LOUISIANA DEPARTMENT OF WILDLIFE & FISHERIES

OFFICE OF FISHERIES

INLAND FISHERIES SECTION

DISTRICT VIII

Pearl River Fish Kill Post Incident

Monitoring Report 2012 - 2014

The Louisiana Department of Wildlife and Fisheries (LDWF) completed a three year fish and mussel monitoring project during the years 2012 through 2014 in the Pearl River and associated waters. The project's primary objective was to monitor the recovery of native species following the August 2011 Pearl River Fish and Mussel Kill (PRFK) and to identify management actions, if necessary, to aid in the recovery of fish and mussel communities (**APPENDIX I**).

Methods

Fish Assemblage Sampling

Fish population sampling for this monitoring effort complied with LDWF standardized sampling procedures. Additional sampling was conducted in tributaries with slight variations of sampling gear to ensure that all representative habitats were sampled. Sampling was conducted in the normal low flow months of late summer and early fall. Seven stations were selected for fish sampling in the Pearl River watershed (Table 1). Five of those stations were within the portion of the river that was impacted by the PRFK. One sampling station was located upstream from the impacted area. Three stations were selected for fish samples in tributaries (Table 1).

Each main stem river station and the Bogue Chitto River tributary station were sampled using the following gear types and techniques. For each gear listed below, all fish were collected and identified to the species level. Common species were sorted to inch group. Individual lengths and weights were recorded for rare species and species of concern (Table 2).

1.) Boat Electrofishing: 900 second samples, randomly chosen shoreline within 500 meters (m) of station GPS location, conducted in downstream manner while speed not exceeding the river flow rate, 3/16 mesh dip net

2.) Hoopnets: Four feet (ft.) hoops, 1.5" mesh, 15ft in length, #15 tarred twine, 2 throats, no lead, no bait, three nets per station, set for 72 hours

3.) Seines: Standard 25 ft. X 6 ft. X 3/16" mesh with 6 ft. bag, 2 hauls per site, at night when possible

Each tributary station was sampled at night with either a 10 ft. X 6 ft. X 3/16" mesh seine or a 20 ft. X 6 ft. X 3/16" mesh seine. Seine hauls were made within 100 m of the established station GPS location. All fish collected were identified to species. Common species were sorted to inch group. Individual lengths and weights were recorded for rare species and species of concern (Table 2).

Table 1. Pearl River Basin fish sampling stations and associated GPS coordinates for the 2012 – 2014 PRFK post incident monitoring.

SITE	LATITUDE	LONGITUDE	MAIN RIVER SAMPLE	TRIBUTARY SAMPLE
PRFK 1	30.78555	-89.81933	X	
PRFK 2	30.72111	-89.84086	X	
PRFK 3	30.61188	-89.82227	X	
PRFK 4	30.52452	-89.80802	X	
PRFK 5	30.47272	-89.77833	X	
PRFK 6	30.37611	-89.73036	X	
BogueChitto1	30.62330	-89.87627		X
Pushepatapa Creek	30.86508	-89.81302		X
Bogalusa Creek	30.76961	-89.89144		X
Cryer Slough	30.53905	-89.82763		X

Table 2. Pearl River Basin freshwater fish species of concern (LDWF 2005)

SCIENTIFIC NAME	COMMON NAME
Acipenser oxyrinchus	Gulf sturgeon
Polyodon spathula	Paddlefish
Alosa alabamae	Alabama shad
Pteronotropis signipinnis	Flagfin shiner
Pteronotropis welaka	Bluenose shiner
Ericymba amplamala	Longjaw minnow
Moxostoma carinatum	River Redhorse
Cycleptus meridionalis	Southeastern Blue sucker
Noturus minutus	Frecklebelly madtom
Crystallaria asprella	Crystal darter
Percina copelandi	Channel darter
Percina lenticula	Freckled darter
Percina aurora	Pearl darter
Percina suttkusi	Gulf logperch

Mussel Assemblage Sampling

Mussel population sampling was consistent with protocol previously established by Louisiana State University (Brown et al. 2010) and is described below. Sampling was conducted annually from late summer to early fall to coincide with the normal period of low flow. A total of eight stations were selected for monitoring (Table 3). Six of these stations were previously sampled in 2007; three of which

were sampled again in 2011 (Table 3). These stations were within the area impacted by the PRFK from Bogalusa to the Interstate-59 overpass. Two additional sites were selected in areas of the river that were not impacted by the PRFK. One of those stations was located upstream of the affected area. The other station was located in the Bogue Chitto River, upstream of the low head sill.

The majority of dead mussels observed during the PRFK were the same species, *Leptodea fragilis*. Shell morphology may explain the significant differences in mortality between thin-shelled mussels and other mussel species during the PRFK. *Leptodea fragilis*, a thin-shelled mussel with a shell that does not always encase its soft tissue may have been more susceptible to poor water quality. Miller and Payne (1997) reported that this species and other thin-shelled mussels have low relative abundance in comparison to other Pearl River mussel species. In 2007, thin-shelled species accounted for only 4.32 percent of mussels sampled (Brown et al. 2010). Previous studies were conducted in waters less than one meter in depth. Additional samples at all sites in depths greater than one meter were collected for this study in an effort to expand the understanding of mussel habitat and differences in species assemblage composition and species diversity at different water depths.

Sampling Protocol

Timed qualitative searches were performed at each established sample site. Biologists located mussels by tactile search along the littoral zones (<1 m depth), retrieving both living mussels and shell. Target effort for each sample site was 90 person minutes. For example, if the mussel crew included 3 people and each person sampled for 30 minutes, there would be a total of 90 person minutes at that site. All collected mussels were identified to species. Additional samples were conducted in water > 1 m depth adjacent to samples taken in the littoral zone at all sites. Biologists utilized SCUBA equipment to collect these samples. At each site, water quality parameters were collected, including water temperature, conductivity, salinity, turbidity, pH, and dissolved oxygen. Analysis of these data included: mortality (% of the individuals collected dead), catch per unit effort (total number of mussels collected per sample in 90 minutes), species richness, and Shannon-Wiener Diversity H' Index.

Table 3. Pearl River Basin freshwater mussel sampling stations and associated GPS coordinates for the 2012 – 2014 PRFK post incident monitoring.

SITE	LATITUDE	LONGITUDE	PREVIOUSLY SAMPLED IN 2007	PREVIOUSLY SAMPLED IN 2011	New
111	30.39830	-89.72236	X	X	
113	30.47441	-89.77951	X	X	
114	30.42955	-89.73927	X	X	
123	30.51872	-89.80377	X		
130	30.60380	-89.82227	X		
143	30.72508	-89.83950	X		
150	30.78305	-89.82730			X
BC	30.6224	-89.87725			X

Table 4. Freshwater mussel species of conservation concern in Louisiana (LDWF 2005)

SCIENTIFIC NAME	COMMON NAME
Anodontoides radzatus	Rayed Creekshell
Elliptio crassidens	Elephant-Ear
Pleurobema beadleianum	Mississippi Pigtoe
Potamilus inflatus	Inflated Heelsplitter
Villosa vibex	Southern Rainbow

Results

Fish Assemblage Sampling

Fifteen thousand, eight hundred and thirty four individual fish representing sixty-one species from seventeen families were collected in all samples from 2012 to 2014 (Table 5). Members of the family Cyprinidae were the most abundant. Fourteen species of Cyprinidae accounted for 76% of total individuals collected. Two species of Cyprinidae accounted for 61% of the total individuals collected, the blacktail shiner and silvery minnow. Members of the family Ictaluridae (catfishes) were the second most represented family in the samples comprising 15% of the total, followed by members of the family Centrarchidae with 6% of the total. Shannon-Weiner H', number of individuals and species richness per site were similar throughout the sample period (Table 6).

Table 5. Species collect during the PRFK post incident monitoring from 2012-2014 in the Pearl River basin.

FAMILY	SCIENTIFIC NAME	COMMON NAME	2014	2013	2012	TOTAL
Achiridae	*Amia calva*	Bowfin , Choupique			1	1
Anguillidae	*Anguilla rostrata*	American eel			2	2
Achiridae	*Trinectes maculates*	Hogchoker	38	14		52
Atherinopsidae	*Labidesthes sicculus*	Brook silverside	1	1	4	6
	Menidia beryllina	Inland silverside		1		1
Catostomidae	*Carpiodes carpio*	River carpsucker	6	9	11	26
	Cycleptus elongates	Blue sucker	1	1	1	3
	Hypentelium nigricans	Northern hogsucker	2	2		4
	Ictiobus bubalus	Smallmouth buffalo	11	10	22	43
	Ictiobus cyprinellus	Bigmouth buffalo		9	3	12
	Ictiobus niger	Black buffalo			1	1
	Moxostoma poecilurum	Blacktail redhorse	4	18	9	31

Centrarchidae	*Ambloplites macrochirus*	Shadow bass	1			1
	Lepomis gulosus	Warmouth		2		2
	Lepomis humilis	Orangespotted sunfish		9		9
	Lepomis macrochirus	Bluegill	80	110	103	293
	Lepomis megalotis	Longear sunfish	68	116	113	297
	Lepomis microlophus	Redear sunfish	1	2	5	8
	Micropterus punctatus	Spotted bass	30	41	24	95
	Micropterus salmoides	Largemouth bass	38	22	22	82
	Pomoxis annularis	White crappie	4	2	4	10
	Pomoxis nigromaculatus	Black crappie	1	3	5	9
Clupeidae	*Brevoortia patronus*	Gulf menhaden			4	4
	Alosa chrysochloris	Skipjack herring	2	2		4
	Dorosoma cepedianum	Gizzard shad	62	22	37	121
	Dorosoma petenense	Threadfin shad	65	6	7	78
Cyprinidae	*Ctenopharyngodon idella*	Grass carp	1			1
	Cyprinella venusta	Blacktail shiner	1515	1972	1517	5004
	Cyprinus carpio	Common carp		2		2
	Hybognathus nuchalis	Silvery minnow	1553	1591	1457	4601
	Luxilus chrysocephalus	Striped shiner	9	9	4	22
	Macrhybopsis aestivalis	Speckled chub			19	19
	Lythrurus roseipinnis	Cherryfin shiner		4		4
	Notropis atherinoides	Emerald shiner	48	127	234	409
	Notropis longirostris	Longnose shiner	56	5	60	121
	Notropis texanus	Weed shiner	2	576	273	851
	Notropis volucellus	Mimic shiner	71	265	48	384
	Notropis winchelli	Clear chub	21	62	9	92
	Opsopoeodus emiliae	Pugnose minnow		13	1	14
	Pimephales vigilax	Bullhead minnow	93	192	238	523
Fundulidae	*Fundulus notatus*	Blackstripe topminnow	3	8	16	27
Ictaluridae	*Ictalurus furcatus*	Blue catfish	16	17	17	50
	Ictalurus punctatus	Channel catfish	219	1292	761	2272
	Noturus leptacanthus	Speckled madtom	2	3		5
	Noturus miurus	Brindled madtom	2			2

	Pylodictis olivaris	Flathead catfish	13	17	16	46
Lepisosteidae	*Atractosteus spatula*	Alligator gar		1		1
	Lepisosteus oculatus	Spotted gar	4	8	4	16
	Lepisosteus osseus	Longnose gar		7	6	13
Moronidae	*Morone*	Hybrid striped bass	1		2	3
Mugilidae	*Mugil cephalus*	Striped mullet	5	8	4	17
Percidae	*Ammocrypta asprella*	Crystal darter	2	2		4
	Ammocrypta beani	Naked sand darter	14	4	29	47
	Etheostoma histrio	Harlequin darter		1	1	2
	Etheostoma stigmaeum	Speckled darter	3	2	1	6
	Percina nigrofasciata	Blackbanded darter	8	9	2	19
	Percina sciera	Dusky darter	5	13	6	24
	Percina suttkusi	Gulf logperch	4	1	1	6
Poeciliidae	*Gambusia affinis*	Western mosquitofish	1	10	2	13
Polyodontidae	*Polyodon spathula*	Paddlefish, Spoonbill		1		1
Sciaenidae	*Aplodinotus grunniens*	Freshwater drum	3	8	7	18
TOTAL # 0F INDIVIDUALS			4089	6632	5113	15834
SPECIES RICHNESS			45	52	46	61

Table 6. Shannon Weiner H', number of individuals (n) per site and species richness per site for samples collected during the PRFK post incident monitoring from 2012-2014 in the pearl River basin.

	2012	2013	2014
NUMBER OF INDIVIDUALS (n) PER SITE	712.42	915	567.85
SPECIES RICHNES PER SITE	22.42	22.85	19.57
SHANNON-WIENER H'	1.6390	1.7319	1.6235

Rare species and species of concern

Three different species of concern were collected from 2012-2014, *Cycleptus elongatus* (blue sucker), *Percina suttkusi* (gulf log perch) and *Polyodon spathula* (paddlefish) (Table 7.).

Table 7. Lengths (mm) and weights (g) of species of concern collected during the PRFK post incident monitoring from 2012-2014 in the Pearl River Basin.

YEAR	SCIENTIFIC NAME	COMMON NAME	LENGTH (mm)	WEIGHT (g)
2012	*Cycleptus elongatus*	Blue Sucker	593	2476
2012	*Percina suttkusi*	Gulf log perch	63	2
2013	*Cycleptus elongates*	Blue Sucker	417	540
2013	*Percina suttkusi*	Gulf log perch	59	1
2013	*Percina suttkusi*	Gulf log perch	56	1
2013	*Percina suttkusi*	Gulf log perch	57	1
2013	*Polyodon spathula*	Paddlefish	635	NA
2014	*Cycleptus elongates*	Blue Sucker	370	402
2014	*Percina suttkusi*	Gulf log perch	61	2
2014	*Percina suttkusi*	Gulf log perch	71	2
2014	*Percina suttkusi*	Gulf log perch	58	1
2014	*Percina suttkusi*	Gulf log perch	58	1

Mussel Assemblage Sampling

Sixteen samples were collected at eight different sites on the West Pearl River and the Bogue Chitto River annually between 2012 and 2014. Each site was sampled twice. One sample was conducted in the littoral zone in waters less than one meter in depth. Another sample was taken in waters greater than one meter. Eight of the samples collected in < 1 m for all years yielded a total of 4,598 individuals and a species richness of 25 (Table 8). Eight of the samples collected in > 1 m for all years yielded a total of 2,404 individuals and a species richness of 20 (Table 9). Sixteen combined samples for all years yielded a total of 7,002 individuals and a species richness of 26 (Table 10). The six most common species sampled were *Quadrula refulgens* (27%), *Glebula rotundata* (21%), *Quadrula apiculata* (20%), *Quadrula quadrula* (11%), *Obliquaria reflexa* (6%) and *Potamilus purpuratus* (4%). These species represented 89% of the total collected (Figure 1). Mussel assemblages conducted pre-PRFK and post-PRFK produced similar results for CPUE per site, species richness per site and Shannon Wiener H' per site (Table 11). Samples completed in depths of one meter or less displayed greater CPUE per site, species richness per site and Shannon Wiener H' per site (Table 12).

Table 8. Total number of mussels by species and species richness for eight samples collected in < 1 meter of depth after the PRFK from 2012-2014 in the Pearl River basin.

	2014	2013	2012	ALL YEARS
SPECIES	TOTAL #	TOTAL #	TOTAL #	TOTAL #
Glebula rotundata	261	661	432	1354
Quadrula refulgens	300	264	282	846
Quadrula apiculata	212	248	319	779
Quadrula quadrula	197	237	228	662
Obliquaria reflexa	63	78	101	242

Lampsilis teres	40	108	69	217
Potamilus purpuratus	46	36	75	157
Pyganodon grandis	17	37	13	67
Plectomerus dombeyanus	9	29	14	52
Villosa lienosa	5	15	31	51
Leptodea fragilis	8	15	14	37
Fusconaia flava	18	7	0	25
Anodonta suborbiculata	11	7	3	21
Lampsilis ornata	3	3	8	14
Amblema plicata	4	6	2	12
Tritogonia verrucosa	3	5	3	11
Ligumia subrostrata	1	6	3	10
Arcidens confragosus	1	1	7	9
Lampsilis claibornensis	0	6	1	7
Toxolasmus Parvus	3	4	0	7
Utterbackia imbecilis	1	4	2	7
Villosa vibex	0	0	5	5
Elliptio crassidens	0	0	4	4
Toxolasmus texasensis	0	1	0	1
Truncilla donaciformis	0	0	1	1
TOTAL # 0F INDIVIDUALS	1203	1778	1617	4598
SPECIES RICHNESS	20	22	22	25

Table 9. Total number of mussels by species and species richness for eight samples collected in > 1 meter of depth after the PRFK from 2012-2014 in the Pearl River basin.

	2014	2013	2012	ALL YEARS
SPECIES	TOTAL #	TOTAL #	TOTAL #	TOTAL #
Quadrula refulgens	322	552	143	1017
Quadrula apiculata	283	254	117	654
Obliquaria reflexa	52	75	44	171
Potamilus purpuratus	48	54	39	141
Quadrula quadrula	46	40	54	140
Glebula rotundata	38	17	77	132
Plectomerus dombeyanus	24	1	0	25
Villosa lienosa	17	5	2	24
Leptodea fragilis	8	5	8	21
Lampsilis teres	13	4	2	19
Pyganodon grandis	9	1	4	14
Toxolasmus Parvus	11	1	1	13

Fusconaia flava	7	4	1	12
Anodonta suborbiculata	6	2	1	9
Elliptio crassidens	0	0	3	3
Fusconaia ebena	0	0	2	2
Lampsilis ornata	1	0	1	2
Ligumia subrostrata	1	1	0	2
Tritogonia verrucosa	0	2	0	2
Truncilla donaciformis	0	1	0	1
TOTAL # 0F INDIVIDUALS	886	1019	499	2,404
SPECIES RICHNESS	16	17	16	20

Table 10. Total number of mussels by species and species richness for all 16 combined samples collected in < 1 meter and > 1 meter after the PRFK from 2012-2014 in the Pearl River basin.

	2014	2013	2012	ALL YEARS
SPECIES	TOTAL #	TOTAL #	TOTAL #	TOTAL #
Quadrula refulgens	622	816	425	1,863
Glebula rotundata	299	678	509	1,486
Quadrula apiculata	495	502	436	1,433
Quadrula quadrula	243	277	282	802
Obliquaria reflexa	115	153	145	413
Potamilus purpuratus	94	90	114	298
Lampsilis teres	53	112	71	236
Pyganodon grandis	26	38	17	81
Plectomerus dombeyanus	33	30	14	77
Villosa lienosa	22	20	33	75
Leptodea fragilis	16	20	22	58
Fusconaia flava	25	11	1	37
Anodonta suborbiculata	17	9	4	30
Toxolasmus Parvus	14	5	1	20
Lampsilis ornata	4	3	9	16
Tritogonia verrucosa	3	7	3	13
Amblema plicata	4	6	2	12
Ligumia subrostrata	2	7	3	12
Arcidens confragosus	1	1	7	9
Elliptio crassidens	0	0	7	7
Lampsilis claibornensis	0	6	1	7
Utterbackia imbecilis	1	4	2	7
Villosa vibex	0	0	5	5
Fusconaia ebena	0	0	2	2

Truncilla donaciformis	0	1	1	2
Toxolasmus texasensis	0	1	0	1
TOTAL # 0F INDIVIDUALS	2,089	2,797	2,116	7,002
SPECIES RICHNESS	20	23	25	26

Table 11. Comparison of species richness, Shannon-Weiner H' diversity and CPUE by year among surveys conducted pre and post PRFK. Only samples taken at one meter or less in depth were compared.

	PRE KILL 2007	DURING KILL 2011	POST KILL 2012	POST KILL 2013	POST KILL 2014
NUMBER PER SITE	221.4	171	235.11	349.25	150.375
SPECIES RICHNESS PER SITE	10.1	10.3	11.7	13.5	11.6
SHANNON-WIENER H' PER SITE	1.402	1.372	1.5065	1.5063	1.4067

Table 12. Comparison of species richness, Shannon-Weiner H' diversity and CPUE by year among PRFK monitoring samples conducted at one meter or less in depth and greater than one meter in depth in the Pearl River basin.

	2012	2012	2013	2013	2014	2014
	LESS THAN 1 METER	GREATER THAN 1 METER	LESS THAN 1 METER	GREATER THAN 1 METER	LESS THAN 1 METER	GREATER THAN 1 METER
NUMBER PER SITE	235.11	83.17	349.25	210.38	150.375	110.75
SPECIES RICHNESS PER SITE	11.7	8	13.5	8.625	11.6	7.75
SHANNON - WIENER H' PER SITE	1.5065	1.3890	1.5064	0.9633	1.4067	1.2079

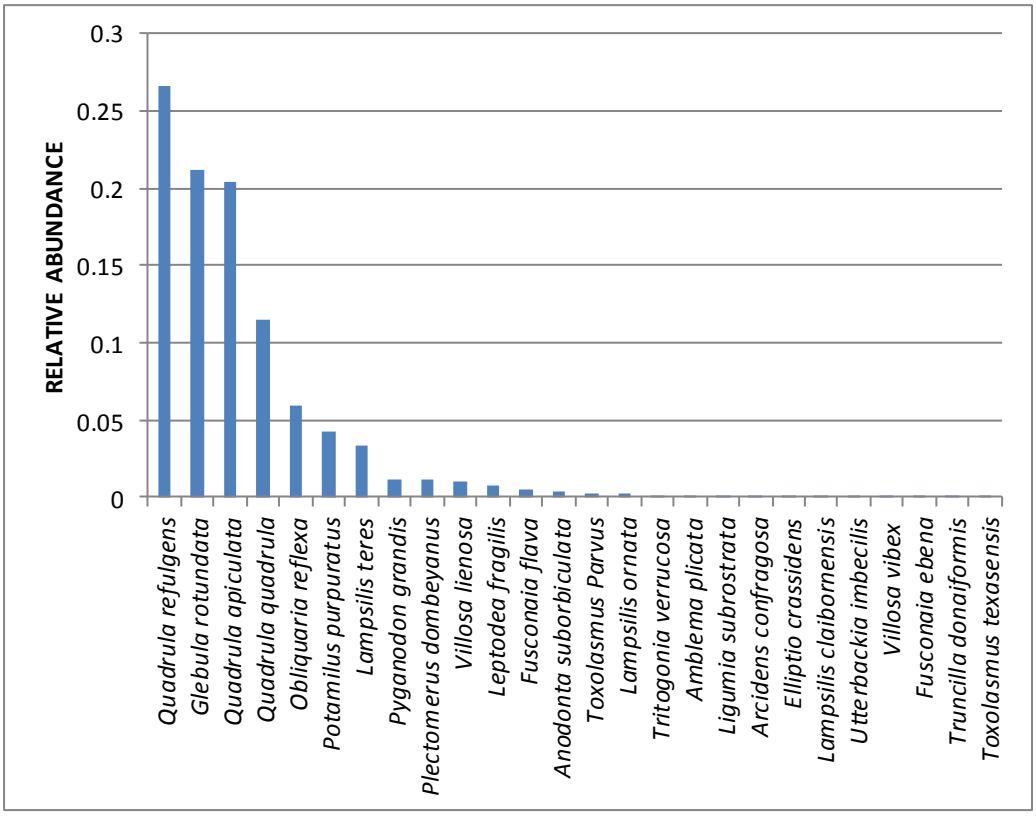

Figure 1. Relative abundance of freshwater mussels collected between 2012 and 2014 from the Pearl River basin (n = 7,002).

Mussel Species of Conservation Concern

The threatened *Potamilus inflatus* was not detected. Seven *Elliptio crassidens* and six *Villosa vibex* were collected between 2012 and 2014 from the Pearl River basin (Table 13).

Table 13. Freshwater mussel species of conservation concern collected between 2012 and 2014 from the Pearl River basin

SPECIES	LENGTH (mm)	HEIGHT (mm)	GIRTH (mm)
Elliptio crassidens	124.68	72.66	45.02
Elliptio crassidens	121.28	71.77	45.29
Elliptio crassidens	139.18	77.1	50.95
Elliptio crassidens	149.93	89.05	62.94
Villosa vibex	53.78	29.41	19.38
Villosa vibex	61.67	32.99	25.72
Villosa vibex	47.73	27.84	18.14
Villosa vibex	58.49	30.8	21.15
Villosa vibex	64.78	41.95	28.52
Villosa vibex	61.07	33.43	24.96

Mussel Mortality

Leptodea fragilis and *Lampsilis teres* exhibited the highest average percent of mortality (percent of recent dead mussels per the total of live and dead mussels) among samples taken between 2012 and 2014 (Table 14). In individual years, three different species displayed the highest percentage of mortality, *Amblema plicata* (60%) in 2012, *Leptodea fragilis* (66.6%) in 2013 and *Lampsilis teres* (61.9%) in 2014.

Table 14. Percent mortality of freshwater mussels collected during the PRFK post incident monitoring from 2012-2014 in the Pearl River Basin.

	2012	2013	2014	AVERAGE
SPECIES	% MORTALITY	% MORTALITY	% MORTALITY	% MORTALITY
Leptodea fragilis	46.10%	66.60%	11.11%	41.27%
Lampsilis teres	32.30%	14.28%	61.90%	36.16%
Lampsilis ornata	0.00%	0.00%	34.15%	11.38%
Ligumia subrostrata	0.00%	33.33%	0.00%	11.11%
Uttebackia imbecilis	0.00%	33.33%	0.00%	11.11%
Anodonta suborbiculata	40%	11.11%	0.00%	17.04%
Amblema plicata	60%	0.00%	0.00%	20.00%
Potamilus purpuratus	10.70%	14.44%	6.15%	10.43%
Glebula rotundata	10%	8.11%	10.53%	9.55%
Plectomerus dombeyanus	22.20%	1%	2.86%	8.69%
Villosa lienosa	3.20%	5%	5.88%	4.69%
Obliquaria reflexa	6.40%	2.61%	4.92%	4.64%
Toxolasma parva	0.00%	2%	7.14%	3.05%
Fusconaia flava	0.00%	0.00%	4.10%	1.37%
Pyganodon grandis	0.00%	2.63%	2.26%	1.63%
Quadrula refulgens	1.70%	1.34%	1.85%	1.63%
Quadrula apiculata	0.58%	0.79%	2.29%	1.22%
Quadrula quadrula	0.00%	1.80%	0.58%	0.79%

Discussion

The Pearl River Basin contains the greatest aquatic species diversity in Louisiana (LDWF 2005). A total of 141 fish species are documented (Ross et al. 2001) in the basin; 116 are native freshwater species of which many are important recreational and commercial species. Approximately 32 mussel species of the family Unionidae occur in the lower Pearl River (Vidrine 1993; Jones et al. 2005; and Hartfield 2011, U.S. Fish and Wildlife Service, personal communication). It is estimated that 591,561 fish and mussels, representing at least 22 species were lost in the PRFK. LDWF was tasked with monitoring the recovery of fish and mussel populations in the Pearl River Basin.

Fish Assemblage

Fish species representing 11 families incurred mortality during the PRFK (APPENDIX I). Most of the species affected were accounted for in the first year (2012) of samples conducted during PRFK monitoring efforts, indicating that these species repopulated the affected areas rapidly. Community structure, species richness and Shannon-Wiener H' were comparable across all years (2012-2014).
Species of concern were not targeted in this study and were not highly represented in the samples. Signs of recruitment were positive for *Ictalurus punctatus* (channel catfish) as juvenile cohorts were represented well. Of the 2,272 individuals collected, 98% were 11 inches in total length or less.

Freshwater Mussels

Freshwater mussels displayed similar biological diversity in samples collected prior, during, and after the 2011 incident. Community structure of mussel assemblage remained constant among all years. *Leptodea fragilis* incurred an estimated 78.9% mortality during the PRFK. However, post PRFK samples indicate that the species successfully retained its position in the community structure. Juvenile *Leptodea fragilis* were present in 2014 samples which is a positive indication of recruitment. Recruitment of *Leptodea fragilis* also indicates the presence of its obligate host fish, *Aplodinotus grunniens* (freshwater drum).

Water Quality

Water quality parameters were in normal range at all sites between 2012 and 2014 during the sampling effort.

Conclusions

1.) Fish species that incurred mortality during the PRFK reestablished rapidly in the affected areas of the Pearl River Basin.

2.) Freshwater mussel assemblages and diversity remained constant in samples prior to and after the PRFK.

Recommendations

No additional management efforts are recommended at this time. Additional samples would be necessary to quantify species abundance.

References

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APPENDIX I

LOUISIANA DEPARTMENT OF WILDLIFE & FISHERIES

Office of Fisheries

Investigation of a fish and mollusk kill in the lower Pearl River, Louisiana and Mississippi

October 2011

Version 2 (11/29/11)

Louisiana Department of Wildlife and Fisheries
P.O. Box 98000, Baton Rouge, LA 70898

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Investigation of the Temple-Inland Incident fish and mollusk kill in the lower Pearl River, Louisiana and Mississippi, August 13 – August 24, 2011

Summary:

Several agencies closely coordinated efforts to mobilize their collective fisheries personnel to provide a comprehensive accounting of the aquatic resources impacted on the Pearl River Basin from the unauthorized release of August 12 – 17, 2011. An estimated total of 591,561 fish and mussels were lost as a result of the event. Total valuation of lost fish and mussels, investigative costs, monitoring and recovery (including stocking) comes to **$1,168,257.06.**

Contributing Agencies:

- Louisiana Department of Wildlife and Fisheries, Fisheries Division, Inland Fisheries Section, P.O. Box 98000, Baton Rouge, LA 70898[1]
- Mississippi Department of Environmental Quality, 1542 Old Whitfield Road, Pearl, MS 39208[2]
- Louisiana State University, Department of Biological Sciences, Benthic Ecology Lab, Baton Rouge, LA 70894
- United States Fish and Wildlife Service, Natchitoches National Fish Hatchery, 615 South Drive, Natchitoches, LA 71457
- United States Fish and Wildlife Service, Baton Rouge Fish and Wildlife Conservation Office, 237 Parker Coliseum, Baton Rouge, LA 70803

Site Description

The Pearl River originates in the low rolling hills of North Central Mississippi and flows in a southerly direction towards the Gulf of Mexico. The lower Pearl River forms approximately 156 miles of boundary between the states of Louisiana and Mississippi (Figure 1). The lowland delta region of the river becomes multi-channeled below the community of Sun, La., with the boundary of the two states forming the East Pearl River channel below that point. The West Pearl River captures 75 percent of the river's flow at Wilson's Slough and the remaining 25 percent at Holmes Bayou. Hobolochitto Creek provides input to Farr's slough and then feeds the lower East Pearl River to its mouth at Lake Borgne. A prominent man-made feature of the area is the Pearl River Navigation Canal (PRNC), which was completed in the 1950s, and runs parallel to, and is situated to the west of, the West Pearl River. The PRNC, a U.S. Army Corps of Engineers Navigation Channel, runs north-south for approximately 23.8 miles, and begins at river mile 32.5 on the West Pearl River. It then steps up vertically through three locking structures and ends at Pools Bluff (river mile 75) on the main stem of the Pearl

[1] Lead fish kill investigation agencies within their respective states.

[2] Ibid.

River. Two low sill structures, one across the Pearl River at Pools Bluff, and one across the Bogue Chitto River near Sun, La., were constructed to provide a water source for the navigation canals to lock barge traffic traveling up and downstream through the system. The Bogue Chitto River, a large and important tributary to the Pearl River Basin, arises in Southern Mississippi and flows southeasterly through Louisiana. It then joins the West Pearl River channel just downstream of the East Pearl-West Pearl channel split.

The Pearl River is popular for both freshwater and saltwater fishing. Spotted bass and longear sunfish are often targeted in the upper reaches of the river and small tributaries. Largemouth bass, catfishes, crappies, warmouth, bluegill, and redear sunfish (*Lepomis)* are targeted in the lower reaches. Recreational fishermen target speckled trout, flounder, croaker, redfish, crabs, and shrimp at the mouth of the river. Commercial fishing for catfishes, garfish, shrimp, and blue crab also occurs. The upper Pearl River in Louisiana is excellent for canoeing and several swimming holes can be found there. Houseboats, camps, and permanent residences are located along the river from Angie, L., to Highway 90. However, 87,000 acres of palustrine and estuarine habitat remain undeveloped along sections of the river encompassed by the Old River Wildlife Management Area (ORWMA), Bogue Chitto National Wildlife Refuge (BCNWR), and the Pearl River Wildlife Management Area (PRWMA). These game management areas provide opportunity for fishing, hunting, trapping, and wildlife observation.

The lower Pearl River Basin is the least human-impacted section of river of all the State of Louisiana's river basins (LDWF, 2005). South of Bogalusa, La., approximately 85 percent of the lower Pearl River flows through the Bogue Chitto National Wildlife Refuge (U.S. Fish and Wildlife Service, USFWS) and the Pearl River Wildlife Management Area (Louisiana Department of Wildlife and Fisheries, LDWF). This large corridor of bottom land hardwood swamp and marshes is known for its high-quality habitat and rich diversity of flora and fauna (LDWF 2005). Ross (2001) lists 140 species of fish for the Pearl River Basin, making it one of the richest and most diverse fish assemblages along the entire Gulf coast (Appendix 1).

Of these 140, 116 are native freshwater species (many of which are important recreational and commercial species), 16 are estuarine/marine species, five are diadromous, and three species are considered introduced into the system. Approximately 32 mussel species of the family Unionidae occur in the lower Pearl River (Vidrine 1993; Jones et al. 2005; and Hartfield 2011, U.S. Fish and Wildlife Service, personal communication). Mussel species known to inhabit the lower Pearl River are found in Appendix 2. Within the diverse fish and mussel communities of the lower Pearl River, is one federally threatened fish, the gulf sturgeon, Acipenser oxyrinchus desotoi, and one federally threatened mussel, the inflated heelsplitter, Potamilus inflatus. Additionally, a number of other aquatic species of conservation concern inhabit the lower Pearl River, Table 1 (LDWF 2005).

Figure 1. Regional map of the lower Pearl River that forms the boundary between the states of Louisiana and Mississippi

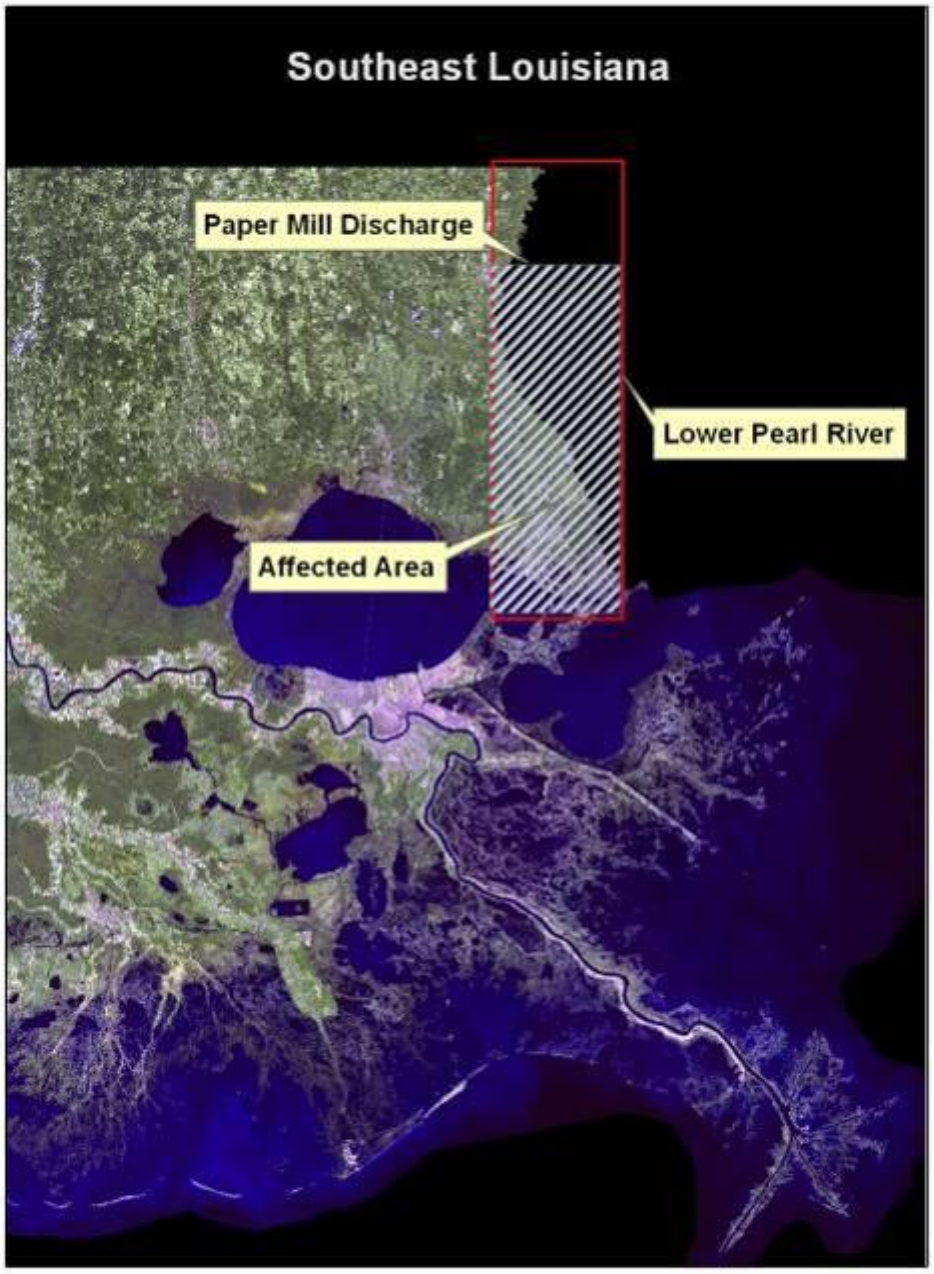


Table 1. Pearl River Basin aquatic species of conservation concern (LDWF 2005)

Crustaceans	**Diadromous Fish**
Ribbon Crawfish	Alabama Shad
Plain Brown Crawfish	Gulf Sturgeon[3]
Flatwoods Digger	
	Mussels
Freshwater Fish	Rayed Creekshell
Paddlefish	Elephant-Ear
Flagfin Shiner	Mississippi Pigtoe
Bluenose Shiner	Inflated Heelsplitter[4]
Silverjaw Minnow	Southern Rainbow
River Redhorse	
Frecklebelly Madtom	**Reptiles**
Crystal Darter	Alligator Snapping Turtle
Channel Darter	Ringed Map Turtle[5]
Freckled Darter	Pascagoula Map Turtle
Pearl Darter	Mississippi Diamond-backed Terrapin
Gulf Logperch	Stripe-neck Musk Turtle

Incident Description, Response, and Investigation

On August 13, 2011 at 1300 hours, LDWF and the Louisiana Department of Environmental Quality (LDEQ) responded to several calls from the public about an extensive fish kill occurring in the lower Pearl River from just below Bogalusa, La., to Pool's and Walkiah bluffs downstream. The Mississippi Department of Environmental Quality (MDEQ) responded to public reports on their section of the river as well. The public reported seeing dark-stained water with persistent foam, and extensive areas of dead and dying fish. Initial investigation by LDEQ and LDWF indicated: 1) very low dissolved oxygen readings (< 0.73 mg/l at Pools Bluff Sill), 2) the hypoxic conditions were lethal to aquatic life, and 3) public reports of dead and dying fish were confirmed. At the time of initial investigation, the river water displayed an abnormal black color and had persistent foam. Fish were continuing to die downstream. The fish and mollusk kill was attributed to a severe water quality problem occurring upstream in the river near Bogalusa, La. It quickly became apparent that a large fish kill was in

[3] Federally threatened species.

[4] Ibid.

[5] Ibid.

progress and moving downstream and could potentially impact many miles of Pearl River stream channel. The fish kill investigation had five phases:

1. Assess the extent of the fish kill.
2. Assess the extent of the freshwater mussel kill.
3. Assess water quality at key stations where fish and mussels were found moribund.
4. Assign valuation for individuals of each species lost in the event.
5. Assign valuation to three-year monitoring and recovery efforts following the kill.

Because the hypoxic water and associated fish kill/mussel kill were extensive and moving downstream daily, the decision was made by LDWF leadership to divide responding personnel into teams to survey specific sections of the river each day. That allowed LDWF to carefully avoiding overlap of river sections during the investigation. A detailed narrative of daily activities and methodology of fish and mussel enumeration is found in Appendix 3.

Personnel involved in the fish and mussel survey efforts included Tim Ruth, Gary Vitrano, Matt Duplessis, and Jeff Thompson from LDWF; Charles Thompson, Emily Cotton, and Al Gibson from MDEQ; Tony Brady from U.S. Fish and Wildlife Services (USFWS), Norfolk National Fish Hatchery; Cedric Doolittle USFWS, Conservation Office; and Ken Brown, Wes Daniel, and Barry Aromhine from Louisiana State University (LSU). Survey methodology followed that of *Fish Kill Procedures and Investigation and Monetary Values of Fish and Freshwater Mussel Kills, Special Publication 30* from the American Fisheries Society (AFS). Dead fish were enumerated by direct counts and stratified segments, while mussels were surveyed by stratified sampling along segments and transects. Water quality measurements collected by LDWF were determined with a YSI 650 water quality meter. The instrument was calibrated daily before use.

Water Quality Determination:

Water quality readings were collected at numerous locations along the river during the fish and mussel kill surveys. Parameters included: temperature, dissolved oxygen, pH, specific conductivity, salinity, and turbidity. Additionally, general appearance of the water, such as color, foam presence, etc., were also noted. Water quality data and associated maps are presented in Appendix 4.

Timeline, Area Covered Each Day, and Activities:

- **Saturday, August 13, 2011:** An LDWF fisheries administrator called field staff with report of fish kill in Bogalusa on the Pearl River. For the duration of 1500 hours until dark, LDWF staff surveyed the Pearl River from Bogalusa to Pools Bluff noting dead fish and mussel species composition and numbers. Water quality parameters were also collected. One dead Gulf sturgeon was recovered at approximately 1600 hours. Field staff sent an initial report of reconnaissance to fisheries administrators.
- **Sunday, August 14, 2011:** Two Inland Fisheries Biologists surveyed 18 river miles of the West Pearl River from Lock 1 to Walkiah Bluff during which time dead fish and mussel species composition and numbers were counted and estimated. Water quality parameters were also recorded. LDWF staff collected dead Gulf sturgeon. A LDWF

District 8 Inland Fisheries biologist manager also attended a meeting at Bogalusa City Hall**.** The daily report was then forwarded to fisheries administrators.

- **Monday, August 15, 2011:** Three Inland Fisheries biologists and one fisheries technician surveyed 45 river miles of the West Pearl River from Lock 1 to the Rigolets; dead fish and mussel species composition and numbers were estimated. Water quality parameters were recorded, dead Gulf sturgeon were collected, and a daily activity report was forwarded to fisheries administrators.
- **Tuesday, August 16, 2011:** Three Inland Fisheries biologists and one fisheries technician surveyed 45 river miles of the West Pearl River from Lock 1 to the Rigolets; the Pearl River from Bogalusa to Pools Bluff Sill was also surveyed. Staff estimated the composition and numbers of dead fish and mussel species. Water quality parameters were also recorded. Additional dead Gulf sturgeon were collected, and a daily report was forwarded to fisheries administrators.
- **Wednesday, August 17, 2011:** Two Inland Fisheries biologists and one fisheries technician surveyed 36 river miles of the West Pearl River from Lock 1 to the Rigolets. Dead fish and mussel species composition and numbers were estimated, water quality parameters were recorded, and LDWF staff collected dead Gulf sturgeon. No new dead fish or mussels were observed for this reporting period. A LDWF District 8 Inland Fisheries biologist manager provided support to the St. Tammany Emergency Operations Center (EOC) at Crawford's landing. A daily report was also forwarded to fisheries administrators.
- **Thursday, August 18, 2011:** Two Inland Fisheries Biologists and one fisheries technician surveyed 36 river miles of the West Pearl River from Lock 1 to the Rigolets, during which time dead fish and mussel species composition and numbers were estimated by LDWF staff. Water quality parameters were recorded, and dead Gulf sturgeon were collected. A LDWF District 8 Inland Fisheries biologist manager provided support to the St. Tammany EOC at Crawford's landing. A daily report was again forwarded to fisheries administrators.
- **Friday, August 19, 2011:** Two Inland Fisheries Biologists conducted mussel surveys on the West Pearl River and recorded water quality parameters. A LDWF Marine Fisheries biologist manager and one Inland Fisheries technician collected fish tissue samples from three stations within affected areas of the river; one sample was collected from an unaffected area of the river. A LDWF District 8 Inland Fisheries biologist manager continued to provide support to the St. Tammany EOC at Crawford's landing. A daily report was sent to LDWF fisheries administrators.
- **Saturday, August 20, 2011:** A LDWF Marine Fisheries biologist manager and one Inland Fisheries technician collected fish tissue samples from one station upstream of the affected area. A LDWF District 8 Inland Fisheries biologist manager also provided support to the St. Tammany EOC at Crawford's landing. The daily report was sent to fisheries administrators.
- **Sunday, August 21, 2011:** A LDWF District 8 Inland Fisheries biologist supervisor provided support to the St. Tammany EOC at Crawford's landing. The daily report forwarded to LDWF fisheries administrators.
- **Monday, August 22, 2011:** Dead Gulf sturgeon were properly documented via the chain of custody and transferred to USFWS.

Fish Kill Investigation:
Since the event resulted in a "plume" of hypoxic conditions that moved downstream killing fish and mussels over a several day period, LDWF used multiple-day counts for fish kills that progress downstream (Southwick and Loftus 2003). This technique involves surveying and enumerating fish over different segments of the stream and avoiding overlap. For enumeration of dead fish, LDWF employed a combination of complete counts and area sampling with transects and segments according to *Fish Kill Procedures and Investigation and Monetary Values of Fish and Freshwater Mussel Kills, Special Publication 30*. Resulting enumeration and estimates were then totaled for daily count, and then all days were summed for a total estimate of fish mortalities for the entire river segments that were impacted by the hypoxic plume.

The investigation of fish mortality on the Pearl River began on August 13, 2011 with initial reconnaissance of the affected areas. Water quality data were recorded, and observations of dead and dying fish were made. August 14, 2011 was the apex of the ongoing fish kills in the main channel of the West Pearl River. A section of the West Pearl River was also comprehensively surveyed on this date. On August 16, another large fish kill event took place in Porter's River – a remnant river channel still hydraulically connected to the West Pearl River. Counts were made on this waterbody. These two dates represent the dates on which the majority of the fish mortalities occurred, though dead and dying fish were observed from August 13 through August 17. Dead fish diminished daily due to predation and degradation. Dead fish counts continued until August 18, 2011. Gulf Sturgeon were also collected as they were encountered throughout the investigation (Appendix 5).

Fish Kill Estimates:

Fish kill estimates were conducted on along portions of the Pearl River in both Louisiana and Mississippi. The explanations for the method and results of those estimates are explained below by the state in which the estimates were conducted.

In Louisiana:

In Louisiana, the lead agency for investigating the fish kill linked to the Temple-Inland Incident was LDWF. Initial reconnaissance trips were made on August 13 and August 14, 2011, with observations of dead fish on the West Pearl River providing instrumental information for determining the spatial and the temporal extent of the kill. Biologists with LDWF observed dead fish diminishing daily due to predation and decomposition. Small-bodied fish species also diminished more rapidly following the apex of the kill.

The dynamic nature of the entire sequence of events related to this kill influenced the accuracy of loss estimates. Fish die at differing rates; they sink or float, are lost to predation and scavengers, strand or decompose, and can be visible but are often overlooked by those investigating the event. More complexities were introduced, as the kill was an ongoing event that traversed the lower Pearl River, a remote and inaccessible stream with multiple channels and thus many avenues in which water may flow and dead fish may drift. Therefore, with consideration of the factors above and delayed notification of the incident, the estimated totals reflected in this report are likely lower than the true number of fish killed by the event.

Measurements for fish length were only taken on August 13, 2011 (Table 2). The following counts include species composition and enumeration. To address the problems associated with multiple day counts, biologists restricted daily counts to areas previously not accounted for in earlier assessments. This was necessary to avoid overlapping and over-estimating. Also, counts were limited to visible fish in pockets on the edge of the river or contained in remnant river channels. No floating dead fish were enumerated.

Kill Zone

The kill zone encompassed the West Pearl River from Bogalusa to Highway 90. Officials with LDWF established the magnitude of the fish kill by way of direct counts and extrapolation of sample units. Counts were made throughout the kill zone (Appendix 3).

Counts

Using direct counts and data from sample units of dead fish LDWF estimated mortality. These data were then extrapolated to an estimated total kill for a specific segment of the kill zone.

Direct counts:

August 13, 2011

Fish mortality total: **871** (Table 2)

Gulf sturgeon counted: 1

August 15, 2011

Fish mortality total: **406** (Table 3)

Gulf sturgeon counted: 4

Paddlefish counted: 97

August 15, 2011

Fish mortality total: **399** (Table 3)

Gulf sturgeon counted: 4

Paddlefish counted: 97

August 17, 2011

Gulf sturgeon counted: 3

Direct counts fish mortality total**: 1,676** (Table 3)

Extrapolated Sample Unit Counts

August 14, 2011

Sampling Unit: Visible dead fish were noted in pockets on the edge of the river – these pockets vary in size, so subsample units were used to enumerate a sample unit.

Subsample units: A 5’ x 5’ section of a sample unit was utilized – counts yielded a mean of 50 dead fish per subsample unit.

Extrapolation: Sample units were counted and enumerated using subsample units. Total unit counts were made in a 16.2-mile segment of the West Pearl River/Wilson sough complex from two miles south of Lock One (N 30 25.746 - W 89 44.441) to Walkiah Bluff (N30 34.128 - W89 48.628).

9 – 200 fish samples unit

2– 300 fish samples unit

1– 500 fish samples unit

1– 1000 fish samples unit

Fish mortality total: 3,900 (Table 3)

Counts included five Gulf sturgeon and 33 Paddlefish.

A species list was compiled, but species were not demarcated in counts. Species demarcation was determined by projecting species distribution in direct counts on August 15, 2011 (Table 2).

August 16, 2011

Sampling Unit: Visible dead fish were documented in Porters River, a remnant river channel still connected to the West Pearl River – this unit was reduced to a .2-mile segment of the channel with a mean width of 10' that was densely covered with dead fish. A subsample unit was used to enumerate a sample unit.

Subsample units– A 10' x 1' section of a sample unit was utilized – counts yielded a mean of 25 Freshwater Drum and 15 Catfish *spp*. per subsample unit.

Extrapolation: Sample units were counted and enumerated using subsample units. Total unit counts were made in a .2-mile segment of Porters River.

Freshwater Drum:

Sample units per area x count per sample unit.

1056 x 25 - **Total of 26,400 Freshwater Drum**

Blue Catfish:

Sample units per area x count per sample unit.

1056 x 25 - **Total of 15,840 Blue Catfish**

Fish mortality total: 42,240 (Table 3)

The total estimated fish mortality for August 13, 2011 – August 17, 2011 including Gulf sturgeon and paddlefish (Tables 2 and 3 summed) is 47,899.

Table 2. Size distributions of some of the species of dead fish enumerated by LDWF crews on the Pearl River below Bogalusa, La., on August 13, 2011

Inch Class	Gulf Sturgeon	Big M. Buffalo	FW Drum	AM Eel	Channel Catfish	LM Bass	Gizzard Shad	Blue Catfish	Darter spp.	Minnow spp.
1										
2										
3								189	242	67
4										
5										
6										
7										
8			14				10			
9										
10			35	6		10	48			
11										
12			20	10	3		16			
13										
14			**60**					12		
15										
16		15	15							
17										
18										
19										
20				70				8		
21										
22										
23										
24				20						
25										
26										
	1									
Totals	**1**	**15**	**144**	**106**	**3**	**10**	**74**	**209**	**242**	**67**

Table 3. Total numbers of fish[6] estimated by LDWF crews on the Pearl River system from below Bogalusa, La., to US Hwy 90 from August 13 – 17, 2011

Pearl River Fish Kill Species List and Count							
Date	**8/13/2011**	**8/14/2011**	**8/15/2011**	**8/15/2011**	**8/16/2011**	**8/17/2011**	**Totals**
Species							
Gulf Sturgeon[7]	1	5	4	0	9	3	22
Paddlefish		33	97	7	2		139
Freshwater Drum	140	1,004	81	60	26,411		27,700
Shad spp.		178	22	3			203
American Eel	106	827	94	22			1,049
Gizzard Shad	74						74
Lepomis spp.		799	32	80			911
Striped Mullet		135	19	0			154
Bigmouth Buffalo	15	15	2	0			32
Crappie spp.		14	2	0			16
Sucker spp.		30	4	0			34
Hogchoker				150			150
Minnow spp.	67						67
Largemouth Bass	10						10
Black Bass spp.		57	3	5			65
Blue Catfish	209				15,860		16,069
Channel Catfish	3						3
Catfish spp.		841	46	72			959
Darter spp.	242						242
Logperch							3
Totals	**871**	**3,938**	**406**	**399**	**42,282**	**3**	**47,902**

[6] Identified to closest possible taxa due to decomposition.
[7] Six Gulf sturgeon were picked up after August 17, 2011 for a total of 28 (Appendix 5).

In Mississippi:

In Mississippi, the lead agency for investigating the fish kill linked to the Temple-Inland Incident was the Mississippi Department of Environmental Quality (MDEQ). Officials established the magnitude of the fish kill by way of estimated counts and extrapolation of sample units.

Kill Zone

As noted by MDEQ, the kill zone encompassed the Pearl River and East Pearl River from Bogalusa to Highway 90.

Counts

Estimated counts were done near the Walkaih State Water Park Boat Ramp. The first 50-meter (approximately) reach count GPS points were **N 30.58499 – W 089.81617** start. **N 30.58350 – W 089.81470** end. MDEQ did not have GPS points for the second 50-meter reach. However, it was identified as being further downstream from the first, but above the boat ramp.

Extrapolated Sample Unit Counts

August 13, 2011

MDEQ conducted two estimated counts at 50 meters each (to equal100 meters) for the 39 river miles affected.

Total fish counted in 100 meters of impacted river = 344.

(179 fish * 1609 meters* 39 river miles)/100 meters = 112,324.29 total fish

Per species:

Blue Catfish = 28,627.51= 17,570.28

Small Mouth Buffalo = 11,627.51= 6,902.61

Freshwater Drum = 20,627.51 = 12,550.20

Freshwater eel = 26,627.51 = 16,315.26

Bluegill (long ear sunfish) = 12,627.51 = 7,530.12

Channel Catfish = 15,627.51 = 9,416.65

Minnows = 58,627.51= 36,395.58

Mussels = 165,627.51 = 103,539.15

Shad = 5,627.51 = 3,137.55

Largemouth Bass = 4,627.51 = 2,510.04

Fish Damage Valuation:

Estimates of fish losses were based on “visible” countable dead fish. Many studies have shown that counts will represent a modest fraction of the resource that is actually lost. Adjustment values for non-recovery of killed fishes were assigned to 15 species or groups of species (Table. 4) as per Davies and Shelton (1983). The true costs associated with fish and mussels kills cannot be fully enumerated using assigned replacement and adjustment for non-recovery values alone. Replacement costs alone do not take into account other important values such as recreational and commercial users, intrinsic/aesthetic values, and ecological values. However, the accepted values assigned to fish loss in this event are

from: Title 76, Wildlife & Fisheries, Part 1, Chapter 3, Subchapter D, Sections 313 – 317 (Appendix 6). Fish loss estimated from LDWF and MDEQ counts were combined for a total valuation by species (Table 4).

Table 4. Values assigned to fish loss in the Pearl River system kill of August 13 – 17, 2011[8]

Species	Estimate/ Count	Adjustment factor for Non-recovery[9]	Approx. Size	Title 76 Value	Calculations	Total
Gulf Sturgeon	28	N/A	Per Fish	$2,762.50/ea.	28 x 2,762.50	$77,350.00
Paddlefish	139	N/A	Per Fish	$2,762.50/ea.	139 x 2,762.50	$383,987.50
Am. Eel	17,364	N/A	0.72 lb.	$0.65/lb.	17,364 x 0.72 x 0.65	$8,126.35
Shad spp.	3,414.55	1.33	0.32 lb.	$0.09/lb.	3,414.55 x 1.33 x 0.32 x 0.09	$130.79
FW Drum	40,250	1.67	1.82 lb.	$0.19/lb.	40,250 x 1.67 x 1.82 lb x 0.19	$23,243.81
Blue Catfish 3”	30,409.90	1.89	0.04	$0.60/lb.	30,409.90 x 1.89 x 0.04 x 0.60	$1,379.39
B. Catfish 14”	1,930.89	1.89	0.80	$0.60/lb.	1,930.89 x 1.89 x 0.82 x 0.60	$1,751.70
B. Catfish 20”	1,285.02	1.89	3.10	$0.60/lb.	1,285.02 x 1.89 x 3.1 x 0.60	$4,517.36
Ch. Catfish 12”	9,419.65	1.89	0.54	$0.60/lb.	9,419.65 x 1.89 x 0.54 x 0.60	$5,768.22
Catfish spp. 12”	959	1.89	0.54	$0.60/lb.	959 x 1.89 x 0.54 x 0.60	$587.25
SM Buffalo 16”	6,934.61	1.52	2.0	$0.22/lb.	6,934.61 x 1.52 x 0.22 x 2.0	$4,637.87
Str. Mullet	154	NA	0.70	$0.74/lb.	154 x .75 lb. x .74	$85.47
Minnows	36,462.58	2.00	3” TL	$0.32/ea.	36,462.58 x 2.0 x .32	$23,336.05
Darters	242	2.00	3” TL	$0.32/ea.	242 x 2.0 x 0.32	$154.88
Suckers	34	1.52	11” TL	$2.20/ea.	34 x 1.52 x 2.20	$113.69
Bluegill	4,220.56	1.85	6” TL	$1.37/ea.	4,220.56 x 1.85 x 1.37	$10,697.01
Longear Sunfish	4,220.56	1.85	6” TL	$0.78/ea.	4,220.56 x 1.85 x 0.78	$6,090.26
L. M. Bass	2, 510.04	1.67	10” TL	$6.20/ea.	2,510.04 x 1.67 x 6.20	$25,988.95
B. bass spp.	65	1.67	10” TL	$6.20/ea.	65 x 1.67 x 6.20	$673.01
Crappie	16	1.64	10” TL	$3.65/ea.	16 x 1.64 x 3.65	$95.77
Hogchoker	150	NA	4” TL	$0.48/ea.	150 x 0.48	$72.00
TOTAL						$578,787.33

[8] LDWF Title 76 values are per animal, per inch group, or per pound. Fish counts and their values are for LA and MS estimates, combined.

[9] Adjustment factors are from Table 10.1, Chapter 10, Fisheries Techniques, American Fisheries Society 1983.

Mussel Kill Investigation:

The mussel mortality investigation on the Pearl River began on August 13 and August 14, 2011 with initial reconnaissance of the affected areas. Water quality data were recorded while observations and counts of dead mussels were made (Appendix 4). Transects, counts, and identification of dead floating mussels were recorded on August 15 and August 16. Additional agencies joined LDWF on August 17th – 19th to conduct more detailed studies of potential impacts to mussel populations. On August 17 and 18, shoreline assessments were conducted by the U.S. Fish and Wildlife Service, while semi-quantitative timed samples were made on August 18 and 19 by personnel from Louisiana State University. The results of these two additional studies are inserted in their entirety within the mussel kill investigation section of this report. Conclusions of both reports lend support to the findings of LDWF and MDEQ with respect to the mussel kill.

Like fish, mussels die and deteriorate at differing rates depending on the species and ambient conditions at the site. Some large-bodied, thin-shelled species such as the fragile papershell mussel readily float when they die and begin to decay. LDWF and MDEQ crews enumerated floating mussels, both whole and disemshelled individuals.

Mussel Kill Estimates:

Initial observations on August 13, 2011 and August 14, 2011 of floating dead mussels were instrumental in determining the spatial extent and temporal extent of the kill.

In Louisiana:

Establish the extent of the kill zone

The kill zone may include the full extent of the Pearl River from the Temple Inland discharge pipes in Bogalusa to Wilson Slough, and Holmes Bayou into the West Pearl River to Crawford's landing, including Porter's River (up to 81.2 linear river miles). However, estimates by LDWF only include river miles observed by biologists on the two days of the highest mussel mortality.

August 15, 2011

LDWF documented 13.7 linear river miles on the West Pearl River from two miles south of Lock One (N 30 25.719 - W 89 44.626) - Crawford's Landing (N30 18.002 - W89 42.213)

August 16, 2011

LDWF documented a 10.3-mile segment of the West Pearl River and the area south of Lock One (N30 20.051 - W89 42.516) to Porter's River (N 30 20.327 - W 89 42.536).

Timing of the mussel kill

The highest mortality of mussels occurred on August 15, 2011 and August 16, 2011.

Counts

Calculations of mortality were performed by using count data from transects of dead floating mussels and extrapolating these to arrive at an estimated total kill for the entire kill zone.

Sampling Unit:

LDWF utilized 0.25 mile x 20 feet (26400 square feet) transects that yielded 208 and 184 dead floating mussels. The mean mussel density per unit equaled 196. Due to variation in the densities of mussels and their sometimes clumped distribution, the numbers of dead mussels were difficult to quantify. Though subject to bias, LDWF counted floating dead mussels along two randomly chosen 0.25 mile x 20 feet (0.6 acre) transects that were fairly representative of the affected area. Mussel numbers for the two transects were 208 and 184.

Kill Zone:

Kill Zone 8/15/2011 Area - 67,584 linear river feet x 362 feet (mean river width in kill zone) = 181,637.12 square feet

Kill Zone 8/16/2011 Area – 54,384 linear river feet x 362 feet (mean river width in kill zone) = 19,687,008 square feet

Extrapolation:

Kill Zone 8/15/2011 - sample units per area x count per sample unit

926.72 x 196 - **Total of 181,637.12 dead floating mussels**

Kill Zone 8/16/2011 - sample units per area x count per sample unit

745.72 x 196 - **Total of 146,161.12 dead floating mussels**

The total number of dead floating mussels was 327,798.24.

The mussels documented in the kill consisted almost exclusively of one species, the fragile papershell *(Leptodea fragilis).* Only four individuals of another species, the paper pondshell *(Utterbackia imbecillis),* were identified.

In Mississippi:

In Mississippi, the lead agency for investigating the fish kill linked to the Temple-Inland Incident was the Mississippi Department of Environmental Quality (MDEQ). Officials established the magnitude of the mussels included in the fish kill by way of estimated counts and extrapolation of sample units.

Kill Zone

As noted by MDEQ, the kill zone encompassed the Pearl River and East Pearl River from Bogalusa to Highway 90.

Counts

Estimated counts were done near the Walkaih State Water Park Boat Ramp. The first 50-meter (approximately) reach count GPS points were **N 30.58499 – W 089.81617** start. **N 30.58350 – W 089.81470** end. MDEQ did not have GPS points for the second 50-meter reach. However, it was identified as being further downstream from the first, but above the boat ramp.

Extrapolated Sample Unit Counts

August 13, 2011

MDEQ conducted two estimated counts at 50 meters each (to equal100 meters) for the 39 river miles affected.

(165 mussels * 1609 meters* 39 river miles)/100 meters = 103,539.15

Totals – 103,539.15 dead floating mussels

These mussels consisted almost exclusively of one species, the fragile papershell (*Leptodea fragilis*).

Contributed Mussel Studies by the U.S. Fish and Wildlife Service and Louisiana State University

Establishing the magnitude of the mussel kill by observation of dead mussels on shoreline of the West Pearl River

By Tony Brady and Cedric Doolittle, USFWS, Gary Vitrano, LDWF, and Wes Daniel, LSU

In response to the 13 August 2011, chemical spill from the Temple-Inland Paper Mill in Bogalusa, LA, biologists from Natchitoches National Fish Hatchery (USFWS), Baton Rouge Fish and Wildlife Conservation Office (USFWS), Louisiana State University and the Louisiana Department of Wildlife and Fisheries spent four days documenting the impact of the spill on freshwater mussels. Due to the unknown toxicity of the chemical in the water, initial mussel surveys were limited to shoreline sampling of dead mussels that had washed ashore (Figure 2).

Figure 2. *Leptodea fragilis* were washed ashore after the chemical spill in the West Pearl River, August 13 – 17, 2011.

METHODS

In a 22 mile stretch of the West Pearl River starting at Crawford's Landing and going upstream, a total of 12 areas were surveyed (Figure 3). A total of 1,898 dead mussels of three species were counted from these locations (Table 5).

West Pearl River Mussel Survey

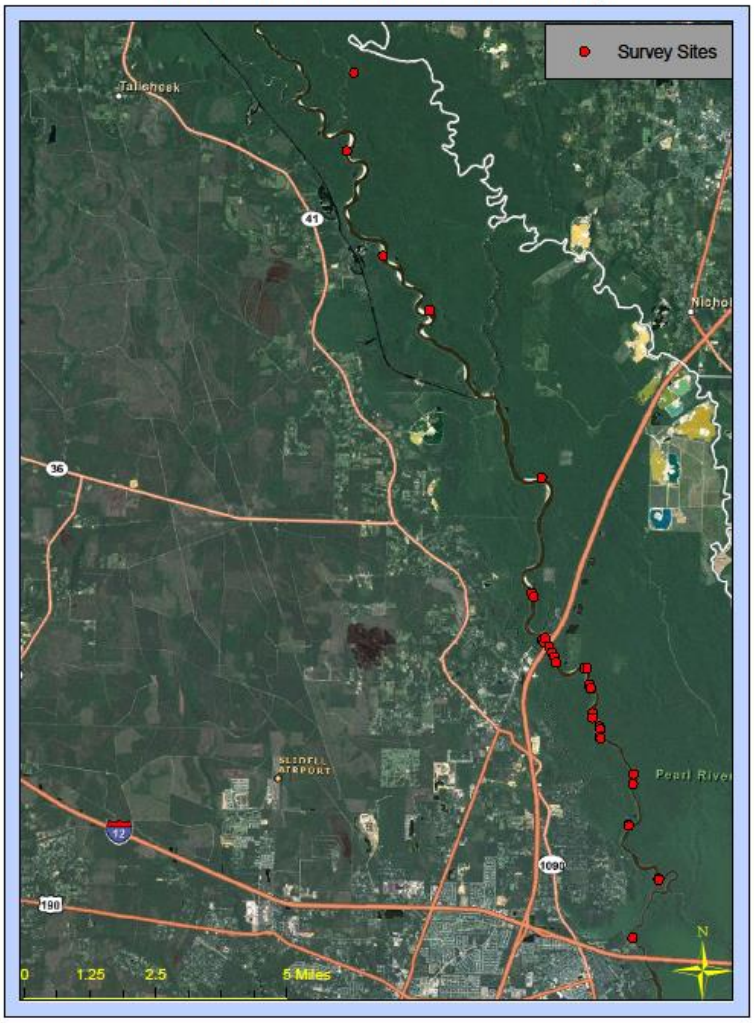


Figure 3. Site map showing locations of mussel surveys associated with investigation of West Pearl River fish and mollusk kill, August 13 – 17, 2011.

Table 5. Shoreline survey sites on the West Pearl River ascending upstream from Crawford's Landing.

Site number	GPS point	Number dead	
		L. fragilis	***U. imbecillis***
1	N 30.31956 W89.63860	44	
2	N 30.33405 W 89.70840	16	
3	N 30.34834 W 89.70732	130	
4	N 30.35857 W 89.71840	253	2
5	N 30.36126 W 89.71870	328	5
6	N 30.36501 W 89.72097	467	1
7	N30.37270 W 89.72212	201	1
8	N 30.37733 W 89.72388	48	
9	N 30.38026 W89.73348	53	
10	N 30.38150 W 89.73436	31	
11	N 30.38501 W 89.73750	60	
12	N 30.39770 W 89.74119	253	

RESULTS AND DISCUSSION

The Fragile papershell *Leptodea fragilis* consisted of 99.4% of the dead mussels counted during the shoreline surveys. As eluded to in its name, the fragile papershell is a thin shelled species whose shell has little mass causing the shell to float to the surface with the body after death. The body will stay connected to the shell until the tissue connecting the body to the shell decays to the point that the shell separates from the body and sinks back to the river bottom. Thousands of disemshelled bodies were seen floating down river and hung up in downed trees along the river (Figure 4).

Figure 4. Floating disemshelled mussel bodies are concentrated at a logjam in the West Pearl River, LA, August 13 – 17, 2011.

Due to the diversity of fish that were killed during this chemical spill, the authors expected to find more than three species of dead mussels. Most of the other mussel species in the West Pearl river have heavier shells that may have prevented them from floating up and washing ashore like the fragile papershell. On 18 August, 2011, the Louisiana Department of Environmental Quality gave clearance to proceed with in-water sampling of freshwater mussels allowing survey crews to begin sampling for dead mussels that did not float up onshore. A total of seven sites were sampled to determine if there were additional mussel species affected by the chemical spill. From these seven sites, a total of 19 species were found alive including live fragile papershell (Table 6). Consistent with the shoreline surveys the

fragile papershell consistently had the highest mortality of all the species surveyed. The average mortality rate for the fragile papershell at these seven in-water sites was 78.9%. Of the other 18 species collected, empty shells were collected from 11 species, and these shells appeared to have been dead prior to the spill. Dr. Ken Brown's lab at Louisiana State University will be comparing mortality data from this survey against their survey from 2007 to separate natural mortality from the spill mortality. Additional surveys should be conducted up stream of the spill site to develop baseline data so sites below the spill site can be monitored in the future for delayed effects from the spill on the mussel populations in the West Pearl River.

Table 6. Live and dead species of mussels surveyed from seven sites along the West Pearl River, LA, following the kill event of August 13 17, 2011.

								SAMPLE STATIONS								
		108		**109**		**110**		**111**		**112**		**113**		**114**		**% Mortality**
Species		Live	Dead	Live	Dead	Live	Dead	Live	Dead	Live	Dead	Live	Dead	Live	Dead	
Andodonta suborbiculata		3	0	4	0			4	0	1	0					0
Arciden confragosa										1	0					0
Glebula rotundata		126	0	124	0	10	1	452	0	31	0	5	2	69	3	0.97
Lampsilis clairbornensis		1	0													0
Lampsilis ornata										15	1	5	0	5	0	3.8
Lampsilis teres		23	6	18	3	39	1	18	0	17	4	4	3	15	4	13.5
Leptodea fragilis		15	76	1	27	10	19	1	2	14	17	9	46	2	7	78.9
Ligumia subrostrata		1	0													0
Obliqaria reflexa		2	0	1	0	2	0	4	1			1	0	5	0	6.3
Plectomerus dombeyanus				5	0	11	0	62	0							0
Potamilus purpuratus		1	1			5	1	4	0	4	1	4	12	20	1	29.6
Quadrula apiculata						5	0	20	0	1	0	1	1	12	0	2.2
Quadrula quadrula		3	0	3	0	2	0	26	0	1	0	1	0	11	0	0
Quadrula refulgens										8	0	11	5	11	5	25
Toxolasma parva														1	0	0
Uniomerus tertalamus										1	0					0
Utterbackia imbecilis				1	2	2	1	0	1							57.1
Villosa lienosa		15	1	8	1	4	0	6	1							8.3
Villosa vibex										2	0	1	1			0
Total mussels per site		190	84	165	33	90	23	597	7	96	23	42	70	157	20	

Establishing the magnitude of the mussel kill by semi-quantitative sampling in affected areas.

By Wesley Daniel and Dr. Ken Brown – LSU

On 18 August, 2011, the Louisiana Department of Environmental Quality gave clearance to proceed with in-water sampling of freshwater mussels allowing survey crews to begin sampling for dead mussels that did not float up onshore. A total of seven sites were sampled to determine if there were additional mussel species affected by the spill. From these seven sites, a total of 16 species were found alive including live fragile papershell (*Leptodea fragilis*). In 2007, Dr. Brown's lab at LSU surveyed the Pearl River for unionid mussels, spending 90 minutes of sampling effort at each site. Here we compare the diversity of mussels at seven sites before and after the spill, noting effects on CPUE, species richness and Shannon-Wiener diversity. We also use a simulation technique to compare diversity, since the sampling effort (no. of mussels collected) differed between the two studies. We also compare mortality rates at the seven sites in the two studies.

METHODS

Sites (Table 7) were qualitatively sampled by collecting all dead shell found along the shoreline, and by "grubbing" (carefully hand searching sediments < 1 m depth) for living mussels. Sampling effort was standardized for 90 minutes effort per site. All mussels were identified, and we noted whether they were alive or dead. At each site, we compare the following parameters between the 2007 and 2011 study: (1) mortality (% of the individuals collected dead), (2) Catch-Per-Unit-Effort (total number of mussels collected per site in 90 minutes), (3) Species richness, and (4) Shannon-Weaver Diversity Index (H'). Because diversity indices are often dependent on sample size (e.g. number of mussels collected), and total CPUE differed between the two studies, we also used a simulation technique (Ecosim, Gotelli and Entsminger 2001) that randomly samples individuals from both data sets with increasing sample size, allowing diversity to be compared between the two studies over a similar range in sampling effort.

Table 7. Latitude and longitude of each site sampled on the Pearl River in 2007 and in 2011 after the spill.

Site	Latitude	Longitude
108	N30 23.183	W89 44.336
109	N30 24.268	W89 44.600
110	N30 22.599	W89 43.834
111	N30 21.898	W89 43.342
112	N30 29.452	W89 47.422
113	N30 28.465	W89 46.777
114	N30 25.773	W89 44.356

RESULTS

A total of 19 species were collected at the seven sites during the 2007 study versus 16 in 2011, but the total number of mussels collected was over twice as high in 2007 (Table 8). In mussel studies, diversity continues to increase with increasing sampling effort (e.g. no. of mussels collected) because some mussels are quite rare and are only encountered with high sample sizes. Comparing the mortality rates in the two studies, *Leptodea fragilis* had much higher mortality rates in 2011 (Fig. 5). *Potamilus purpuratus* also had a higher mortality rate. Mortality rates were not significantly different for the other species.

Comparing the mussel assemblages in the two studies, there was no significant difference in CPUE per site, species richness or H' (Table 9). The simulation, which compares mean diversity between the studies at similar numbers of mussels collected, also indicated little difference (Fig. 6); the confidence intervals overlapped between the two curves at common levels of sampling effort.

Table 8. Mussel species and numbers collected during sampling of 7 sites on Pearl River in 2007 and after the spill in 2011.

Species	**2007**	**2011**
Glebula rotundata	817	363
Plectomerus dombeyensis	197	79
Lampsilis teres	185	134
Potamilus purpuratus	169	38
Quadrula nobilis	140	47
Pyganodon grandis	123	0
Quadrula refulgens	96	30
Leptodea fragilis	94	52
Ligumia subrostrata	63	1
Quadrula apiculata	53	44
Obliquaria reflexa	37	15
Amblema plicata	12	0
Villosa lienosa	10	33
Lampsilis claibornensis	5	0
Megalonaias nervosa	2	0
Fusconaia ebena	2	0
Elliptio crassidens	2	0
Uttebackia imbecilis	1	3
Andodonta suborbiculata	1	0
Lampsilis ornata	0	25
Villosa vibex	0	3
Toxolasma parva	0	1
Uniomerus tetralasmus	0	1

Figure 5. Differential mortality (% of mussels collected dead) for several mussel species collected from the Pearl River in both 2007 and 2011. Asterisk indicates significant difference in mortality rate. ** = P = 0.053.

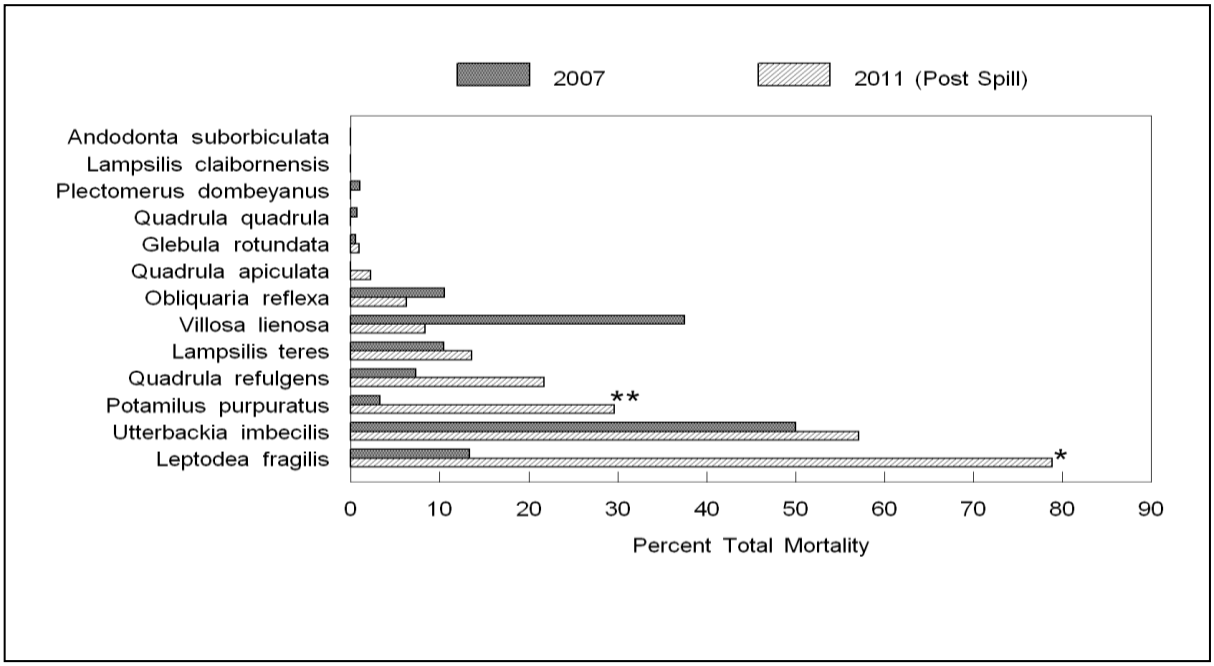
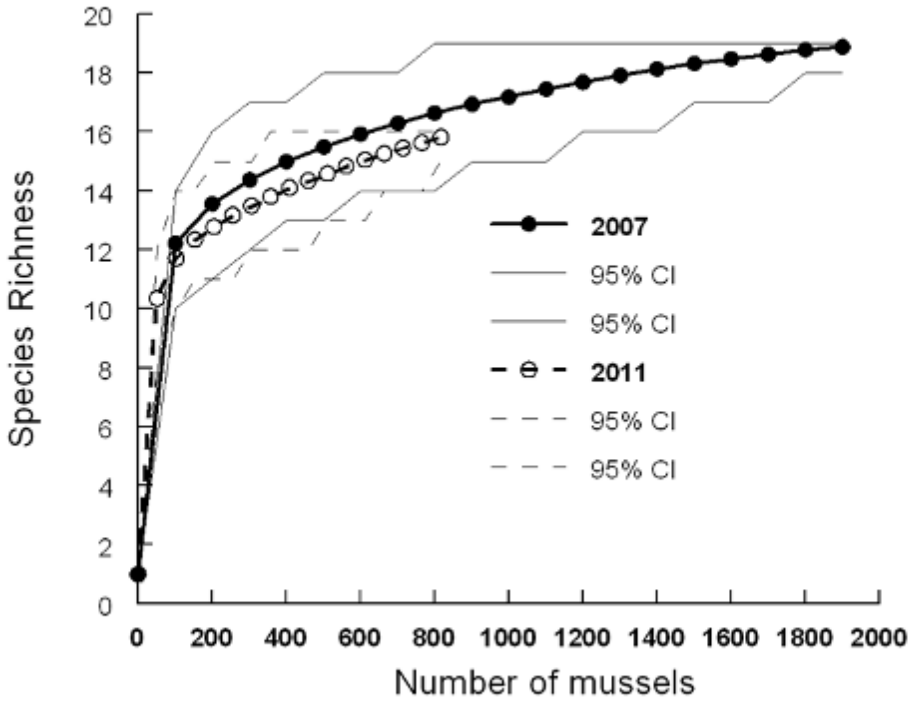


Table 9. Comparison of species richness, Shannon-Weaver diversity and CPUE among the same seven sites before and after the spill. F values are from an ANOVA comparing the two studies.

	2007	2011	F	P
Species Richness/site	10.1 ± 1.5	10.3 ± 0.4	0.01	0.92
H'	1.402 ± 0.162	1.372 ± 0.189	0.01	0.91
Number per site	221.4 ± 96.1	171 ± 67.2	0.18	0.67

Figure 6. Comparison in simulated diversity between the 2007 and 2011 data sets as N (no. of mussels collected) increases. Note the overlap in 95 % confidence intervals indicating little difference in diversity.



DISCUSSION

L. fragilis was obviously affected by the spill. The leak included high concentrations of black liquor, used to refine paper from wood pulp. Black liquor contains strong bases, and high concentrations of lignin, which can create high biological oxygen demands as it decomposes. *L. fragilis* has a thin shell that only partially covers its body, perhaps explaining why it was differentially affected. *P. purpuratus* has a much thicker shell, and we are unaware why it would be differentially affected, although we have also noticed a decrease in its relative abundance over time in the Pearl River (see also Table 4). The threatened inflated heelsplitter (*Potamilus inflatus*) has also been historically reported in the Pearl River (George 1996), although we have been unable to locate it in more recent studies (Brown et al. 2010). It is important to note that it also has a thin shell that does not cover the whole foot, like *L. fragilis*, so any extant populations could have been affected. At the community level, the spill did not seem to dramatically affect parameters like total abundance and species diversity. However, follow up studies should be conducted to look for longer term effects.

Mussel Damage Valuation:

Because the dead mussels consisted almost entirely of one species, the fragile papershell, *Leptodea fragilis*, floating mussel counts from LDWF and MDEQ were combined for a total valuation. *Fish Kill Procedures and Investigation and Monetary Values of Fish and Freshwater Mussel Kills, Special Publication 30*, lists the replacement value of the fragile papershell at $0.44 each and allows for Consumer Price Index (CPI) based increase. CPI based value for 2011 includes an additional 0.25% (Table 10).

Table 10. Values assigned to mussel loss in the Pearl River system kill of August 13 – 17, 2011. AFS values are per animal.

Dead Mussels	AFS Value	Calculation	Total
Fragile papershell			
431,337	0.44/ea.	431,337 x 0.44 x .25	**$237,235.07**

Investigative costs:

Table 11. Costs incurred by LDWF to investigate the fish and mussel kill on the lower Pearl River for August 13 – September 4, 2011

				Expenditures (as of 9/24/2011)
Salaries & Related Benefits				$37,054.79
Supplies (crab bait)				$20.00
Operating Services (boat launch)				$35.00
Vessel Usage (single engine)	Hours	107	$33.44	$3,578.08
Vessel Usage (twin engine)	Hours	29	$66.88	$1,939.52
Vehicle Usage	Miles	2125	$0.51	$1,083.75
TOTAL				43,711.14

Monitoring and recovery costs:

LDWF will increase sampling frequency for the lower Pearl River to monitor the recovery from the kill and initiate necessary management actions. We know that all waters of the Pearl River system were not impacted and that a representation of native fishes remains. Sport fish, including bass and sunfish will be re-stocked the first year following the kill – 2012. The return of other native fishes will be monitored through sampling. If necessary, re-stocking efforts to restore other lost populations will be conducted. Because fisheries resources can rebound in a little as three years following a devastating fish kill (LDWF 2009), we propose a three-year sampling program to monitor aquatic resource recovery.

1) Six sampling stations will be established along the Pearl/West Pearl Rivers to monitor recovery, five to be situated in the kill zone from Bogalusa, LA to US Hwy. 90, and one (base line station) located above Bogalusa in an un-impacted reach of the river.
2) LDWF fisheries personnel will conduct standardized samples at the six stations utilizing approved sampling gear and techniques as per LDWF Standardized Sampling Protocol for a period of three years.
3) Projected costs for re-stocking 200,000 largemouth bass and 400,000 bluegill/redear sunfish (not including transportation costs) is $222,400.00.

4) Projected costs for a three year monitoring program, including salaries, benefits, per diem and travel costs are found in Table 12 below.

Table 12. Summary of expenditures required for monitoring the Pearl River for three years following the fish and mussel kill event of August 13 – 17, 2011.

				Expenditures	
Salaries & Related Benefits*	Hours	1,440	$32.90	$47,376.00	
Supplies (nets)	1 set			$2,650.00	
Vessel Usage (single engine)	Hours	1,013	$33.44	$33,874.72	
Vehicle Usage	Miles	8,280	$0.51	$4,222.80	
TOTAL				$88,123.52	
*This is total personnel costs per hour including salary and associated related benefits.					

Conclusions:

1) An unauthorized release from the Temple-Inland Paper mill resulted in a fish and mollusk kill in 120 stream miles below Bogalusa, LA, including the main stem Pearl, East Pearl, West Pearl, Wilson's Slough, and Porter's River to US Hwy. 90 near the Gulf of Mexico.
2) It is estimated that 591,561 fish and mussels, representing at least 22 species were lost in the event, and the estimated replacement value for these animals was **$816,022.40.**
3) It is estimated that 28 Gulf sturgeons, a federally threatened species, died as a result of the unauthorized release. Replacement value for Gulf sturgeon is $2,762.50 per fish (Table 4).
4) One hundred and thirty-nine paddlefish were also estimated to have been killed in the event. Paddlefish are considered a regulated recreational species of conservation concern. The replacement value per animal is $2,762.50.(included in Table 4).
5) Employees' salaries, benefits, per diem and travel expenses incurred while investigating the kill and compiling related data and reports totaled **$43,711.14.**
6) A three-year recovery and monitoring plan will be put into action to measure the fish and mollusk recovery of impacted areas totals $**88,123.52.**
7) Re-stocking efforts to include largemouth bass and bluegill/redear sunfish at a cost of **$220,400.** Monitoring phase will determine if other species will need recovery actions such as stocking.
8) Grand total including fish and mollusk loss, investigative costs, monitoring and recovery (including stocking) comes to **$1,168,257.06.**

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Appendices:

Appendix 1.
Species list of fishes inhabiting the Pearl River basin, Louisiana and Mississippi. List after Ross (2001).

Pearl River Basin Mississippi and Louisiana Species List:	
Cynoscion nebulosus	*Ictiobus bubalus*
Leiostomus xanthurus	*Minytrema melanops*
Paralichthys lethostigma	*Moxostoma carinatum*
Trinectes maculatus	*Moxostoma poecilurum*
Etheostoma fusiforme	*Bagre marinus*
Etheostoma gracile	*Ameiurus melas*
Etheostoma histrio	*Ameiurus natalis*
Etheostoma kennicotti	*Ameiurus nebulosus*
Etheostoma lynceum	*Ictalurus furcatus*
Etheostoma parvipinne	*Ictalurus punctatus*
Etheostoma proeliare	*Noturus funebris*
Etheostoma stigmaeum	*Noturus gyrinus*
Etheostoma swaini	*Noturus leptacanthus*
Etheostoma histrio	*Noturus miurus*
Percina aurora	*Noturus minutus*
Percina lenticula	*Noturus nocturnus*
Percina maculata	*Noturus phaeus*
Percina nigrofasciata	*Pylodictis olivaris*
Percina sciera	*Esox americanus*
Percina shumardi	*Esox niger*
Percina suttkusi	*Notropis chalybaeus*
Percina vigil	*Notropis longirostris*
Stizostedion canadense	*Notropis maculatus*
Stizostedion vitreum	*Notropis shumardi*
Aplodinotus grunniens	*Notropis texanus*
Elassoma zonatum	*Notropis volucellus*
Eucinostomus argenteus	*Notropis winchelli*
Gobionellus shufeldti	*Opsopoeodus emiliae*
Gobiosoma bosc	*Pimephales notatus*
Microgobius gulosus	*Pimephales promelas*
Morone saxatilis	*Pimephales vigilax*
Ammocrypta beani	*Pteronotropis signipinnis*

Ammocrypta vivax	*Pteronotropis welaka*
Crystallaria asprella	*Semotilus atromaculatus*
Etheostoma chlorosoma	*Carpiodes cyprinus*
Syngnathus scovelli	*Carpiodes velifer*
Oligoplites saurus	*Cycleptus meridionalis*
Ambloplites ariommus	*Erimyzon oblongus*
Centrarchus macropterus	*Erimyzon sucetta*
Lepomis cyanellus	*Erimyzon tenuis*
Lepomis gulosus	*Hypentelium nigricans*
Lepomis humilis	*Anchoa mitchilli*
Lepomis macrochirus	*Carassius auratus*
Lepomis marginatus	*Cyprinella camura*
Lepomis megalotis	*Cyprinella venusta*
Lepomis microlophus	*Cyprinus carpio*
Lepomis miniatus	*Ericymba buccata*
Lepomis symmetricus	*Hybognathus hayi*
Micropterus punctulatus	*Hybognathus nuchalis*
Micropterus salmoides	*Luxilus chrysocephalus*
Pomoxis annularis	*Lythrurus roseipinnis*
Pomoxis nigromaculatus	*Macrhybopsis aestivalis*
Aphredoderus sayanus	*Macrhybopsis storeriana*
Mugil cephalus	*Nocomis leptocephalus*
Strongylura marina	*Notemigonus crysoleucas*
Cyprinodon variegatus	*Notropis atherinoides*
Fundulus catenatus	*Ichthyomyzon castaneus*
Fundulus chrysotus	*Ichthyomyzon gagei*
Fundulus dispar dispar	*Lampetra aepyptera*
Fundulus grandis	*Acipenser oxyrinchus*
Fundulus jenkinsi	*Polyodon spathula*
Fundulus notatus	*Lepisosteus oculatus*
Fundulus nottii	*Lepisosteus osseus*
Fundulus olivaceus	*Amia calva*
Fundulus pulvereus	*Hiodon tergisus*
Lucania parva	*Anguilla rostrata*
Gambusia affinis	*Alosa alabamae*
Heterandria formosa	*Alosa chrysochloris*
Poecilia latipinna	*Brevoortia patronus*
Labidesthes sicculus	*Dorosoma cepedianum*
Menidia beryllina	

Appendix 2.

Species list of mussels known to inhabit the lower Pearl River, Louisiana and Mississippi*

Scientific Name	Common Name
Uniomerus declivis	Tapered Pondhorn
Pleurobema beadleianum	Mississippi Pigtoe
Uniomerus tetralasmus	Pondhorn
Arcidens confragosus	Rock Pocketbook
Lasmigona complanata complanata	White Heelsplitter
Glebula rotundata	Round Pearlshell
Lampsilis teres	Yellow Sandshell
Quadrula quadrula	Mapleleaf
Plectomerus dombeyanus	Bankclimber
Quadrula apiculata	Southern Mapleleaf
Elliptio crassidens	Elephant-ear
Quadrula refulgens	Purple Pimpleback
Tritogonia verrucosa	Pistolgrip
Utterbackia imbecillis	Paper Pondshell
Pyganodon grandis	Giant Floater
Lampsilis straminea claibornensis	Southern Fatmucket
Villosa lienosa	Little Spectaclecase
Corbicula fluminea	Asiatic Clam
Fusconaia ebena	Ebonyshell
Truncilla donaciformis	Fawnsfoot
Ligumia subrostrata	Pondmussel
Fusconaia cerina	Gulf Pigtoe
Obliquaria reflexa	Threehorn- Wartyback
Leptodea fragilis	Fragile Papershell
Potamilus purpuratus	Bleufer
Potamilus inflatus	Inflated Heelsplitter**
Elliptio arca	Alabama Spike
Obovaria unicolor	Alabama Hickorynut

* List after Jones et al. 2005, and Vidrine 1993

** USFWS threatened species

Appendix 3.

A narrative of daily actions taken by the respective agencies and their teams as they completed the fish and mollusk kill investigation. The kill occurred on the lower Pearl River, in St. Tammany and Washington Parishes, Louisiana and in Hancock and Pearl River Counties, Mississippi. Poor water quality resulting from an unauthorized discharge into the Pearl River impacted and killed fish and mollusks in up to 81.2 miles of river habitat. Fish and mussel kill surveys were conducted from August 13 – August 19, 2011.

Narrative of actions:

Fish Kill Investigation Timeline:

August 13, 2011
Tim Ruth LDWF
10.8 mile segment of the Pearl River from Richard Landing in Bogalusa (N30 45.902 - W 89 49.968) to Pools Bluff Sill (N 30 42.248 - W 89 50.357):
Dead fish were found in pockets deposited along the river edge; dead fish were also observed floating down stream and over the low head sill at Pools Bluff; counts and measurements were made of the dead fish found in pockets deposited along the river edge; species list, counts and measurements were compiled (Tables 2 & 3); contact was made with MDEQ, biologists with this agency informed us they would be surveying the river from Pools Bluff Sill to Holmes Bayou and the East Pearl River; one Gulf Sturgeon was collected (see Appendix 5).

August 14, 2011
Gary Vitrano - LDWF
Matt Duplessis- LDWF
16.2 mile segment of the West Pearl River / Wilson sough complex from two miles south of Lock One (N 30 25.746 - W 89 44.441) to Walkiah Bluff (N30 34.128 - W89 48.628):
Dead fish were observed floating downstream, but the majority was in pockets deposited along the river edge; these pockets were usually delineated by slow moving water pools and debris piles (see photo PRFK_FM02, PRFK_FM03, PRFK_FM04); these pockets were treated as sample units for estimating the number of visible dead fish; these sample units are defined by subsamples – 5' x 5' area; the numbers of sample units were counted and estimates of fish counts were made based on subsamples; species list and counts were compiled (Tables 2 & 3); five Gulf Sturgeon were collected (Appendix 5).

August 15, 2011
Gary Vitrano - LDWF
Tim Ruth - LDWF
9.7 mile segment of the West Pearl River from two miles south of Lock One (N 30 25.719 - W 89 44.626) to Porter's River (N 30 20.327 - W 89 42.536):
Dead fish were observed floating downstream, but the majority was in pockets deposited along the river edge; visible dead fish diminished drastically due to predation and degradation; direct counts of dead fish were made in these pockets; thousands of distressed and piping fish were observed in Porter's River; ninety seven paddlefish were counted (Photos PRFK_FM05, PRFK_FM06); Species list and counts were compiled (Tables 2 & 3), (Appendix 3); four Gulf Sturgeon were collected (Appendix 5).

August 15, 2011
Matt Duplessis – LDWF
Jeff Thompson - LDWF
39.7 mile segment of the Pearl River from the East Pearl at Highway 90(N 30 14.313 - W 89 36.901) to Porter's River (N 30 20.327 - W 89 42.536) including portions of the West Middle Pearl River:
Dead fish were observed floating downstream, but the majority was in pockets deposited along the river edge; direct counts of dead fish were limited to a 4.4 mile stretch of the West Pearl river south of Porter's river; species list and counts were compiled (Tables 2 & 3).

August 16, 2011
Matt Duplessis – LDWF
Jeff Thompson – LDWF
46.6 mile segment of the Pearl River from the East Pearl at Highway 90(N 30 14.313 - W 89 36.901) to Highway 59 (N 30 20.051 - W 89 42.516) including 4.9 miles of Porters River:
Dead fish were observed floating downstream, but the majority were in pockets deposited along the river edge; visible dead fish diminished drastically due to predation and degradation; no new counts on the West Pearl were made; instead efforts were focused on a new fish kill event in Porters River, a remnant river channel still connected to the West Pearl River; sample units for estimating the number and species of visible dead fish was established; sample units are defined by subsamples – 10' x 1' area; fish species and counts were recorded and averaged to establish species density of the subsample unit; the numbers of sample units were extrapolated over the affected areas and estimates of fish counts and species composition were made based on subsamples; species list and counts were compiled (Tables 2 & 3); nine Gulf Sturgeon were collected (Appendix 5).

August 17, 2011
Gary Vitrano - LDWF
Jeff Thompson – LDWF
35.5 mile segment of the Pearl River from the East Pearl at Highway 90(N 30 14.313 - W 89 36.901) to Porter's River (N 30 20.327 - W 89 42.536:
Visible dead fish diminished drastically due to predation and degradation; no new counts on the West Pearl were made; three Gulf Sturgeon were collected (Appendix 5).

August 18, 2011
Matt Duplessis – LDWF
Jeff Thompson – LDWF
34.5 mile segment of the Pearl River from the East Pearl at Highway 90(N 30 14.313 - W 89 36.901) to Porter's River (N 30 20.327 - W 89 42.536):
With each passing day, visible dead fish diminished drastically due to predation and degradation. No new counts were made on the Pearl River after this date.

<u>Mussel Kill Investigation Timeline:</u>

August 13, 2011
Tim Ruth LDWF
10.8 mile segment of the Pearl River from Richard Landing in Bogalusa (N30 45.902 - W 89 49.968) to Pools Bluff Sill (N30 42.248 - W 89 50.357):
Dead mussels were observed floating among dead fish in pockets deposited along the river edge. These mussels appeared to consist almost exclusively of one species.

August 14, 2011
Gary Vitrano - LDWF
Matt Duplessis- LDWF
16.2 mile segment of the West Pearl River including Wilson sough from two miles south of Lock One (N 30 25.746 - W 89 44.441) to Walkaih Bluff (N30 34.128 - W89 48.628):
Dead mussels were observed floating among dead fish in pockets deposited along the river edge. These mussels appeared to consist almost exclusively of one species. Voucher specimens were collected for Identification purposes.

August 15, 2011
Gary Vitrano - LDWF

Tim Ruth - LDWF
9.7 mile segment of the West Pearl River from two miles south of Lock One (N30 25.719 - W89 44.626) to Porter's River (N30 20.327 - W89 42.536):
Tens of Thousands of dead mussels were observed floating on the river surface. These mussels appeared to consist almost exclusively of one species.

August 15, 2011
Matt Duplessis – LDWF
Jeff Thompson - LDWF
16.4 mile segment of the Pearl River complex from the East Pearl and Highway 90(N 30 14.313 - W 89 36.901) to Highway 59 (N 30 20.051 - W 89 42.516):
Tens of Thousands of dead mussels were observed floating on the surface in a 3.7 mile section of the West Pearl River from Crawford's Landing (N30 18.002 - W89 42.213) to Porters River (N 30 20.327 - W 89 42.536). These mussels appeared to consist almost exclusively of one species.

August 16, 2011
Gary Vitrano - LDWF
Beau Gregory- LDWF
10.3 mile segment of the West Pearl River an area south of Lock One (N30 20.051 - W89 42.516) to Porter's River (N 30 20.327 - W 89 42.536):
Beau Gregory, Zoologist for LDWF's Natural Heritage Program assisted with the investigation. Several thousand dead mussels were observed floating in this stretch of the river. However, considerably less was observed than on the previous day. Beau was able to identify the dead floating mussels as the Fragile papershell (*Leptodea fragilis*). Only four individuals of another species, the Paper pondshell (*Utterbackia imbecillus*), were identified. The majority of the mussels were observed south of Highway 59. Variation in the densities and the sometimes clumped distribution, the number of dead mussels was difficult to quantify. Though subject to bias, we counted floating dead mussels along two randomly chosen 0.25 mile x 20 feet (0.6 acre) transects that were fairly representative of the affected area. Mussel numbers for the two transects were 208 and 184.
Photos: PRFK_MM01, PRFK_MM06
By the end of the day a decision was made to begin a more concentrated investigation. Tony Brady, Mussel Propagation Biologist with the Natchitoches National Fish Hatchery would begin shoreline assessments and Dr. Ken Brown and Wesley M. Daniel, with the Benthic Ecology Lab, Biological Sciences Department at Louisiana State University would conduct semi-quantitative sampling.

August 17, 2011
Tony Brady – USFWS
Cedric Doolittle – USFWS
22 mile segment of the West Pearl River from Crawford's Landing (N30 18.002 - W89 42.213) to two miles south of Lock One (N 30 25.746 - W 89 44.441):
This part of the investigation included shoreline sampling of dead mussels that had washed ashore.

August 18, 2011
Tony Brady – USFWS
Cedric Doolittle – USFWS
22 mile segment of the West Pearl River from Crawford's Landing (N30 18.002 - W89 42.213) to two miles south of Lock One (N 30 25.746 - W 89 44.441):
This part of the investigation included shoreline sampling of dead mussels that had washed ashore.

August 18, 2011
Gary Vitrano – LDWF
Wesley Daniel – LSU
Barry Aromhine – LSU
Sample site located on the West Pearl river by Highway 59 (N30 23.183 - W89 44.336), (N30 24.268 - W89 44.600), (N30 22.599 - W89 43.834), (N30 21.898 - W89 43.342):
Mussels were collected with semi-quantitative sampling (time limited searches). Sites were selected to replicate historic sites to facilitate comparisons. Thirteen species of live mussels were observed and voucher specimens collected. Dissolved oxygen concentrations were normal. No new mussel mortality observed.
Photos: PRFK_MM02, PRFK_MM03, PRFK_MM04

August 19, 2011
Gary Vitrano – LDWF
Matt Duplessis - LDWF
Tony Brady – USFWS
Sample site located on the West Pearl river by Lock One (N30 29.452 - W89 47.422), N30 28.465 - W89 46.777), (N30 25.773 - W89 44.356):
Mussels were collected with semi-quantitative sampling. Sites were selected to replicate historic sites to facilitate comparisons. Fifteen species of live mussels were observed and voucher specimens collected. Dissolved oxygen concentrations were normal. No new mussel mortality observed.
Photo: PRFK_MM05

Appendix 4.

Water quality data collected along the lower Pearl River during the fish and mussel kill investigation by LDWF, August 13 – 19, 2011[10]

Surface Measurements:

Station	Date	Time	Temperature	Dissolved Oxygen	Conductivity	Salinity
5	8/13/2011	N/A	32.06	0.78	N/A	N/A
6	8/13/2011	N/A	33.8	6.07	N/A	N/A
Station	Date	Time	Temperature	Dissolved Oxygen	Conductivity	Salinity
7	8/14/2011	1504	31.93	0.38	1.91	0.09
9	8/14/2011	1136	32.52	0.35	0.174	0.08
10	8/14/2011	1030	32.01	0.76	0.169	0.08
11	8/14/2011	1048	31.5	1.7	0.132	0.06
12	8/14/2011	1207	34.5	2.0	0.174	0.08
Station	Date	Time	Temperature	Dissolved Oxygen	Conductivity	Salinity
12	8/15/2011	1027	30.9	2.17	0.172	0.07
13	8/15/2011	1404	32.1	3.65	0.174	0.07
14	8/15/2011	1416	32.1	3.1	0.175	0.07
17	8/15/2011	1000	31.0	0.52	N/A	0.08
22	8/15/2011	1121	31.9	0.66	0.174	0.07
23	8/15/2011	1143	32.1	0.4	0.182	0.07
25	8/15/2011	1158	32.7	1.21	0.17	0.08
26	8/15/2011	1237	33.39	2.83	0.152	0.07
27	8/15/2011	1115	31.7	0.47	0.17	0.08
28	8/15/2011	1043	31.22	0.71	0.158	0.07
29	8/15/2011	1030	31.31	1.04	0.157	0.07
30	8/15/2011	1014	31.22	1.34	0.153	0.07
31	8/15/2011	0958	30.98	2.15	0.25	0.12
36	8/15/2011	0942	30.97	2.83	2.59	1.33
38	8/15/2011	1425	33.39	1.92	0.213	0.1
40	8/15/2011	1330	32	0.5	0.169	0.08
41	8/15/2011	1340	32.88	3.02	0.316	0.05
43	8/15/2011	0937	30.53	3.53	7.2	3.88
Station	Date	Time	Temperature	Dissolved Oxygen	Conductivity	Salinity
1	8/16/2011	1125	30.87	6.87	0.099	0.04

[10] Corresponding station maps A4.1 – 4.4 follow.

2	8/16/2011	1135	30.81	6.82	0.99	0.04
3	8/16/2011	1220	31.15	6.92	0.099	0.04
4	8/16/2011	1245	31.12	6.75	0.099	0.04
5	8/16/2011	1242	30.44	5.93	0.101	0.04
12	8/16/2011	1328	31.8	7.25	0.126	0.05
15	8/16/2011	1519	32.6	4.07	0.177	0.07
17	8/16/2011	0948	31.2	4.0	0.146	0.06
19	8/16/2011	1305	31.6	5.35	0.145	0.06
21	8/16/2011	1037	32.1	4.4	0.166	0.07
22	8/16/2011	1133	32.3	0.19	0.195	0.08
24	8/16/2011	1433	32.1	1.13	0.174	0.08
25	8/16/2011	1140	32.32	4.4	0.156	0.07
27	8/16/2011	1100	31.32	2.05	0.162	0.07
28	8/16/2011	1040	31.41	1.77	0.168	0.08
29	8/16/2011	1025	31.51	2.0	0.169	0.08
30	8/16/2011	1010	31.59	2.24	0.169	0.08
31	8/16/2011	1000	31.31	1.7	0.415	0.19
32	8/16/2011	0950	31.02	3.58	4.342	2.28
33	8/16/2011	0942	33.32	4.23	2.643	1.35
34	8/16/2011	0935	30.12	4.85	6.44	3.31
36	8/16/2011	0918	31.26	0.95	1.51	0.6
38	8/16/2011	1535	33.56	4.33	0.459	0.23
39	8/16/2011	1515	33.52	3.77	0.455	0.22
40	8/16/2011	1500	31.9	2.75	0.165	0.08
43	8/16/2011	0906	30.23	4.56	7.386	4.04
Station	Date	Time	Temperature	Dissolved Oxygen	Conductivity	Salinity
17	8/17/2011	1318	31.55	6.8	0.08	0.04
27	8/17/2011	1129	31.45	5.31	0.127	0.06
32	8/17/2011	1603	30.04	6.62	1.896	1.02
34	8/17/2011	1552	33.79	7.63	4.691	2.47
35	8/17/2011	1545	33.32	4.23	2.643	1.35
36	8/17/2011	1002	31.57	1.62	1.912	0.96
37	8/17/2011	1039	32.15	3.32	1.264	0.63
40	8/17/2011	1106	31.73	4.03	0.139	0.06
Station	Date	Time	Temperature	Dissolved Oxygen	Conductivity	Salinity
15	8/18/2011	1109	32.1	5.35	0.101	0.09
16	8/18/2011	0945	33.7	5.4	0.098	0.04
18	8/18/2011	1242	33.0	5.57	0.096	0.04
20	8/18/2011	1349	33.9	6.8	0.097	0.04
27	8/18/2011	1336	32.21	6.77	0.092	0.04

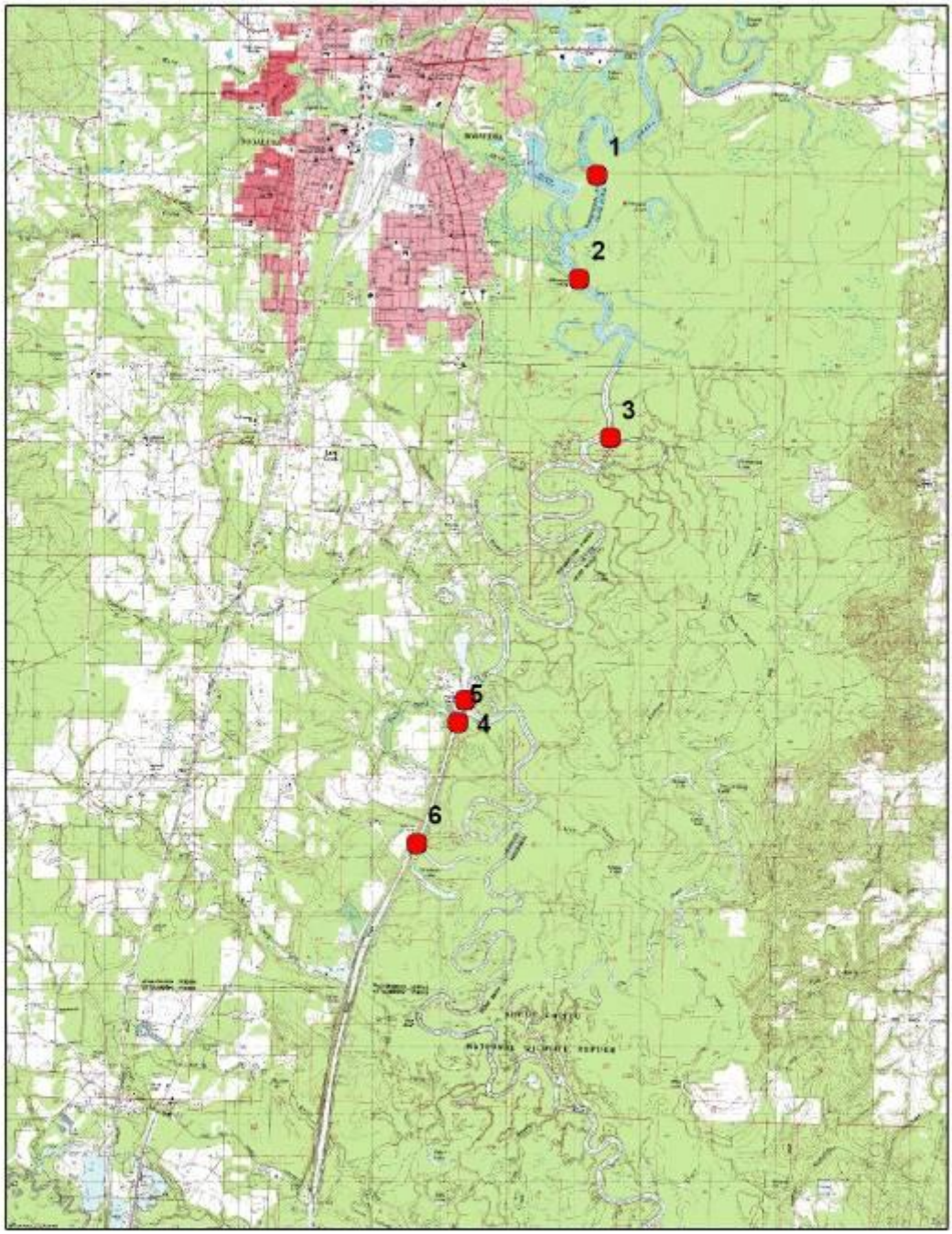
36	8/18/2011	1138	32.1	4.55	1.76	0.88
40	8/18/2011	1311	32.1	4.55	1.76	0.88
42	8/18/2011	1218	31.01	3.49	0.133	0.06
Station	Date	Time	Temperature	Dissolved Oxygen	Conductivity	Salinity
8	8/19/2011	1055	32.2	7.65	0.93	0.04
9	8/19/2011	1240	32.4	6.94	0.094	0.04
12	8/19/2011	1355	33.7	8.9	0.097	0.04

Bottom Measurements:

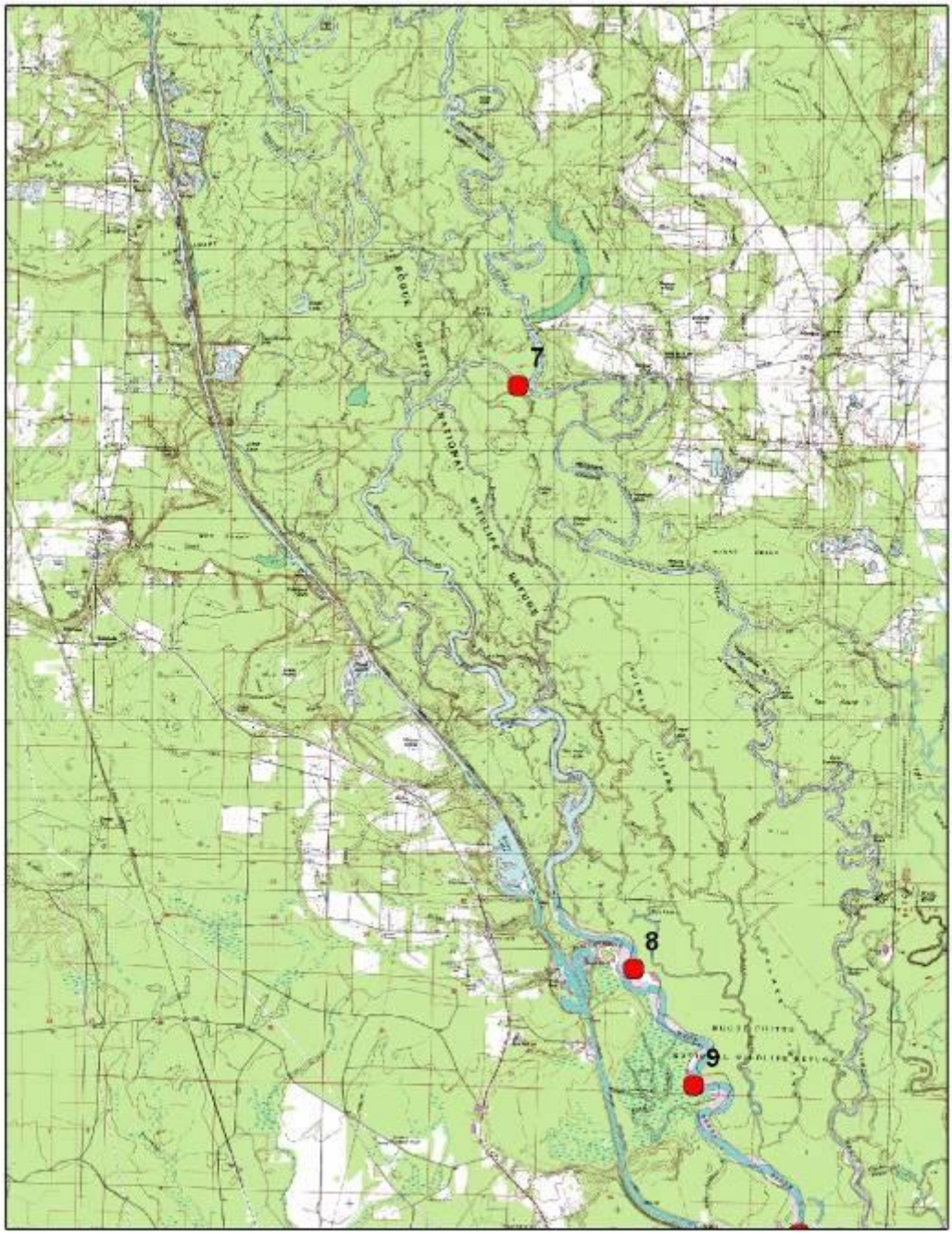
Station	Date	Time	Temperature	Dissolved Oxygen	Conductivity	Salinity	Depth
6	8/13/2011	N/A	N/A	1.58	N/A	N/A	N/A
Station	Date	Time	Temperature	Dissolved Oxygen	Conductivity	Salinity	Depth
11	8/14/2011	1048	31.55	0.06	0.136	0.06	6FT
Station	Date	Time	Temperature	Dissolved Oxygen	Conductivity	Salinity	Depth
12	8/15/2011	1027	30.9	2.19	0.172	0.07	N/A
13	8/15/2011	1404	32.1	3.44	0.174	0.07	7FT
14	8/15/2011	1416	32.1	2.7	0.175	0.07	5FT
17	8/15/2011	1000	31.1	0.47	0.186	0.08	15FT
22	8/15/2011	1121	31.7	0.18	0.174	0.07	6FT
23	8/15/2011	1143	32.0	0.03	0.181	0.07	N/A
27	8/15/2011	1115	31.68	0.2	0.17	0.06	22FT
29	8/15/2011	1030	31.32	0.88	0.157	0.07	7FT
38	8/15/2011	1425	31.66	1.14	4.68	2.47	20FT
40	8/15/2011	1330	31.93	0.4	0.169	0.08	25FT
Station	Date	Time	Temperature	Dissolved Oxygen	Conductivity	Salinity	Depth
1	8/16/2011	1125	30.86	6.85	0.1	0.04	6.5FT
2	8/16/2011	1135	30.78	6.74	0.98	0.04	5.6FT
3	8/16/2011	1220	31.19	6.87	0.099	0.04	N/A
4	8/16/2011	1245	31.09	6.58	0.099	0.04	10.8FT
12	8/16/2011	1328	31.8	7.8	0.126	0.05	8FT
15	8/16/2011	1519	32.6	4.1	0.177	0.07	N/A
17	8/16/2011	0948	31.1	2.8	0.177	0.07	25FT
19	8/16/2011	1305	31.6	5.04	0.145	0.06	2FT
21	8/16/2011	1037	32.1	4.0	0.166	0.07	4FT
22	8/16/2011	1133	31.4	0.03	0.195	0.08	7FT
25	8/16/2011	1143	32.2	3.76	0.156	0.07	25FT
27	8/16/2011	1100	31.28	2.03	0.162	0.07	25FT
28	8/16/2011	1040	31.4	1.62	0.168	0.08	10FT
29	8/16/2011	1025	31.49	1.85	0.168	0.08	N/A

31	8/16/2011	1000	31.64	3.44	9.8	5.49	25FT
33	8/16/2011	0942	30.51	4.88	16.15	9.38	22FT
36	8/16/2011	0918	30.9	1.75	13.22	7.55	25FT
39	8/16/2011	1515	31.09	1.07	12.41	7.06	25FT
Station	Date	Time	Temperature	Dissolved Oxygen	Conductivity	Salinity	Depth
17	8/17/2011	1318	31.52	6.53	0.089	0.04	22FT
27	8/17/2011	1129	31.46	5.1	0.126	0.06	25FT
32	8/17/2011	1603	31.47	5.61	15.56	8.92	10FT
34	8/17/2011	1552	33.58	4.98	16.18	9.84	21FT
35	8/17/2011	1545	30.51	4.88	16.15	9.38	22FT
36	8/17/2011	1002	30.76	1.26	18.43	10.85	25FT
37	8/17/2011	1039	30.73	0.78	17.36	10.11	25FT
40	8/17/2011	1106	31.34	2.51	0.144	0.07	25FT
Station	Date	Time	Temperature	Dissolved Oxygen	Conductivity	Salinity	Depth
27	8/18/2011	1336	31.95	6.53	0.09	0.04	25FT
36	8/18/2011	1138	30.53	1.1	21.99	13.15	25FT
40	8/18/2011	1311	30.53	1.1	2199	13.15	25FT
42	8/18/2011	1218	28.43	0.32	0.187	0.09	20FT

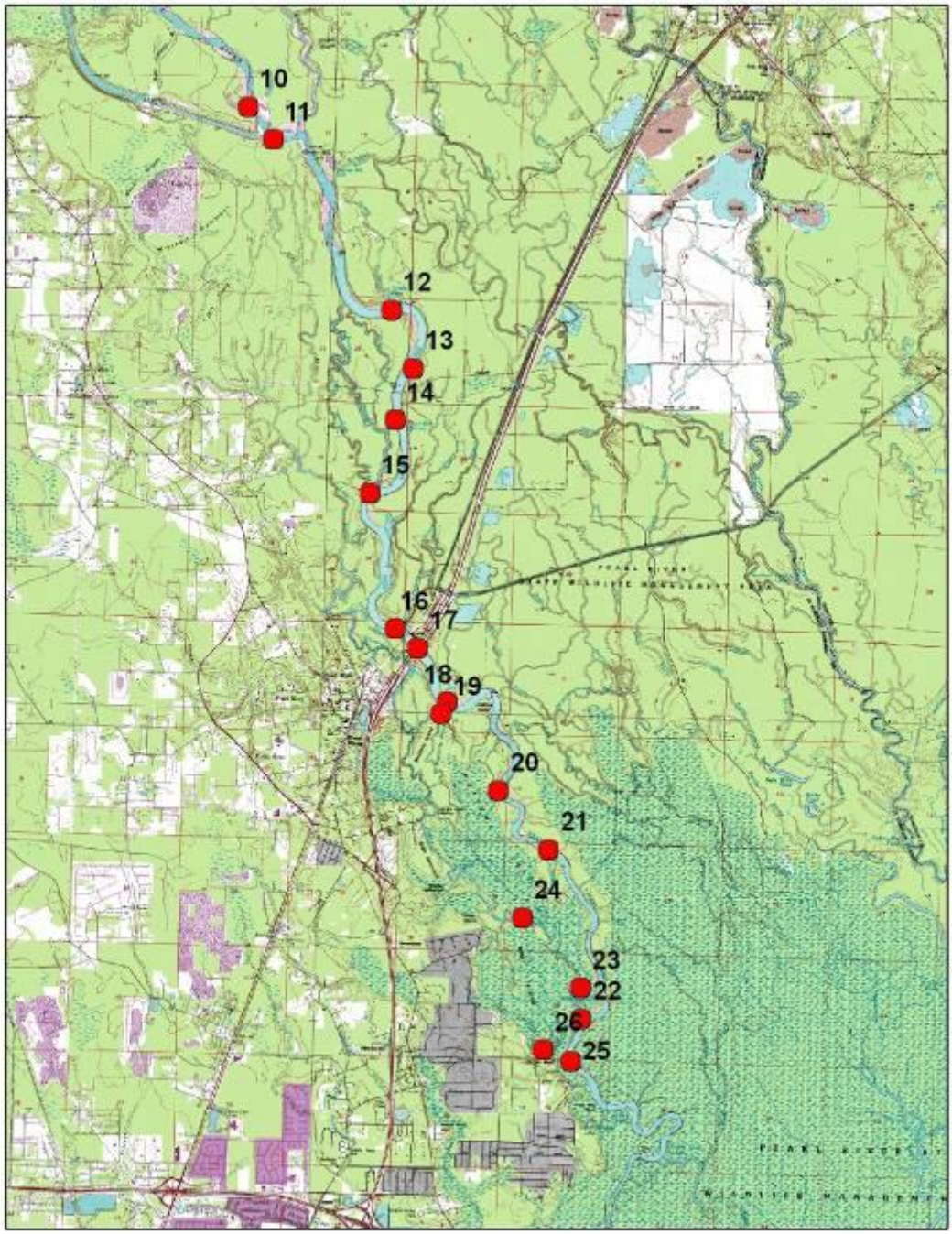
Map A4.1. Pearl River, LA, fish kill water quality stations 1 – 6, August 13 – 17, 2011.



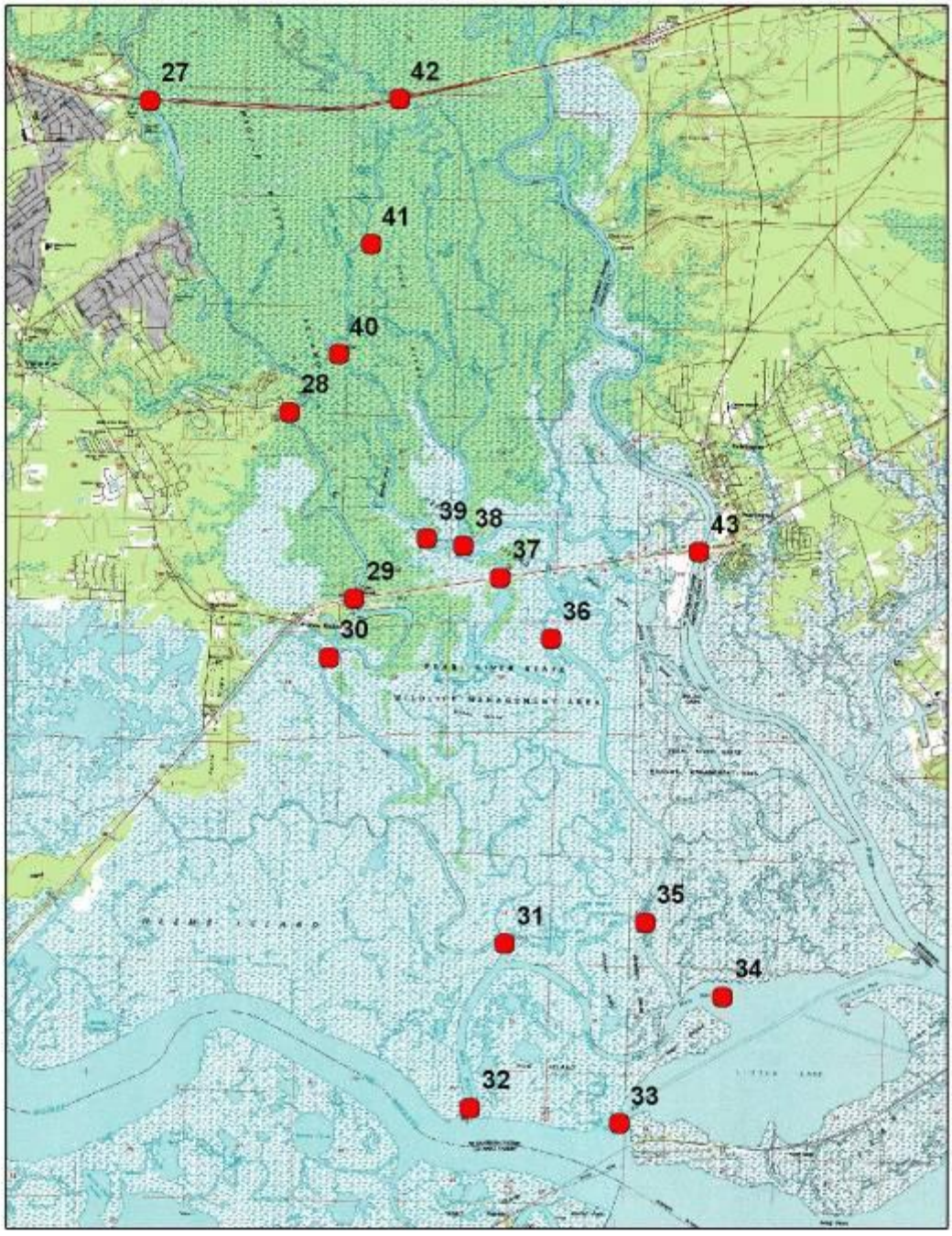
Map A4.2. Pearl River, LA, fish kill water quality stations 7 – 9, August 13 – 17, 2011.



Map A4.3. Pearl River, LA, fish kill water quality stations 10 –26, August 13 – 17, 2011.



Map A4.4. Pearl River, LA, fish kill water quality stations 27 –43, August 13 – 17, 2011.



Appendix 5.

Gulf sturgeon found dead while surveying the lower Pearl River, LA fish and mussel kill from August 13 – August 24, 2011.

Date	Latitude	Longitude	Picture	Time	Tag
8/14/2011	N30 27.354	W89 45.820	P8140097	1049	781682
			P8140098		
8/14/2011	N30 28.528	W89 46.835	P8140106	1135	781684
			P8140107		
8/14/2011	N30 25.746	W89 44.441	P8140110	1214	781685
8/14/2011	N30 25.746	W89 44.441	P8140111	1214	781686
8/14/2011	N30 34.128	W89 48.628	P8140114	1518	781687
8/15/2011	N30 25.713	W89 44.397	N/A	1123	802482
8/15/2011	N30 25.782	W89 44.242	P8140119	1315	802487
8/15/2011	N30 25.751	W89 44.188	P8140120	1321	802486
8/15/2011	N30 25.709	W89 44.150	P8140122	1333	802485
8/17/2011	N30 13.570	W89 38.282	*N/A*	0950	802494
8/17/2011	N30 13.217	W89 38.316	P8140139	1005	802493
8/17/2011	N30 13.571	W89 38.948	P8140140	1018	802490
8/21/2011	N30 34.098	W89 48.419	N/A	1343	802489
8/21/2011	N30 34.089	W89 49.116	N/A	1411	802495
8/13/2011	N30 42.220	W89 50.698	N/A	1600	781681
8/16/2011	N30 14.373	W89 39.471	N/A	1515	781688
8/16/2011	N30 14.373	W89 39.471	N/A	1515	781689
8/16/2011	N30 19.172	W89 41.480	N/A	1135	781690
8/16/2011	N30 14.323	W89 39.133	N/A	1535	781691
8/16/2011	N30 13.945	W89 38.738	N/A	1551	781614
8/16/2011	N30 14.294	W89 39.344	N/A	1528	802450
8/16/2011	N30 14.321	W89 39.245	N/A	1530	802451
8/16/2011	N30 15.459	W89 39.844	N/A	1505	802452
8/16/2011	N30 20.882	W89 43.090	N/A	1433	802488
8/24/2011	N30 20.009	W89 42.534	N/A	1600	802445
8/24/2011	N30 20.009	W89 42.534	N/A	1600	802446

Total Gulf Sturgeon: 28

Appendix 6.

Title 76 fisheries and wildlife valuations.

Title 76
WILDLIFE AND FISHERIES
i *Louisiana Administrative Code March 2005*
Part I. Wildlife and Fisheries Commission and Agencies Thereunder
7

Subchapter D. Wildlife Values
§313. Guidelines for Determining Wildlife Values

A. With respect to fish and shellfish species, published hatchery values reflecting estimated costs involved in rearing various fishes to particular size classes are available for many groups of freshwater fishes and are contained in the *Fish Kill Procedures and Investigation and Monetary Values of Fish and Freshwater Mussel Kills, Special Publication 30*. These figures, adjusted by the most recent Consumer Price Index; current data relating to expenditures of both sport and commercial fishermen relating to the animal or species which, directly or indirectly, result in revenues being generated for the state; ex-vessel commercial prices, as presented in the annual National Marine Fisheries Survey of Louisiana Landings; estimated costs involved in the capture, purchase, transportation and release of species of fish; the current commercial retail selling price of living replacement animals; and, the current commercial selling price of meat and/or other products which are derived from the animal and traded in commerce, shall be considered by the department in formulating its recommendations concerning valuation.

E. Certain species are highly prized because of their rarity or may have a high intangible perceived value placed on the animal or species by the public. Other species have an intrinsically high value because they are threatened or endangered. In addition to the guidelines set forth above, the department shall, with respect to these rare and/or threatened and/or endangered species which might have limited commercial value but which possess a high intangible, intrinsic, aesthetic, ecological, or biological value, consider those factors when determining its recommendations with respect to valuation.

Species of Special Concern Fish
Paddlefish $2,762.50/animal
Sturgeon $2,762.50/animal

Recreational Fishes Replacement Costs:

Length (in)	Largemouth Bass	Bluegill	Crappie
1	$0.35	$0.27	$0.35
2	$0.80	$0.56	$0.58

AUTHORITY NOTE: Promulgated in accordance with R.S. 56:40.2.
HISTORICAL NOTE: Promulgated by the Department of Wildlife and Fisheries, Wildlife and Fisheries Commission, LR 16:39 (January 1990), amended LR 18:290 (March 1992).