

2021 Winter Storm
Coastal Fisheries Impacts
Texas Parks and Wildlife Department
March 2021



Introduction

The February 2021 winter storms that moved through Texas brought freezing temperatures to the entire coast. While freezing events along the coast are rare, extreme cold temperatures are a natural cause of fish kills. If fish do not make it to a refuge in deeper, more temperature stable water, they may die when water temperatures reach a certain threshold (Figure 1). In preparation of the freeze event Texas Parks and Wildlife Department (TPWD) issued a fishing closure for thermal refuge areas for 48 hours. TPWD also requested voluntary and temporary suspension of barge traffic from the Gulf Intracoastal Canal Association (GICA). In response, GICA suspended tow operations in the Gulf Intracoastal Waterway (GIWW) from the John F. Kennedy Memorial Causeway south to Port Isabel from February 15, 2021 at 12:00 a.m. to February 17, 2021 at 10:00 a.m. This effort was a precautionary measure to protect fish and sea turtles during the coldest period of the event. Concerns for barges transiting the section of the GIWW between Rockport and Ingleside also prompted public requests to divert barge traffic to the Lydia Ann Channel. On February 16, 2021 GICA leadership responded to the appeal by issuing a request for barge operators to avoid transiting that section of the GIWW during the cold period.

TPWD received its first fish kill notification from the Lower Laguna Madre on February 14th, and TPWD Coastal Fisheries teams conducted fish kill assessments through the end of February. As the winter storm ended, the geographic extent of the fish kills was coast wide, impacting all Texas bay systems. The greatest impacts were observed in Matagorda Bay (East and West Matagorda were combined for analysis purposes), San Antonio Bay, Aransas Bay, Upper Laguna Madre, and Lower Laguna Madre.

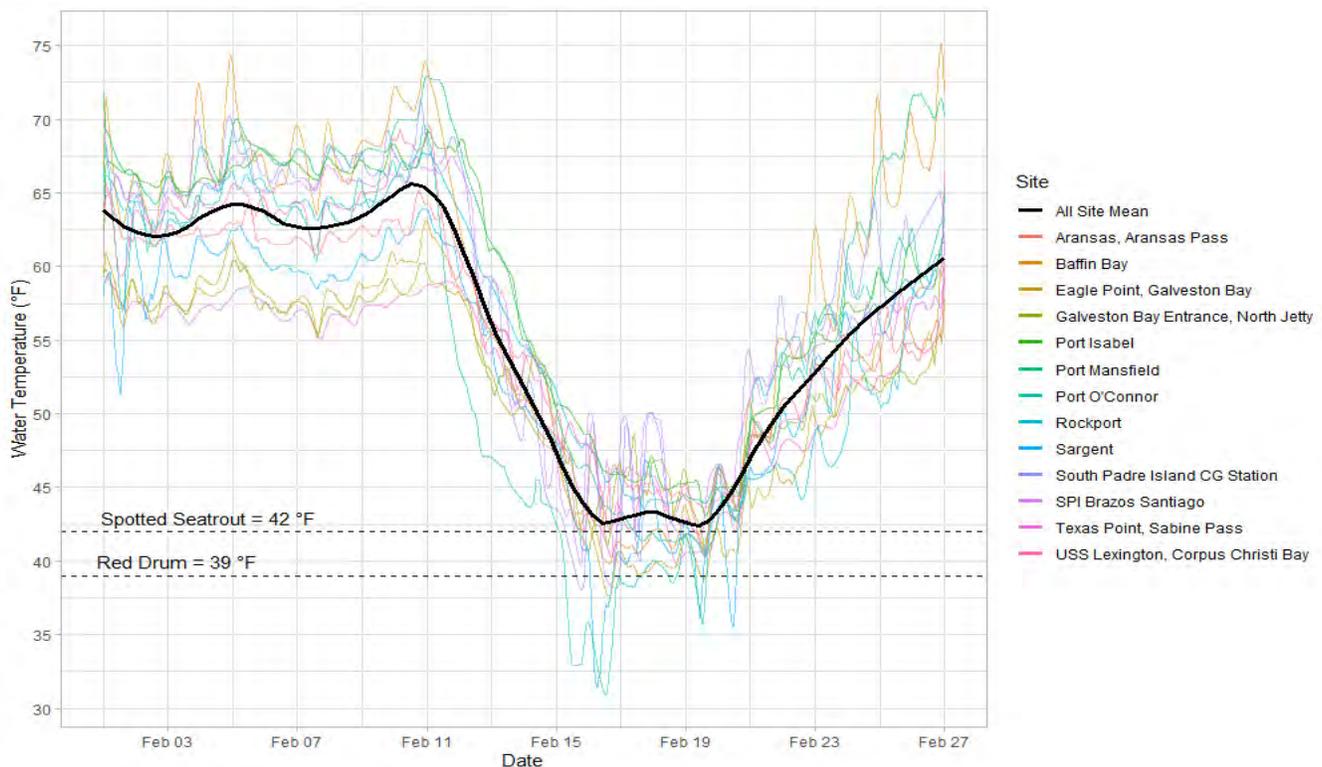


Figure 1. Water Temperatures from NOAA Tide Stations for February 2021 and Lethal Temperatures for Spotted Seatrout (juvenile and adult) and Red Drum. The literature suggests various lethal ranges of temperature across several studies. Many of these studies probably do not incorporate some of the longer durations of temperature or other conditions that could be experienced in a natural freeze event.

Impacts to Marine Fish

An estimated minimum of 3.8 million fish were impacted coastwide consisting of at least 61 species. Species seen most frequently in the TPWD fish kill assessment for the 2021 Freeze event are listed in Table 2A of the Appendix, and a total list of all impacted species can be found in Table 3A. Recreationally important game species accounted for 9% of the total estimated fish kill. Of that percentage, the dominant species included Spotted Seatrout (48%), Black Drum (31%), Sheepshead (8%), Sand Seatrout (7%), Red Drum (3%), Gray Snapper (2%), and Red Snapper (<1%). Spotted Seatrout, which have a higher lethal temperature, were the most impacted game fish (Table 1). Non-recreational species contributed to 91% of the total impact. Dominant non-game species included Silver Perch, Hardhead Catfish, Pinfish, Bay Anchovy, and Striped Mullet (Table 2). While not sought after by most anglers, non-game fish are ecologically important and play a significant role in the overall health and diversity of marine ecosystems. They are often present in high abundance and serve as the primary means for transferring production up the food chain to larger game fish, marine mammals, and seabirds.

The Laguna Madre bay systems were hit particularly hard by this event in terms of both game and non-game fish mortality. The Lower Laguna Madre had the highest mortality of Spotted Seatrout with an estimated 103,907 fish and accounted for 65% of the total estimated coastwide Spotted Seatrout mortality (Table 1). Combined with the Spotted Seatrout mortality in the Upper Laguna Madre (38,982 fish), the Laguna Madre system comprised 89% of the total estimated Spotted Seatrout mortality along the Texas coast. Similarly, Black Drum mortality in the Upper Laguna Madre totaled an estimated 82,560 fish and comprised 78% of the coastwide Black Drum mortality (Figures 2 & 3).

Table 1. Estimated mortalities for most abundant game fish species in major bay systems.

Species	Sabine Lake	Galveston Bay	Matagorda Bay	San Antonio Bay	Aransas Bay	Corpus Christi Bay	Upper Laguna Madre	Lower Laguna Madre	Species Total
Spotted Seatrout	NS	113	533	6,501	8,804	1,636	38,982	103,907	160,476
Black Drum	764	NS	345	1,685	1,191	2,533	82,560	16,735	105,813
Sheepshead	NS	-	2,734	1,049	1,198	1,086	8,408	13,684	28,159
Sand Seatrout	-	-	2,904	1,684	2,803	16,506	-	232	24,129
Red Drum	1,139	NS	152	2,246	771	NS	3,894	1,443	9,645
Grand Total	1,903	113	6,668	13,165	14,767	21,761	133,844	136,001	328,222

NS – Not significant as individual species estimate is less than 100.

Table 2. Estimated mortalities for most abundant non-game species in major bay systems.

Species	Sabine Lake	Galveston Bay	Matagorda Bay	San Antonio Bay	Aransas Bay	Corpus Christi Bay	Upper Laguna Madre	Lower Laguna Madre	Species Totals
Silver Perch	-	NS	17,661	351,372	330,447	4,606	465,344	21,352	1,190,782
Hardhead Catfish	-	NS	223	654,307	32,200	53,175	182,392	76,238	998,535
Pinfish	-	-	289	160,887	95,202	2,572	71,253	105,730	435,933
Bay Anchovy	-	-	NS	106,857	-	-	309,259	-	416,116
Striped Mullet	-	NS	402	6,950	15,622	41,038	88,191	31,175	183,378
Bay Totals	-	NS	18,575	1,280,373	473,471	101,391	1,116,439	234,495	3,224,744

NS – Not significant as individual species estimate is less than 100.

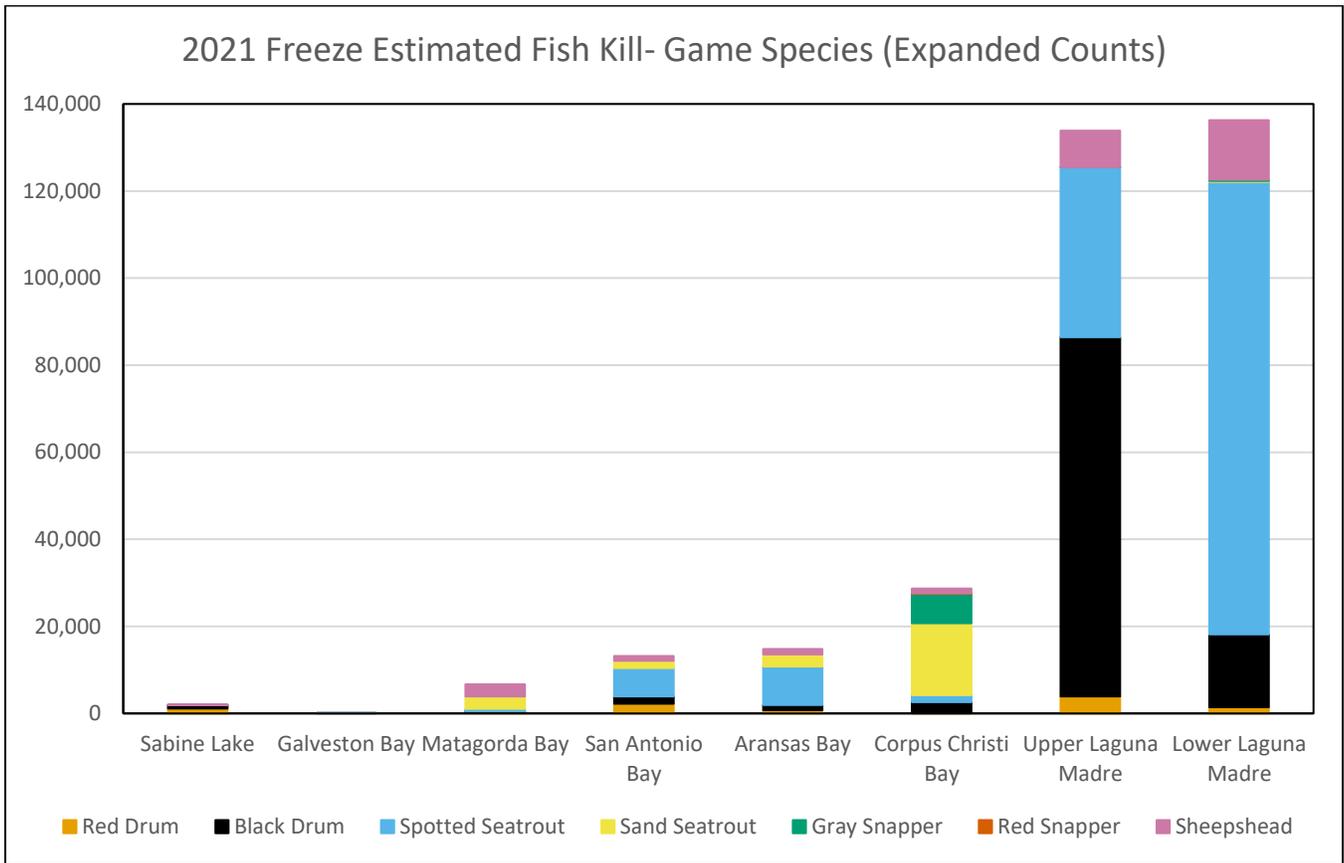


Figure 2. Estimated proportions of game species impacted by February 2021 Freeze Event for major bay systems.

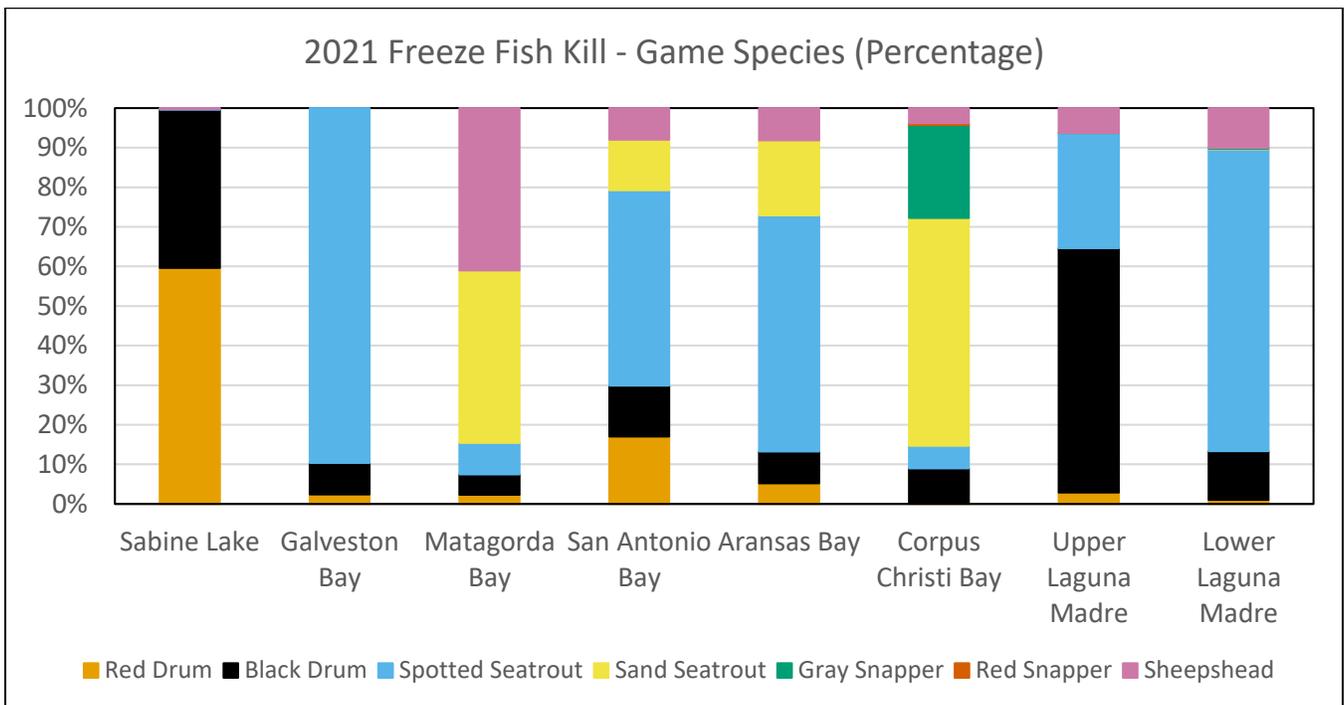


Figure 3. Relative percentages of game species impacted by February 2021 Freeze Event for major bay systems.

Fish Kill Assessment

Assessments for large scale fish kills use a phased approach. The first phase is determining the geographic extent and distribution of fish. This is achieved through observations from staff, state and local partners, and the public. Then, rapid assessments determine rough estimates of the number of fish killed as well as which species were impacted.

Next, TPWD coastal fisheries biologists are assigned sampling areas, and staff count, measure, and record each individual fish present in an area. By following American Fisheries Society guidelines (AFS 2017, full reference below) for sampling in this manner, a summary can be completed for each bay system along with a coast wide assessment. While assessment methods have evolved slightly over time due to better technology and resources, the general methodology for how TPWD assesses fish kills is comparable over the decades.

TPWD considers these to be minimum estimates of the number of fish killed since there may be fish mortalities that are missed by assessments due to a variety of factors. During events like these not all fish will surface to be counted, and there is loss of fish to predation almost immediately. In addition, there is typically a delay in fish floating to the surface after a freeze mortality event, which may lead to fish not being counted due to the timing of fish surfacing relative to assessment activities in each area.

Historical Comparison

Multiple freeze events during the 1980s killed almost 32 million fish coastwide, and like the February 2021 event, the impacts were more severe in the lower coast. While the February 2021 event similarly impacted a large area of the Texas coast, the overall number of fish killed in this event appears to be lower than any of the three freeze events in the 1980s. However, this event appears to have been larger than any other winter fish kill event seen since the 1980s, including those in the 1990s and early 2000's. A summary of historical freeze events and their associated fish kills is presented in Table 1A in the accompanying appendix, Texas Coastal Freeze Events Historical Summary.

Comparatively, the freeze events from the 1980's resulted in greater overall numbers of fish killed and also had larger numbers of Spotted Seatrout mortalities. The three events from the 1980's (Dec. 83', Feb. 89' and Dec. 89') totaled an estimated loss of 1.4 million Spotted Seatrout. In comparison, the most recent event led to the loss of an estimated 160,000 Spotted Seatrout (Table 3). Coastwide, each of the events in the 1980's resulted in twice as many Spotted Seatrout killed compared to the 2021 event. However, in the Laguna Madre, the impact on trout was more comparable to the 1980's freezes. This event resulted in higher trout mortality in the Laguna Madre than either of the two 1989 events when compared independently, and approximately 20% less mortality than seen in the 1983 freeze event.

Table 3. Spotted Seatrout Mortality in select bay systems in thousands of fish for freeze events during the 1980's and February 2021. Coastwide estimates include all bay systems.

Year-Month	Coastwide	San Antonio Bay	Aransas Bay	Corpus Christi Bay	Upper Laguna	Lower Laguna
1983 -Dec	623.9	15.4	246.6	124.1	43.1	127.6
1989 - Feb	350.7	21.2	76.1	0	48.6	34.3
1989 - Dec	409.1	7.7	135.9	23.7	103.9	20.2
2021 - Feb	160.4	6.5	8.8	1.6	38.9	103.9

Recovery of fish stocks to pre-freeze event levels depends on several factors, including the actual number of fish killed, the recruitment of the particular species in the year(s) following the event, and the overall abundance prior to the event. Historical datasets provide some insight into the recovery to pre-freeze catch rates following previous freeze events. For example, based on gill net catch rates, Spotted Seatrout recovery took 2-3 years to reach pre-freeze levels after the 1980's events. Recovery of Spotted Seatrout took one year following the less severe events of the 1990's and 2000's. It is important to note that this is the length of time to recover to pre-freeze gill net catch rates and does not indicate that the size structure of the population was the same at those recovery points.

Future Plans

As TPWD coastal fisheries biologists continue to assess this event and determine the impact to the overall fish populations, they will compare this event to past freeze events and brief the Texas Parks and Wildlife Commission (TPWC) on those impacts relative to the historical record of coastal freezes. In the near term, TPWD will continue to analyze this event's impacts on populations by species and bay systems and work with the TPWC to determine what actions, if any, may be needed to accelerate recovery of fish populations and to help address future events.

TPWD's long-term routine monitoring program (e.g. gill nets, bay trawls, and bag seines) has collected data for over 40 years. These data are invaluable to biologists in evaluating the impacts of events of this type by benchmarking post-freeze numbers against sampling efforts from previous years. This type of historical data also allows for analysis of this freeze event by comparing it to past events, even before additional routine sampling is conducted. For many key game and non-game species, more informative data will start coming in with sampling that occurs post event. This includes spring gill net sampling which runs from mid-April thru mid-June for 10 consecutive weeks. It must be noted that comparisons will be made to 2019 spring gill net surveys as COVID 19 did not allow for spring gill net sampling in 2020. Additionally, as a part of year-round survey efforts, biologists are already collecting information from recreational anglers at boat ramps through our routine sampling at boat ramps. These data will provide additional information regarding the impacts of this cold-weather event on angler catch rates of game fish. TPWD will also be evaluating an increase in Spotted Seatrout production at its coastal fish hatcheries to aid the recovery efforts.

The TPWD Coastal Fisheries Division will continue to inform the public and the Texas Parks and Wildlife Commission on its assessment of the magnitude of this event's impacts on fishery populations. The

department will also review the potential to modify other management strategies such as the placement, timing and duration of thermal closures.

References

AFS 2017. Investigation and monetary values of fish and freshwater mollusk kills. RI Southwick, AJ Loftus eds. Special Publication 35, American Fisheries Society, Bethesda, MD, USA.

APPENDIX

Texas Coastal Freeze Events Historical Summary

Table 1A. Texas Coastal Freeze Event Comparison

Date and Duration	Geographic extent	Mortality Estimates	Notes
December 1983 (6 Days)	Entire Coast	14.4 million fishes and 1.3 million invertebrates	During the three freezes in the 1980's, 71% of spotted seatrout, 60% of red drum, and 78% of all fish mortality occurred along the lower coast – Aransas Bay to the lower Laguna Madre.
February 1989 (3 Days)	East Matagorda south to Lower Laguna Madre. little reported in other bay systems	11.3 million fishes and 13,000 invertebrates	
December 1989 (3 Days)	Entire Coast	6.2 million fishes and 155,000 invertebrates Most (69%) of spotted seatrout mortality occurred from Aransas Bay to the Lower Laguna Madre	
January 1997 (3 Days)	Lower Coast Aransas Bay, Upper Laguna Madre and Lower Laguna Madre with very little reported from other bay systems.	328,000 fishes	Recreationally important species accounted for 56% of total fish kill including Spotted Seatrout, Black Drum, and Red Drum.
December 2004 (3 Days)	Lower Laguna Madre and minor reports in Aransas Bay and Upper Laguna Madre	35,306 fishes	Recreationally important species accounted for 11% of the total fish kill including Spotted Seatrout and Snook
January 2010 (3 Days)	Primarily mid and lower coast	51,000 fishes	Recreationally important species accounted for <1% of the total fish kill including Spotted Seatrout, Snook, and Tarpon.
February 2011 (2 Days)	Entire coast	290,000 fishes	
December 2017 (1 Day)	Non-event	N/A	N/A
January 2018 (2 Days)	Entire Coast. The majority of the kills were located in developed areas such as canal subdivisions or marinas.	70,000 fishes	Recreationally important species accounted for 10% of the total fish kill including Red Drum, Black Drum, Spotted Seatrout, Sheepshead, Snook, and Tarpon.
February 2021 (3 Days)	Entire Coast. Majority of kills located in San Antonio Bay, Aransas Bay, Upper Laguna Madre, and Lower Laguna Madre with minor reports from other bay systems.	3.8 million fishes	Recreationally important species accounted for 9% of the total fish kill included Spotted Seatrout, Black Drum, Sheepshead, Sand Seatrout, Red Drum, Gray Snapper, and Red Snapper. Non-recreational species accounted for 91% of the total impacted. Dominant species included Silver Perch, Hardhead Catfish, Pinfish, Bay Anchovy, and Striped Mullet

Coastal Freeze Events - Historical Summary

Background and History

- Prior to 1983, the longest continuous freeze on record began on December 19, 1924 and ended 74 hours later. This record was eclipsed in December 1983 when 77 hours of continuous below freezing temperatures were recorded in Port Arthur.
- Three unusually cold weather events occurred along the Texas coast in the 1980's, one in 1983 and two in 1989, which caused massive fish kills. Approximately, 32 million fish died in those events, representing 159 species – 103 fishes, 45 invertebrates and 11 vertebrates other than fishes.

Major Freeze Events, Impacts, and Management Actions

- **December 1983 – Lasted 6 days. Impact – Entire Coast.** Estimated 14.4 million fishes and 1.3 million invertebrates died along the Texas coast. Dramatic reduction in coastwide recreational fisheries landings. For example, recreational Spotted Seatrout angler catch rates surveys did not reach pre-freeze levels until 1987. Spring gill net catch rates in the upper Laguna Madre for Spotted Seatrout dropped from 0.7/hr in 1983 to 0.1/hr in the spring of 1984.
 - **Emergency Management Actions enacted as a result of the event.**
 - Emergency action closed East Matagorda Bay to all fishing for 120 days which was highly controversial.
 - Spotted Seatrout: Minimum size increased from 12 to 14” and reduced daily bag limit from 20 to 10.
 - Red Drum: Minimum size increased from 16 to 18” and reduced daily bag limit from 10 to 5.
 - Recovery of Spotted Seatrout based on gill net catch rates took 3 years to reach the pre-freeze level. This does not imply size structure was the same prior to freeze.
- **February 1989 – Lasted 3 days. Impact – East Matagorda south to Lower Laguna Madre.** Estimated 11.3 million fishes and 13,000 invertebrates died along the Texas coast. 84% of the fish mortality occurred in the Upper and Lower Laguna Madre.
- **December 1989 – Lasted 3 days. Impact – Entire Coast.** Estimated 6.2 million fishes and 155,000 invertebrates died along the Texas coast. Most (69%) Spotted Seatrout mortality occurred from Aransas Bay to the Lower Laguna Madre during the December 1989 freeze.
 - **Management Action – Spotted Seatrout:** Minimum size limit increased from 14” to 15”

- Recovery of Spotted Seatrout based on gill net catch rates took 2 years to reach the pre-freeze level. This does not imply size structure was the same prior to freeze.
- During the three freezes in the 1980's, 71% of Spotted Seatrout, 60% of Red Drum, and 78% of all fish mortality occurred along the lower coast (Aransas Bay to the lower Laguna Madre).
- **January 1997 – Lasted 3 days. Impact – Primarily in lower coast.** Estimated 328,000 fish died including 99,000 Spotted Seatrout, 82,000 Black Drum and 2,000 Red Drum. Mortalities of fish occurred in Aransas Bay, Upper Laguna Madre and Lower Laguna Madre with very little reported from other bay systems.
 - Recovery of Spotted Seatrout based on gill net catch rates took 1 year to reach the pre-freeze level. This does not imply size structure was the same prior to freeze.
- **December 2004 – Lasted 3 days. Impact – Primarily in lower coast.** In the lower Laguna Madre, 35,306 fish died (15,628 Gray Snapper, 9,860 Striped Mullet, 5,322 Silver Perch, 3,552 Spotted Seatrout, 522 Snook, 177 Pinfish and <100 each of an additional 11 other species – many with tropical affinities, e.g. Gag Grouper, Lookdown, Irish Pompano, Red Snapper. A few other minor kills were reported in Aransas Bay and the Upper Laguna Madre.
 - Recovery of Spotted Seatrout based on gill net catch rates took 1 year to reach the pre-freeze level. This does not imply size structure was the same prior to freeze.
- **January 2010 – Lasted 3 days. Impact – Primarily in mid coast.** Estimated 51,000 fish died. Over 400 sea turtles were stranded (with estimates of over 2/3 mortality). Thermal refuges were not closed during this event, but there was a voluntary barge traffic stoppage in the ICW from JFK Causeway through the Landcut.
- **February 2011 – Lasted 2 days. Impact – Entire coast.** Estimated 290,000 fishes died along the Texas coast. 1,520 sea turtles (1,518 greens) were stranded (over 230 were mortalities).
 - **Management Action Prior to Event** – Fishing closure for thermal refuge areas for 3 days.
- **December 2017 – Lasted 1 day. Non-event for fish kills.**
- **January 2018 – Lasted 2 days. Impact - Entire Coast.**

- Fish - A minimum of 70,000 fish died. Less than 10 species were impacted. Majority of fish impacted were non-recreational species including Mullet, Hardhead Catfish, and other forage fish. Recreationally important species included Red Drum, Black Drum, Spotted Seatrout, Sheepshead, Grey Snapper, Snook, and Tarpon. Proportionally, these species accounted for less than 10% of the total mortality event. The majority of the kills were located in developed areas such as canal subdivisions or marinas.
- Turtles - 3,702 turtles reported.
- **Management Action Prior to Event** - Fishing closure for thermal refuge areas for 40 hours. Requested voluntary suspension of barge traffic from the Gulf Intracoastal Canal Association (GICA), which resulted in the voluntary and temporary suspension of tow operations in the Intracoastal Waterway (ICWW) from the John F. Kennedy Memorial Causeway south to Port Isabel beginning January 2, 2018 at 6:00 p.m.

Table 2A. Top 99% of the estimated coastwide mortalities per major bay system from the 2021 Freeze Event. Species that were not observed in a particular bay system are denoted with a dash (-) and species numbers that were estimated to be below 100 are denoted as NS (not significant).

Species	Sabine Lake	Galveston Bay	Matagorda Bay	San Antonio Bay	Aransas Bay	Corpus Christi Bay	Upper Laguna Madre	Lower Laguna Madre	Species Totals
Silver Perch	-	NS	17,661	351,372	330,447	4,606	465,344	21,352	1,190,782
Hardhead Catfish	-	NS	223	654,307	32,200	53,175	182,392	76,238	998,535
Pinfish	-	-	289	160,887	95,202	2,572	71,253	105,730	435,933
Bay Anchovy	-	-	NS	106,857	-	-	309,259	-	416,116
Striped Mullet	-	NS	402	6,950	15,622	41,038	88,191	31,175	183,378
Spotted Seatrout	NS	113	533	6,501	8,804	1,636	38,982	103,907	160,476
Spot	-	-	5,339	608	72,303	486	11,381	25,996	116,113
Black Drum	764	NS	345	1,685	1,191	2,533	82,560	16,735	105,813
Gulf Menhaden	-	-	-	4,969	419	268	38,608	1,751	46,015
Striped Burrfish	-	-	NS	2,932	153	21,817	943	4,823	30,668
Sheepshead	NS	-	2,734	1,049	1,198	1,086	8,408	13,684	28,159
Sand Seatrout	-	-	2,904	1,684	2,803	16,506	-	232	24,129
Atlantic Croaker	-	-	11,385	172	-	NS	6,047	6,340	23,944
Red Drum	1,139	NS	152	2,246	771	NS	3,894	1,443	9,645
Ladyfish	-	-	-	-	-	4,989	3,309	244	8,542
Atlantic Cutlassfish	-	-	2,465	4,320	127	NS	295	-	7,207
Gray Snapper	-	-	-	-	-	6,722	NS	300	7,022
Scrawled Cowfish	-	-	-	-	153	6,315	110	190	6,768
Total	1,903	113	44,432	1,306,539	561,393	163,749	1,310,976	410,140	3,799,245

Table 3A. Coastwide list of all species collected in assessments of the 2021 Freeze Event. Note: 326 fish were unidentifiable to species due to deterioration and /or predation, and 162 fish were identified to the Family level.

Atlantic Croaker	Gulf Kingfish	Sea Robin
Atlantic Cutlassfish	Gulf Menhaden	Sheepshead
Atlantic Midshipman	Gulf Pipefish	Sheepshead Minnow
Atlantic Needlefish	Gulf Toadfish	Shrimp Eel
Atlantic Spadefish	Hardhead Catfish	Silver Perch
Atlantic Stingray	Inshore Lizardfish	Smallmouth Buffalo
Banded Drum	Irish Pompano	Smooth Butterfly Ray
Bay Anchovy	Ladyfish	Smooth Puffer
Bay Whiff	Least Puffer	Soapfish
Bermuda Chub	Mojarra	Southern Kingfish
Bighead Searobin	Oyster Toadfish	Spot
Black Drum	Pigfish	Spotfin Butterflyfish
Blackcheek Tonguefish	Pinfish	Spotted Seatrout
Common Snook	Pipefish	Star Drum
Cownose Ray	Red Drum	Striped Burrfish
Family Bothidae (Left-eyed Flounder)	Red Snapper	Striped Mullet
Filefish	Redfin Needlefish	Tarpon
Gafftopsail Catfish	Sand Trout	White Mullet
Gizzard Shad	Sargassum Triggerfish	Yellowfin Mojarra
Gray Snapper	Scorpionfish	
Guitarfish	Scrawled Cowfish	