries resources and acts to adequately protect the public's legal right to fish.

[7] To this end, the "Release Over 20" campaign is an ongoing effort that CCA NC helped start in cooperation with "Eye Strike Fishing," aimed at preventing severe age truncation in state speckled trout, a North Carolina fishery which has historically been a public, rather than a commercial fishery. The purpose of the campaign is to promote the voluntary, live release of speckled trout 20 inches or greater in length caught by public anglers, in order to ensure the retention of older fish in that species' spawning stock biomass.