



## North Carolina's Collapsing & Collapsed Coastal Fisheries Resources: Impact of State Management Under the Fisheries Reform Act of 1997

For decades, if not centuries, North Carolina's fisheries managers believed coastal resources were inexhaustible; the term "collapsed" wasn't in their vocabulary. However, human population growth and subsequent increased demand for seafood, coupled with advances in fishing gear and supporting technologies, prove that fisheries resources are indeed finite. At present, many—if not most—fish stocks worldwide are overfished. This paper examines the current status of North Carolina's fish stocks and answers the question, "*When does overfishing result in actual stock collapse?*"

### Definitions of collapse and collapsing

In the early 1980s, author J.G. Cooke defined "collapse" as the "reduction of a fish stock by fishing or other causes to levels at which the production is only a negligible proportion of its former levels" (Ferguson-Cradler 2018). The article further notes, "fisheries collapses were understood as State failures, thus becoming events critical in the remaking of management regimes." In these cases, "collapse" was a crisis of scientific modeling and interpretation, with significant implications for how managers would conceive of risk, crisis and uncertainty.

An article published in Proceedings of the National Academy of Sciences (Pinsky et al. 2011) provides a more scientifically rigorous analysis and definition of "collapsed" in the fisheries management context. The authors defined a stock as collapsed if the minimum annual biomass fell to less than 20% of the biomass necessary to support maximum sustainable yield. In the absence of robust stock assessments to provide these values, the authors suggest examining landings as a proxy. If for 2 consecutive years stock landings fall below 10% of the average of the 5 highest years' landings recorded, then the stock has collapsed. The authors found that employing landings data had a lower misclassification rate than others.

This paper uses Pinsky et al.'s landings method for measuring collapse in two ways: (1) it applies the methodology to determine fisheries collapse status in North Carolina stocks, and (2) it builds upon the methodology to identify state stocks that are "collapsing" or approaching collapse. In the latter instance, stocks are defined as "collapsing" if:

- There has been a general, downward trajectory in landings for decades;
- Current landings are less than 25% of the average for the 5-year highest landings period; and
- There is objective evidence supporting negative biological trends (e.g., unhealthy population age structure).

North Carolina Division of Marine Fisheries (DMF) provides state commercial landings data back to 1972. Using that data, this paper examines the current status of North Carolina public-trust fish stocks relative to the above definitions of "collapsed" and "collapsing," for all fisheries managed exclusively by DMF.

In addition, we added three species—Atlantic croaker, spot and weakfish—that, while primarily managed by the [Atlantic States Marine Fisheries Commission](#) (ASMFC), have special significance in North Carolina fisheries management. Each stock was once a significant component of North Carolina’s commercial gill net, fly net, pound net and haul seine fisheries, and all are historically sought after by public anglers.

### **State-managed species**

In its 2022 analysis of state fishery management plans, or FMPs ([2021 Fishery Management Plan Review](#)), DMF lists 13 state-managed species—bay scallop, blue crab, Eastern oyster, estuarine striped bass, hard clam, kingfishes, red drum, river herring, sheepshead, shrimp, southern flounder, spotted seatrout and striped mullet. For each species, DMF gives its “objective” determination of the “stock status” of that species under state management. “Stock status” is essentially a determination of current stock health or “viability.” By statute, a stock’s “long-term viability” is the benchmark management standard for public-trust fisheries management.

Table 1 compares the stock status reported by DMF in 1998—the year after the enactment of the [North Carolina Fisheries Reform Act of 1997](#) (FRA)—with its most recent status report some 24 years later in 2022.

**Table 1. Evidence of precipitous stock declines of state-managed species under the Fisheries Reform Act.**

SPECIES	1998 STOCK STATUS REPORTED BY DMF	2022 STOCK STATUS REPORTED BY DMF	2022 STOCK STATUS RELATIVE TO COLLAPSE	INDICATORS OF STOCK'S COLLAPSED / COLLAPSING STATUS	NOTES RELATED TO STOCK STATUS
Bay scallop	Viable	Of concern	Collapsed		No stock assessment; listed only as a species of concern b/c of populations declines.
Blue crab	Unknown	Overfished w/overfishing occurring	Collapsing	Highest 5-year landings average 57.8M lbs. 2019-2020 landings data average 17.7M lbs., 30% of 5-year peak. By definition, blue crabs aren't collapsed, but declining trends indicate they're headed toward collapsing status.	Though stock is overfished and overfishing is occurring, there are no pot limits.
Eastern oyster	Depressed	Unknown, but in decline	Collapsed	Highest 5-year landings average 1.5M bushels. Current landings 50-60K bushels, 3% of historical high.	No stock assessment.
Estuarine striped bass	Viable AR/Unknown	A/R stock, overfished w/overfishing occurring; CSMA stock, unknown	Collapsed or Collapsing		Central/Southern stock under a harvest moratorium. A/R stock overfished with overfishing occurring.
Hard clams	Unknown	Unknown	Collapsing	Highest 5-year landings average 30.7M clams. 2019-2020 landings data average 4.9M clams, 16% of 5-year peak. By definition, hard clams are collapsing.	No stock assessment.
Kingfishes	Unknown	Unknown	Unknown		DMF - "no concerns with the stock and no need for management."
Red drum	Stressed-declining	Overfished status unknown; overfishing not occurring	Recovering w/ increasing age structure & recruitment		Managed through strict quotas and restrictive bag limits.
River herring	Depressed	Depleted; A/R stock overfished; overfished status unknown elsewhere	Collapsed		Harvest moratorium since 2007. Stock remains overfished at historically low levels of abundance.
Sheepshead	Not included	Unknown	Unknown		Precautionary management implemented.
Shrimp	Viable	No concerns	Unknown		Tremendous concerns w/finfish bycatch.
Southern flounder	Viable	Overfished; overfishing occurring	Collapsing	Highest 5-year landings average 4.3M lbs. 2019-2020 landings data average 0.64M lbs., 15% of 5-year peak average.	Unlikely to rebuild stock under current management scheme.
Spotted sea trout	Viable	Not overfished, but overfishing is occurring	Depressed		2022 stock assessment indicates overfishing; biomass at low levels. No harvest cap.
Striped mullet	Unknown	Overfished; overfishing occurring	Depressed		No restrictions.

An examination of Table 1 shows:

- Six of the 13 species, nearly half, have moved from viable or unknown to collapsed or collapsing.
- Two depressed stocks in 1998 remain at that level in 2022.

- Only one species, red drum, has seen verifiable improvements.

Moreover, as Table 1 evidences, **most state-managed coastal fish species have collapsed or are collapsing mainly due to overfishing.** While low current landings for Southern flounder, and possibly a few other species, are impacted by currently strict harvest limits, biological data associated with those fisheries—a pivotal component to assessing fish stocks—are consistent with collapsed or collapsing fisheries.

This analysis, however, doesn't discount the potential influence in some fisheries of environmental conditions beyond the control of fisheries managers. Disease, water quality and habitat loss can play varying roles in fisheries declines, depending on the species. But continued fishing on populations stressed or depressed by adverse environmental impacts only amplifies the problem, especially for fisheries with high rates of unknown bycatch. Consequently, state fisheries managers cannot allow continuing harvest of any kind—public or commercial—on public-trust stocks currently existing at pre-collapse levels, with a reasonable expectation of population recovery.

### **NC stock viabilities of species managed by Atlantic States Marine Fisheries Commission in relation to collapsed and collapsing definitions**

Some fish stocks are not confined to North Carolina but migrate across state boundaries, where they are subject to different environmental conditions and harvest regimes related to management restrictions and allowable gear. As a result, those stocks are managed cooperatively by the various states and are termed “interjurisdictional fisheries.” North Carolina manages those stocks by participating in the ASMFC and [U.S. Regional Fishery Management Councils](#). In North Carolina, the ASMFC manages several fish stocks that are historically important both to public anglers and commercial fishermen, including Atlantic croaker, spot and weakfish.

Based on North Carolina landings data, these three species are classified as “collapsed” or “collapsing,” just as is true for many stocks managed solely by DMF. However, examining the stock throughout its geographic range is critical to determine true biological, coastwide species viability. But that wider stock viability context does not negate the trustee duty of state fisheries managers. North Carolina law requires DMF to manage Atlantic croaker, spot and weakfish under a state FMP. As such, we argue the State is legally obligated to remedy non-viable stock status whenever possible through state management, even if the collapse occurred only in North Carolina.

### **Coastwide stock viabilities of ASMFC-managed stocks in relation to collapsed and collapsing definitions**

Looking, then, at the collapsed/collapsing status of Atlantic croaker, spot and weakfish under coastwide management, we find that their individual statuses are not significantly better than when their statuses are considered for North Carolina alone.

#### ***Atlantic croaker data***

- The 5 highest years of commercial landings of Atlantic croaker in North Carolina averaged 18.2 million pounds.

- The last 2 years of Atlantic croaker landings data (2019-2020) show average annual landings of 0.53 million pounds, 5% of the 5-year peak harvest.
- The 5 highest years of public landings in North Carolina averaged 1.2 million pounds.
- The last 2 years of Atlantic croaker landings data (2019-2020) indicate average annual landings of 0.3 million pounds (870,000 fish), 17% of the 5-year peak harvest.
- Combined commercial and public harvest peak North Carolina landings show reduced annual landings going from 19.4 million pounds to 0.83 million pounds, a 96% decline.
- Atlantic croaker historically contributed as much as 19%-36% of the annual commercial finfish landed in North Carolina. In 2020, the contribution of Atlantic croaker to total North Carolina finfish landings was 3%.
- Total harvest from Florida to New York peaked in 2001 at 28.6 million pounds and declined to 0.80 million pounds in 2020—a 97% decline.
- Similarly, coastwide public angler landings have declined from 18.9 million pounds in 2003 to 1.8 million pounds in 2019—a 90% decline.

These data, viewed collectively, clearly indicate that the Atlantic croaker stock is collapsed coastwide. Despite this collapsed condition, harvest restrictions of Atlantic croaker under ASMFC management have been extremely limited, with a very liberal public bag limit of 50 fish, no species size limit, and only a two-week commercial closure in the primary producing states of Virginia and North Carolina.

The most significant source of Atlantic croaker mortality in North Carolina is the killing of juvenile fish taken as shrimp trawl bycatch.

The [2017 ASMFC Atlantic Croaker Stock Assessment Peer Review Panel](#) reported that “shrimp trawl bycatch accounted for 81-99% of annual Atlantic croaker removals and averaged 91.6% of all removals.” To compound that bycatch problem, Atlantic croaker are also a significant component of the scrap/bait fishery, peaking at over 3.5 million pounds in 1989.

### ***Spot data***

- The 5 highest years of commercial landings of spot in North Carolina averaged 6.6 million pounds.
- The last 2 years of spot landings data (2019-2020) show average annual landings of 0.9 million pounds, 20% of the 5-year peak.
- Spot historically contributed 5%-7% of the annual commercial finfish landed in North Carolina.
- In 2020, spot contribution to total North Carolina finfish landings was 3%.
- The 2017 ASMFC Spot Stock Assessment Peer Review indicated that shrimp trawl bycatch is the most significant source of mortality.
- Commercial spot landings have declined from a high of 14.5 million pounds in 1952 to 1.9 million pounds in 2020.
- Public angler landings have declined from 17.3 million pounds in 1985 to 6.3 million pounds in 2020.
- Spot are also a significant component of the scrap/bait fishery, peaking at over 3.5 million pounds in 1989.

The collective data for spot show a coastwide collapse of that species. The relative “contribution to total North Carolina finfish landings” data also indicates that the spot stock was collapsing in North Carolina from 2016 to 2019. Despite this condition, ASMFC management has been minimal, relying heavily on bycatch reduction devices (BRDs) in shrimp trawls as the primary management approach to protecting the coastwide spot stock.

However, state BRD research only examines the reduction in bycatch at the “tow level.” Studies have not examined the impacts throughout the months-long shrimp season to assess the population effects of repeated tows in the confines of North Carolina’s sounds and rivers. Studies also ignore the impacts of predation during and after the fishing operation. To date, no quantitative analysis shows any resource benefit from the implementation of BRDs.

### ***Weakfish data***

- The 5 highest years of North Carolina weakfish landings average 16.3 million pounds.
- The last 2 years of weakfish landings data (2019-2020) show average landings of 0.1 million pounds, less than 1% of the 5-year peak.
- Shrimp trawl bycatch is the most significant source of weakfish mortality in North Carolina.
- Historically, weakfish contributed 16%-21% of the annual commercial finfish landing in North Carolina.
- In 2020, the contribution of weakfish to total North Carolina finfish landings was less than 1%.
- Commercial fisheries peaked in 1980 at 36 million pounds, while public anglers removed 26 million pounds in 2000.
- Current landings from the ASMFC indicate commercial landings dropped to 102,492 pounds in 2018, and public anglers harvested 1.3 million pounds.
- Commercial trips are now limited to 100 pounds, and anglers are limited to one fish. The stocks show little sign of recovery, yet their bycatch in non-directed fisheries, especially shrimp trawls, continues unchecked.

Collectively, these data show the coastwide weakfish fishery has also collapsed.

### **Discussion of coastwide stock viabilities of ASMFC-managed stocks in relation to collapsed and collapsing definitions**

Based on our review, these ASMFC-managed species—Atlantic croaker, spot and weakfish—historically comprised a significant portion of North Carolina’s public and commercial harvest of state coastal fisheries resources. Today, their stock landings are just a fraction of their historical values. All stocks are collapsed coastwide, yet reducing stock harvest mortality is not a priority of either ASMFC or DMF.

It is extremely important that, while the stocks have declined coastwide, the most significant source of fishing mortality for all three collapsed fisheries is shrimp trawl bycatch in North Carolina’s Pamlico Sound.

This area includes surrounding sounds, bays and rivers that serve as critical nursery habitats for these collapsed and other finfish species. Further, the fact that juvenile spot and Atlantic croaker comprise a sizable component of the bait/scrap fisheries in North Carolina and Virginia is a significant concern for

future management of this species to reverse their collapsed statuses and to restore coastwide stock viabilities.

Other South Atlantic states also have significant shrimp trawl fisheries; however, those states either substantially restrict estuarine trawling or limit shrimp trawling to the Atlantic Ocean. Their shrimp trawl fisheries have less bycatch of larger fish (Brown 2015) and do not occur on primary nursery grounds. Although DMF highly touts BRDs as an effective way to reduce finfish bycatch, no verified studies support the quantitative benefits of BRDs to finfish stocks. Further, North Carolina’s failure to implement appropriate size limits for Atlantic croaker, spot and weakfish, coupled with the continued allowance of these species as a bait component, only adds to the collapsed fisheries problem.

ASMFC’s historical hesitancy to develop an interjurisdictional shrimp FMP to reduce shrimp trawl bycatch further is primarily because most of the problem occurs in one state—North Carolina. While ASMFC has always hoped that North Carolina would voluntarily and independently address the situation, that is unlikely to happen. The State’s recent adoption of Amendment 2 to the N.C. Shrimp FMP demonstrates North Carolina’s unwillingness to responsibly regulate the shrimp trawl industry in the best interest of *all* North Carolinians, much less the interests of citizens in our neighboring states.

In comparing even the very lowest finfish bycatch estimates, North Carolina’s shrimp trawl bycatch vastly exceeds the public and commercial harvest of Atlantic croaker, spot and weakfish for the entire East Coast (Table 2). Because each of these three stocks is collapsed or collapsing, it’s unlikely that these species and others adversely impacted by excessive shrimp trawl bycatch (blue crab, Southern flounder and kingfishes stocks) can achieve even short-term harvest sustainability. It is virtually impossible that any of these species will achieve long-term viability absent responsible regulation of the North Carolina shrimp trawl fishery by DMF.

**Table 2. Total, coastwide commercial and public landings in numbers from the most recent state compliance reports to Atlantic States Marine Fisheries Commission (for ALL states) compared to the estimated number of fish harvested as bycatch (from NC's Division of Marine Fisheries shrimp trawl bycatch characterization study in 2012-2015, the most recent minimal sampling of shrimp trawl fishery.)**

<b>SPECIES</b>	<b>COMMERCIAL HARVEST</b> (in pounds)	<b>PUBLIC HARVEST</b> (in pounds)	<b>SHRIMP BYCATCH ESTIMATES</b> (in pounds)
Atlantic croaker	2.4M (2021)	5.2M (2021)	270-540M (2012-15)
Spot	5.9M (2020)	20.4M (2020)	92-230M (2012-15)
Weakfish	0.14M (2019)	0.22M (2019)	17-34M (2012-15)

## Conclusions

As the above analysis shows, there is little to celebrate in North Carolina state-agency management of its public-trust, coastal fish stocks under the FRA. Nearly half of the state's thirteen independently managed stocks are collapsed or collapsing, and the collapsed status of many others cannot be determined due to the lack of adequate data. Similarly, three species historically significant to both the North Carolina public and commercial fisheries are collapsed or collapsing both in North Carolina and coastwide.

Finally, we note that there are at least two historically valuable public and commercial North Carolina fisheries—Atlantic sturgeon and shortnose sturgeon—that are not discussed above because the fishery collapsed long ago (and the stock remains under a fishing moratorium because population numbers cannot sustain harvest), or because stock depletion and collapse caused by overfishing was so severe that the stock was placed under the protection of the federal Endangered Species Act, imposing a complete harvest moratorium on the fishery.

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