APPENDIX C

Hurricane Ida Inland Fish Kill Report
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12/1/21

<u>Methods</u>

Reporting
Fish kills following Hurricane Ida were logged from various sources including reports from the public, reports from LDWF staff, Facebook posts, and Youtube videos. Authors of social media posts were contacted to gather relevant information, if necessary. LDWF staff took water quality readings across the impacted area and looked for signs of fish kills following the storm.

Fish Kill Estimates
National Wetlands Inventory data were used to calculate the acres of open water within the area of reported fish kills and hypoxic conditions. Lake Pontchartrain and much of New Orleans were eliminated from the calculation due to the lack of fish kill reports in a highly populated area.

For calculations of fish mortality, 1/3 of lacustrine habitat was used based on observations of limited fish kills in the lakes. Three-quarters of riverine habitat (including bayous and canals) was used in the calculation for fish mortality based on widespread observed kills and anoxia observed in those waters. Rotenone data from coastal marsh sampling conducted in 2011-2013 was used in calculations with habitat areas to estimate fish mortality.

<u>Results</u>
The first reported fish kill following Ida's landfall was made on September 2 for a kill on Bedico Creek that began on August 30. Twenty fish kills were reported between September 2 and September 16, most being reported as significant or total (Figure 1). Reported inland kills and measured hypoxia (Figure 2) spanned an area of over 1.8 million acres. All reported kills, except for one reported in Gibson, LA, occurred within the path of hurricane-force winds
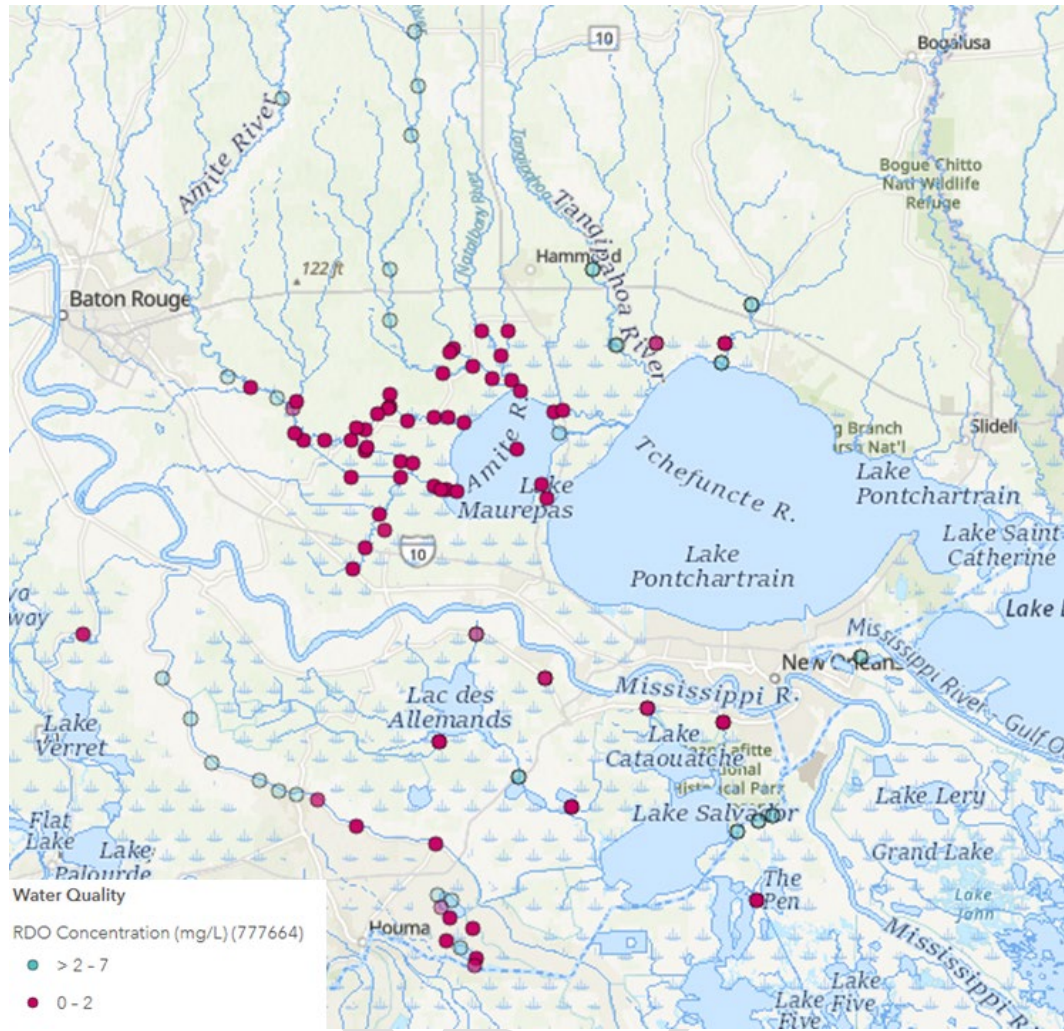
Figure 1. Observed fish kills following Hurricane Ida with hurricane-force winds in red.

Figure 2. Dissolved oxygen following Hurricane measured between September 7 and September 16, 2021. Hypoxia (< 2 mg/L) is in red, and transparency of points increases as oxygen concentration increases. Blue dots represent oxygen levels > 2 mg/L, and increase in transparency as oxygen concentration increases.

Using National Wetlands Inventory data, it was determined that 114,500 acres of lacustrine habitat and 225,619 acres of riverine (including canals and bayous) habitat was present in the zone of observed fish kills.

The total fish kill estimate calculated from rotenone data is 277,857,419 individuals (Table 1). Notable estimates of fish mortality include 2.74 million Largemouth Bass, 8 million Channel Catfish, and 12.75 million Striped Mullet.

Table 1. Estimated mortality of fishes following Hurricane Ida based on coastal marsh rotenone data.

Species	Number in 1 acre	Lacustrine Kill (1/3 of area calculated)	Riverine Kill (3/4 of area calculated)	Total
Alligator Gar	0.061795149	2,358.52	10,456.60	12,815
Atlantic Croaker	21.13394099	806,612.15	3,576,158.69	4,382,771
Atlantic Needlefish	2.224625367	84,906.54	376,437.76	461,344
Atlantic Stingray	0.123590298	4,717.03	20,913.21	25,630
Bay Anchovy	396.4158814	15,129,874.13	67,079,116.95	82,208,991
Bay Whiff	1.853854472	70,755.45	313,698.13	384,454
Bighead Carp	0.123590298	4,717.03	20,913.21	25,630
Bigmouth Buffalo	0.803336938	30,660.70	135,935.86	166,597
Black Crappie	1.235902982	47,170.30	209,132.09	256,302
Black Drum	1.235902982	47,170.30	209,132.09	256,302
Blackcheek Tongufish	0.061795149	2,358.52	10,456.60	12,815
Blue Catfish	8.898501468	339,626.17	1,505,751.03	1,845,377
Bluegill	47.0879036	1,797,188.48	7,967,932.52	9,765,121
Carp	0.370770894	14,151.09	62,739.63	76,891
Channel Catfish	38.93094392	1,485,864.49	6,587,660.74	8,073,525
Clown Goby	0.185385447	7,075.55	31,369.81	38,445
Crevalle Jack	0.061795149	2,358.52	10,456.60	12,815
Darter Goby	0.494361193	18,868.12	83,652.83	102,521
Flathead Catfish	0.617951491	23,585.15	104,566.04	128,151
Freshwater Drum	3.769504094	143,869.42	637,852.87	781,722
Freshwater Goby	0.123590298	4,717.03	20,913.21	25,630
Gafftopsail Catfish	4.572841032	174,530.11	773,788.72	948,319
Gizzard Shad	44.67789279	1,705,206.39	7,560,124.95	9,265,331
Golden Shiner	0.123590298	4,717.03	20,913.21	25,630
Gulf Killifish	0.803336938	30,660.70	135,935.86	166,597
Gulf Menhaden	533.044956	20,344,550.93	90,198,669.18	110,543,220
Gulf Pipefish	1.297698131	49,528.82	219,588.69	269,118
Hogchoker	1.174107833	44,811.79	198,675.48	243,487
Inland Silverside	6.982851846	266,512.20	1,181,596.29	1,448,108
Ladyfish	6.488490653	247,644.08	1,097,943.46	1,345,588
Largemouth Bass	13.2241619	504,722.22	2,237,713.33	2,742,436
Least Puffer	0.123590298	4,717.03	20,913.21	25,630
Leatherjacket	0.061795149	2,358.52	10,456.60	12,815
Longear Sunfish	0.865132087	33,019.21	146,392.46	179,412
Longnose Gar	0.061795149	2,358.52	10,456.60	12,815
Madtoms	0.123590298	4,717.03	20,913.21	25,630
Naked Goby	2.966167156	113,208.72	501,917.01	615,126

Species	Number in 1 acre	Lacustrine Kill (1/3 of area calculated)	Riverine Kill (3/4 of area calculated)	Total
Pinfish	0.617951491	23,585.15	104,566.04	128,151
Pirate Perch	0.061795149	2,358.52	10,456.60	12,815
Rainwater Killifish	5.932334312	226,417.45	1,003,834.02	1,230,251
Red Drum	3.213347752	122,642.78	543,743.43	666,386
Redear Sunfish	41.58813533	1,587,280.64	7,037,294.73	8,624,575
Redspotted Sunfish	11.74107833	448,117.86	1,986,754.83	2,434,873
Sailfin Molly	0.123590298	4,717.03	20,913.21	25,630
Sand Seatrout	4.202070137	160,379.02	711,049.10	871,428
Sea Catfish	8.09516453	308,965.47	1,369,815.17	1,678,781
Sharptail Goby	0.308975745	11,792.58	52,283.02	64,076
Sheepshead	0.741541789	28,302.18	125,479.25	153,781
Sheepshead Minnow	0.185385447	7,075.55	31,369.81	38,445
Shrimp Eel	0.061795149	2,358.52	10,456.60	12,815
Silver Carp	0.741541789	28,302.18	125,479.25	153,781
Silver Perch	4.758226479	181,605.66	805,158.54	986,764
Skilletfish	1.112312683	42,453.27	188,218.88	230,672
Skipjack Herring	0.123590298	4,717.03	20,913.21	25,630
Smallmouth Buffalo	3.213347752	122,642.78	543,743.43	666,386
Southern Flounder	3.707708945	141,510.90	627,396.26	768,907
Speckled Worm Eel	1.112312683	42,453.27	188,218.88	230,672
Spot	14.39826974	549,534.01	2,436,388.82	2,985,923
Spotted Gar	3.831299243	146,227.93	648,309.47	794,537
Spotfin Mojarra	0.061795149	2,358.52	10,456.60	12,815
Star Drum	0.123590298	4,717.03	20,913.21	25,630
Spotted Seatrout	8.465935424	323,116.56	1,432,554.80	1,755,671
Striped Mullet	61.48617334	2,346,722.49	10,404,321.33	12,751,044
Threadfin Shad	7.230032442	275,946.26	1,223,422.71	1,499,369
Violet Goby	0.370770894	14,151.09	62,739.63	76,891
Warmouth	7.353622741	280,663.29	1,244,335.92	1,524,999
Western Mosquitofish	1.606673876	61,321.39	271,871.71	333,193
Whit Mullet	0.061795149	2,358.52	10,456.60	12,815
White Bass	0.247180596	9,434.06	41,826.42	51,260
Yellow Bass	0.432566044	16,509.61	73,196.23	89,706
Yellow Bullhead	0.123590298	4,717.03	20,913.21	25,630

Discussion

Fish kills following a tropical storm are generally caused by one, or a combination of up to three factors: churning and decomposition of organic sediments causing a drop in dissolved oxygen, decomposition of debris falling and flowing into waterways, and storm surge. Following the initial factors that led to

hypoxic conditions, rotting fish and other biota killed by the original hypoxia caused by the storm caused prolonged hypoxic conditions as they decomposed. Fish have also been observed escaping hypoxic waters en masse, only to deplete the oxygen in the water they have crowded into, causing more fish kills. Hypoxia was observed for a number of weeks following the storm, and conditions improved at variable rates depending on environmental conditions.

Estimating fish kills on such a large scale following a major natural disaster is a difficult task. Destruction was widespread following Hurricane Ida, and communications were down in many areas. The public, who we largely depend on to report fish kills, was largely displaced or occupied with cleanup efforts. Our staff, who we rely on to respond to reported fish kills, were in a similar situation.

When possible, people did begin to report fish kills by phone, and we recorded each report and responded in person where it was deemed necessary and possible. Mining social media for fish kill reports proved to be a very useful method to track the extent of fish kills. Many posts and comment threads had pictures, videos, and/or geographic descriptions of mortality events. Authors of posts and comments were easy to contact and usually generous with information. I recommend this method become standard for tracking the extent of mortality events following major hurricanes or other widespread events.

Even with an expanded monitoring network thanks to modern communications, many fish kills were not reported in lightly populated areas and coastal areas that were prone to storm surge and evacuated. It can probably be safely assumed that there were fish kills south of the area reported here, following the pattern of mortality being primarily confined to the path of hurricane-force winds. Only one fish kill was reported north of Interstate 12, and that is probably because it is lightly populated and the substrates are sandier with higher relief (and flow) than the habitat to the south, and less prone to hypoxia.

The rotenone data available covers freshwater coastal marsh habitat, and the variety of habitats impacted by Ida are populated by different fish communities. Rotenone sampling provides a fairly complete sample of fishes, but has limitations, especially in a one-day set. The estimate provided here is likely low for freshwater species, in numbers and species, and high for brackish and saltwater species, in the area covered in this report. The estimates can, however, inform the possibilities of the magnitude of an event similar to Hurricane Ida.

Following hurricane-caused fish kills of comparable magnitude, fish populations have been observed to bounce back naturally in the following years. It can be safely assumed that coastal populations of fishes in Louisiana have evolved to persist through tropical storm events with life history strategy and physiological adaptations. Because of the resilient nature of the local fish populations, introducing genetics from outside of the impacted area in an effort to restock fish populations is not advised. If a restocking effort with non-local genetics is successful at all, it will likely only dilute the genetics that have evolved in local populations to help survive and rebound from these events.