PRELIMINARY REVIEW OF L KONG (2017) THESIS CONCERNING CRAWFISH

PART 1 – The 2016 Data Set.

DRAFT EXPERT REPORT

of

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PART 1 – The 2016 Data Set.

Objectives

Kong's (2017) thesis was basically aimed at measuring various environmental and water quality parameters in a section of the Atchafalaya Basin in order to try to determine if there was a relationship between water quality and crawfish production. Temperature, Dissolved Oxygen (DO), pH, Secchi depth (a simple measure of turbidity), and specific conductance were recorded at all sample locations on every sample date and hemolymph samples were collected from ten red swamp crayfish *Procambarus clarkii* at each site to evaluate hemolymph protein concentration. Kong's data was only collected during the flooding stage of the Atchafalaya River 2016 and 2017 respectively.

This review assesses Kong's techniques, her assumptions, the quality of her data, interpretations, and conclusions. Where necessary data has been subjected to different plots and other data sets have been incorporated to further interpret the data. Missing from her thesis is any quality control or assessment of the accuracy of her measurements, no calibration data. This is a fundamental of any such study and so does raise the question as to the validity of the measurements. Additionally, Kong (2017) does not have an appendix listing or tabling her data, very important parameters such as GPS coordinates, weather conditions prior to and during sampling, and a table listing of all data sets. This is generally a prerequisite of any academic research effort so that other researchers can utilize the actual data instead of trying to interpret from small scale graphs and maps.

This study reflects data that was only collected during the flood stage of the Atcahafalaya River for each sample site. There was no data collected for the rest of the hydrologic year, so flood vs non-flood comparisons are not possible. As a management tool this thesis thus has very limited application especially as the two floods covered, namely 2016 and 2017, very different in Missisppi River flooding regime, timing, and scale.

Characteristics of 2016 Flood

Plate 1 depicts the Missisppi Catchment and location of its main distributaries. Suspended sediment loads for each Mississippi/Atchafalaya flood are controlled in part by which upstream tributaries are in flood. Reference will be made in this discussion to the extreme flood on the Mississippi River of 2011 when the major contributor of streamflow to the lower Mississippi-Atchafalaya River sub basin during April and May was the Ohio River, whose water contained lower concentrations of suspended sediment, pesticides, and nutrients than water from the upper Mississippi River (Welch et al, 2014).

By comparison the 2016 flooding on the Missouri and Upper Mississippi Rivers which included extensive snow melt would have contributed very high levels of suspended sediment. Although not part of this study, the 2017 flood represented the result of 1:1000-year rainfalls in the lower half of the Mississippi catchment and suspended sediment loads reaching the Atcahafalaya Basin were lower than normal.

Plate 1. Tributaries of the Missisppi River and its catchment

Sample Locations

In reviewing this thesis, and as a rule when dealing with relationships such as dissolved oxygen variations at a site, one needs to know the ground elevation of the site in relation to a nearby water level gauge in order to assess whether the sample site is getting flow from adjacent areas especially channels or canals, or is in a near stagnant condition. Inundation depth is also an important factor.

Figure 1 is a Google Image depicting the sample sites where Kong (2017) collected her intensive data for the 2016 and 2017 Atchafalaya River floods. As stated previously Kong does not supply any explanations as to why her sites were chosen other than ease of access, and the environment or elevation. I.e., was it on a levee or was it in an open pond or in a forested swamp? The assumption as she was collecting crawfish implied that there was sufficient water depth to move by boat. The Nature Conservancy (TNC) have since 26th June 2016 almost continuously also collected water quality data in the same region of the Basin although not at the same locations. Figure 2 depicts the location of TNC data collection sites. Figure 3 is an attempt to superimpose the Kong (2017) data collection locations (Figure 1) on the TNC map (Figure 2). This Part 1 review will focus on the Kong sites that cluster closest to the TNC sites (Blue box in Figure 3).

Determining ground elevations at sites.

Kong (2107) does not supply any data on ground elevations at any of her sites. The measure she uses to determine inundation of her sites is based on an unofficial crawfish season. I quote

"Intensive and extensive sites were sampled twice a month during the crayfish seasons from 19 March to 9 June 2016 and from 7 May to 3 July 2017. There is no official crayfish season set by

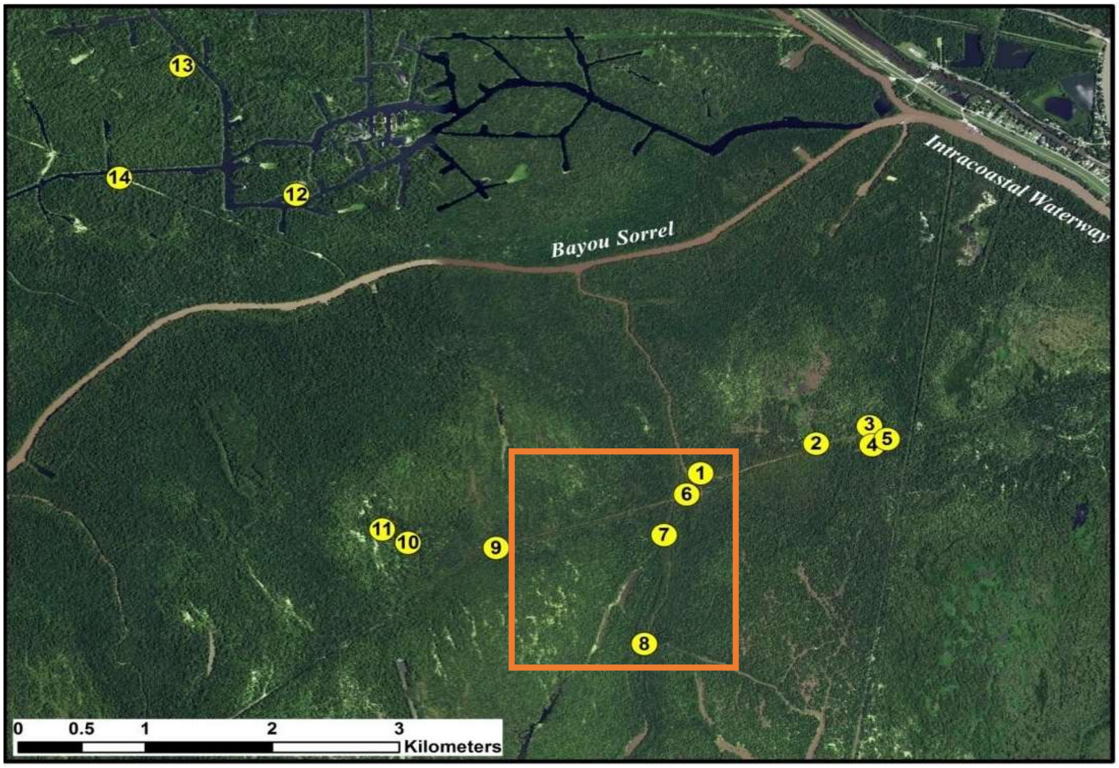

Figure 1. Location of Kong (2013) intensive sample sites. Review sites in orange box.

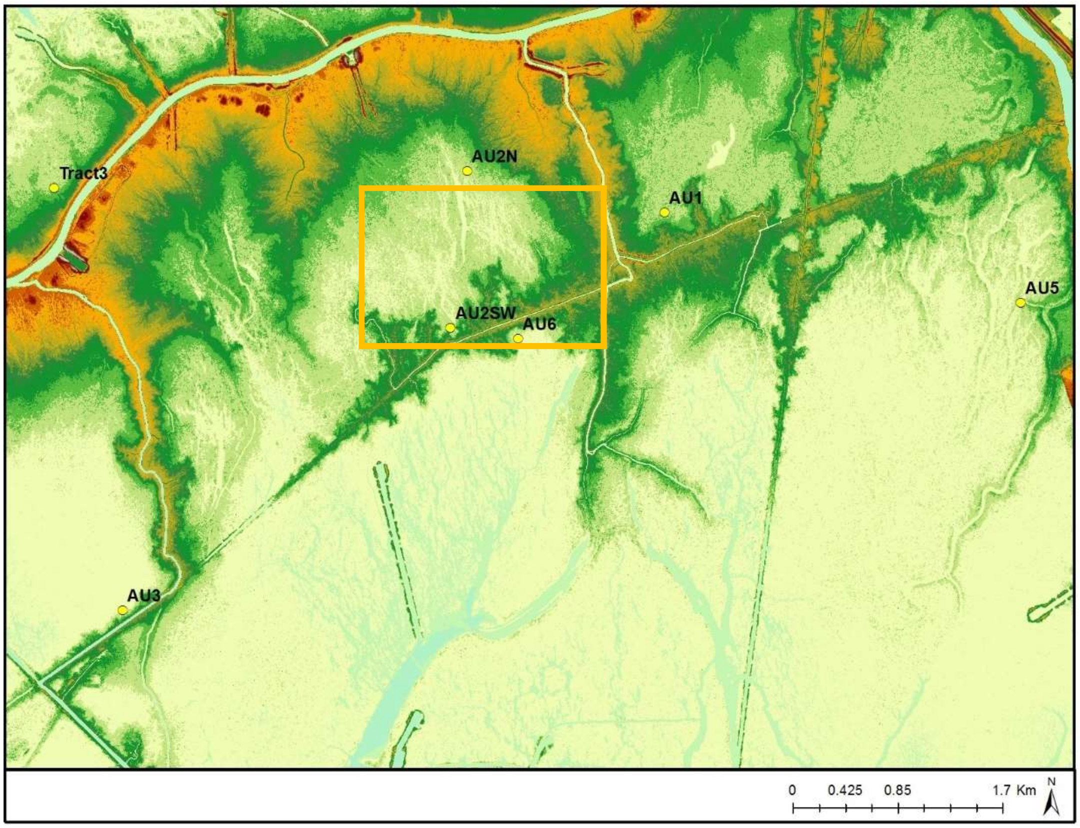

Figure 2. Location of TNC data sites (TNC Personal Comm.) Review sites in orange box.

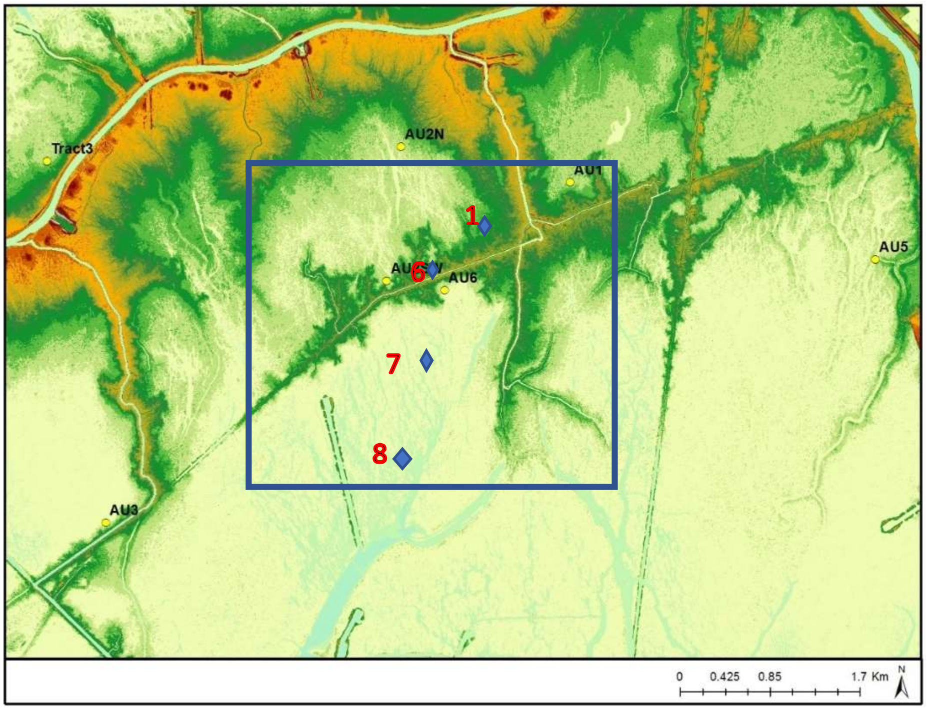

Figure 3. Four of Kong's 2016 sampling sites, namely sites 1, 6, 7, and 8, that are in the same region of the Basin as data collected by TNC at sites AU1, AU6, and AU2SW in 2017 and 2018. Note this is a LiDAR image and the richer the color the higher the elevations. Thus, all the TNC sites and Kong's 1, 6, and 7 are on the edges of levees all be they subaqueous, at higher elevations that the interior backswamp in this portion of the Basin. Kong's site 8 is more of a backswamp location.

resource managers in Louisiana, instead, wild crayfish harvest is determined by Atchafalaya River water level. The crayfish season began when the Atchafalaya River level at Butte La Rose, Louisiana (U.S. Army Corps of Engineers gauge 03120, 30°16'57" N, 91°41'17" W) was greater than 3.5 m, which resulted in floodplain inundation at intensive site locations."

So, Kong (2107) seems to be suggesting that the ground elevation, or perhaps the average ground elevation of her sites is 3.5 m or lower as relates to the Butte La Rose gauging station. There is no real or hard data to support her 3.5 m (11.48 ft) assertion. In discussion with commercial crawfishermen in the Basin I am told that they start commercial harvesting once the stage at Butte la Rose has exceeded 7.0 ft for a week. In their experience this overtopping takes about a week to fill the swamp so that they can get boat access. Generally, they need about 18 inches of water to move their boats to their trap sites. Thus, there is no scientific justification for Kong's 3.5 m assertion, none so ever . This is a major flaw of this study. She gives no indication whatsoever of the elevations of her sample sites other than water depths must have exceeded 18 inches for her to have boat access.

Figure 4 from Kong (2017) presents Butte la Rose daily water level stage data for 2016 and 2017 with her assumed 3.5 m 'line.' TNC however, do supply data from which make it possible to get a representation of the ground elevation at their sites. Figure 5 is their representation of the daily mean water stage for 2017 at Butte La Rose and Figure 6 represents mean daily water levels at their 7 monitoring sites for the same time period. TNC verbal communication via email 01/28/2019 informed that the water levels presented in Figure 6 are as follows; "The depth sensor on the Sonde (instrument) is about 15 cm off of the sediment surface, so these data … would be the water levels above the sensor, which is 15 cm above the soil surface." Thus, if one knows the river stage and one knows the water depth at each sample site; by simple subtraction and ten subtracting the instruments height above ground of 15 cms, one can get the elevation of each site as it relates to the datum used for the Butte La Rose gauging station. TNC (2017) state that Sonde water level data track the stage at Butte La Rose.

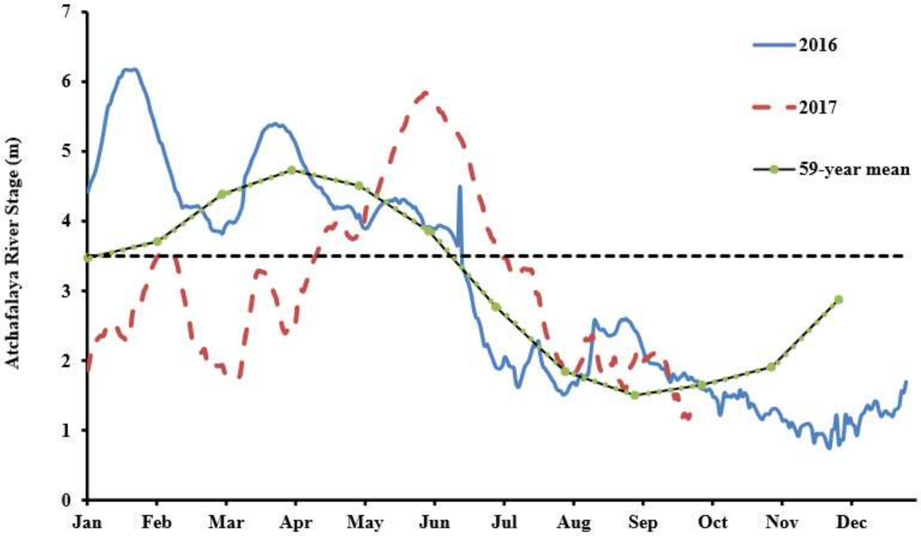

Figure 4. Daily Atchafalaya River stage at Butte La Rose, Louisiana (US Army Corps of Engineers gauge 03120) during the 2016 and 2017 sample years and the 59-year monthly mean. Also shown is the Kong 3.5 m line.

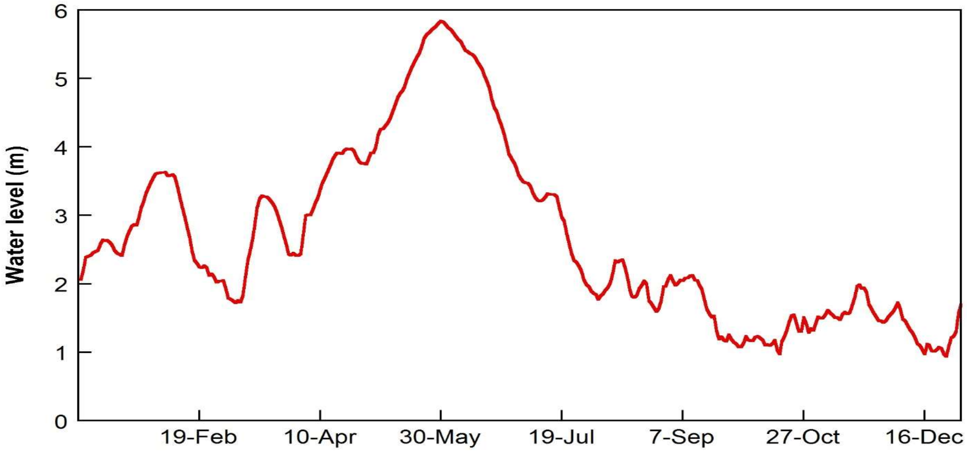

Figure 5. Daily mean water levels at Butte La Rose during 2017. Preliminary data from USGS gage 07381515 Atchafalaya River at Butte La Rose, LA (TNC 2017).

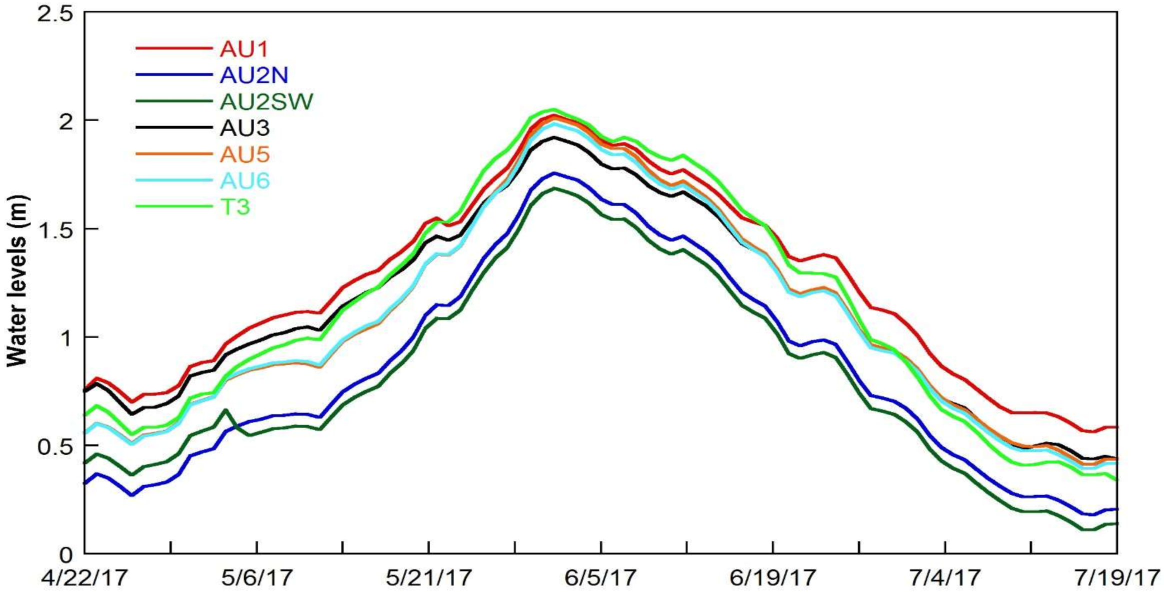

Figure 6. Daily mean water levels during the 2017 flood pulse at the seven TNC (2017) monitoring sites.

Doing the subtraction for the TNC sites AU1, AU6, and AU2SW gives a ground elevation for these sampling data sites and then calculating the average gives a ground elevation as relates to the Butte La Rose gauge datum of 2.47 meters (8.1 ft), which is 1.0 meter (3.28 ft) lower than the unscientific assumption made by Kong (2017).

So, we have the water levels during the sampling period based on the Butte La Rose gauge and we have a determination of the ground elevations. So now we can assess the water quality data against these known parameters; we can tell if the sites were receiving flood water at the time each was sampled.

Kong's Results

Figure 7 is a stage curve from Kong with the relevant elevations and the study period outlined. The only data that Kong (2017) presents for actual measurements over time at each of her sample sites is dissolved oxygen; all others she presents as means calculated for data collected at all 14 sites on the days sampled. This averaging in another flaw and includes two outlier clusters (Table 1). However, the DO data is useful (Figure 8). There are three very important features of Kong's DO plot as reveled in Figure 8. Firstly sites 3, 4, and 5 that form a cluster in the eastern edge of her study area reveal that through out the study period they did not experience hypoxia, the DO concentrations did not drop below the 2.0 mg/l level. We can ask why, but given the lack of GPS data and not knowing exact elevations and the proximity to a channel intersection suggests these three sites were not in a swamp or pond location, rather adjacent to a channel or a

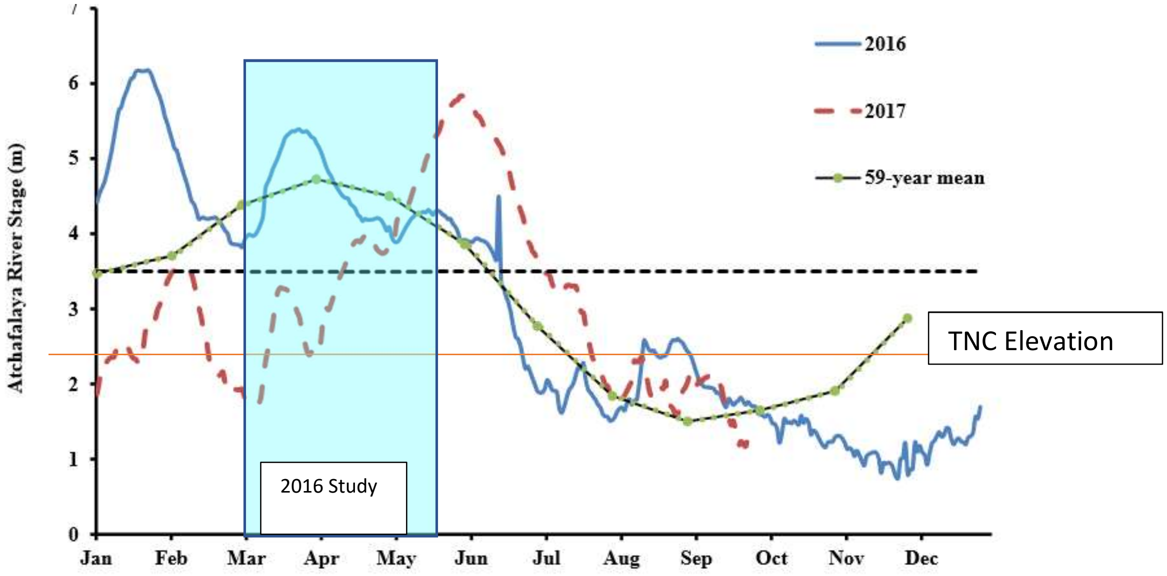

*Figure 7***.** *Daily Atchafalaya River stage at Butte La Rose, Louisiana (US Army Corps of Engineers gauge 03120) during the 2016 and 2017 sample years and the 59-year monthly mean. Also shown is the Kong 3.5 m line and TNC elevation of 2.47 m. Modified from Kong (2017).*

crossing of two channels. Sites 12,13,14 are distinctly separate from the rest of the sample sites being North of Bayou Sorrel (Figure 1). These sites appear to have experienced hypoxia the whole study period (Table 1).One of Kong's objectives was to determine if hypoxia was the result of a lack of flushing which seems to be interwoven into the thesis, then these outlier cluster data are a misfit and must be ignored. For the same reason, when these data are utilized to determine average or mean conditions for a sample date, they will skew the data away from the actual hypoxic condition at each site. Another major flaw of Kong's data presentation and conclusions is that in Figure 8 she assumes that every occasion that a sample falls in the hypoxic zone (Brown circles) that it means that the sample location became hydrologically disconnected. This will be shown not to be true.

<u>*Site 1.*</u>

The replot of the Kong data for Site 1 (Figure 9) reveals that for the full study period the site was flooded with at least 4.0 feet of water using a ground elevation determined for this site based on the TNC (2017) data. It was being flushed by Atchafalaya River flood waters. So, there was a hydrologic connection to a channel somewhere. If such is good for the system, then there is obviously something else going on that is driving down the oxygen levels as the flood progresses. If connectivity to a channel and flushing were healthy for this site, then The DO should remain above the hypoxic zone. Kong (2017) states categorically without any justification that there was no hydrologic connection from at least 04/29/2016 onwards! This is another major flaw of this thesis. The question at this site becomes what is driving down the oxygen concentrations as the flood progresses?

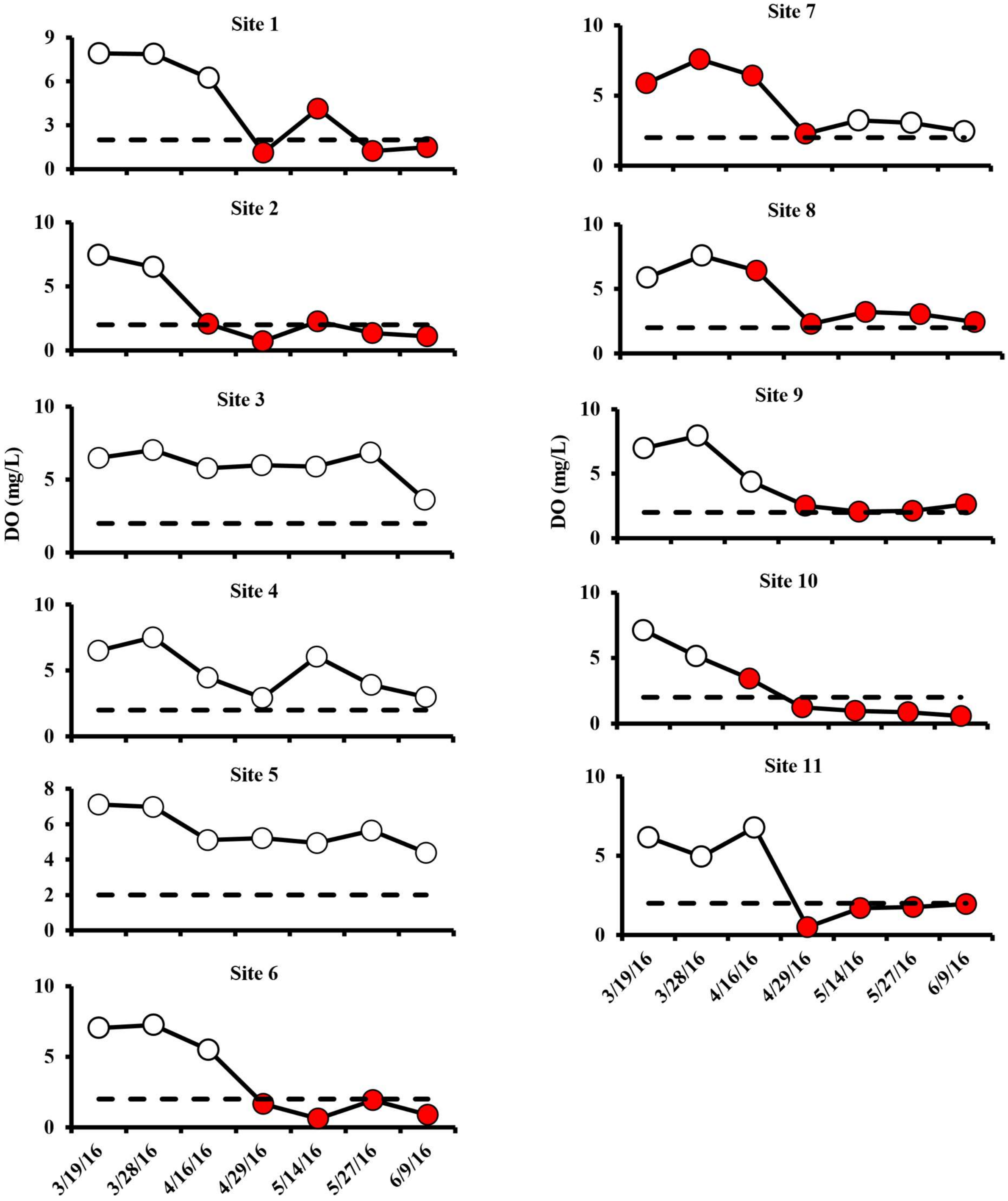

Figure 8. Dissolved oxygen (DO) concentration and hydrologic connectivity at Atchafalaya Basin Preserve sample locations during the 2016 sample season (Kong 2017). The red dots indicate when Kong assumes the site is hydrologically disconnected from flood water input.

Table 1. Mean (±SE) physicochemical parameters at intensive sample (*n* = 14) locations in the Atchafalaya Basin Preserve and adjacent state land from 19 March to 9 June 2016 (*n* = 7 sample dates) and 7 May to 3 July 2017 (*n* = 5 sample dates). Velocity and pH were only recorded in 2017.

	DO (mg/ L)		Temperature (°C)		Specific Conductance (mS/cm)		Secchi (cm)		pH	Velocity (cm/s)
Site	2016	2017	2016	2017	2016	2017	2016	2017	2017	2017
1	4.29 ± 1.16	3.24 ± 0.85	20.85 ± 1.29	23.60 ± 1.70	0.438 ± 0.089	0.423 ± 0.078	17.7 ± 0.6	30.6 ± 4.8	7.32 ± 0.08	0.009 ± 0.006
2	3.07 ± 1.03	3.27 ± 0.59	21.27 ± 1.23	23.83 ± 1.57	0.318 ± 0.061	0.361 ± 0.021	28.5 ± 5.4	41.2 ± 6.01	7.15 ± 0.09	0.054 ± 0.042
3	5.95 ± 0.43	5.07 ± 0.64	21.14 ± 1.20	24.40 ± 1.58	0.252 ± 0.030	0.341 ± 0.017	19.6 ± 2.8	39.4 ± 5.9	7.30 ± 0.05	0.051 ± 0.024
4	4.91 ± 0.68	3.40 ± 0.46	21.22 ± 1.22	24.45 ± 1.40	0.250 ± 0.025	0.347 ± 0.015	28.9 ± 4.0	51.6 ± 7.4	7.11 ± 0.06	0.183 ± 0.040
5	5.63 ± 0.39	4.36 ± 0.36	21.14 ± 1.25	24.37 ± 1.41	0.251 ± 0.029	0.347 ± 0.020	23.2 ± 2.6	47.2 ± 3.5	7.14 ± 0.03	0.301 ± 0.042
6	3.55 ± 1.11	3.39 ± 0.88	21.13 ± 1.24	24.16 ± 1.57	0.205 ± 0.017	0.275 ± 0.036	24.0 ± 2.7	29.4 ± 6.1	7.15 ± 0.10	0.035 ± 0.021
7	4.42 ± 0.81	2.88 ± 1.08	21.39 ± 1.20	24.61 ± 1.41	0.261 ± 0.022	0.372 ± 0.019	21.6 ± 3.5	36.0 ± 6.6	7.14 ± 0.11	0.030 ± 0.022
8	4.68 ± 0.75	3.67 ± 0.75	21.53 ± 1.30	24.48 ± 1.52	0.266 ± 0.028	0.367 ± 0.012	19.7 ± 2.8	35.4 ± 6.6	7.20 ± 0.08	0.051 ± 0.038
9	4.09 ± 0.92	3.89 ± 0.85	22.09 ± 1.21	24.41 ± 1.62	0.257 ± 0.023	0.337 ± 0.017	26.4 ± 4.5	46.4 ± 7.9	7.21 ± 0.08	0.026 ± 0.020
10	2.75 ± 0.96	1.68 ± 0.49	22.25 ± 1.40	24.19 ± 1.83	0.273 ± 0.030	0.371 ± 0.021	29.7 ± 4.3	51.0 ± 5.5	6.91 ± 0.08	0.005 ± 0.003
11	3.40 ± 0.94	3.24 ± 1.11	21.83 ± 1.29	25.16 ± 1.85	0.261 ± 0.029	0.361 ± 0.026	17.6 ± 2.3	32.8 ± 5.0	7.10 ± 0.09	0.006 ± 0.002
12	1.59 ± 0.33	0.53 ± 0.24	21.53 ± 1.04	23.97 ± 1.17	0.236 ± 0.012	0.325 ± 0.009	96.8 ± 11.6	91.8 ± 14.7	6.80 ± 0.03	0.016 ± 0.010
13	1.57 ± 0.38	0.58 ± 0.17	21.42 ± 1.01	24.13 ± 1.29	0.233 ± 0.015	0.324 ± 0.006	95.1 ± 19.3	121.8 ± 8.6	6.75 ± 0.06	0.021 ± 0.008
14	1.64 ± 0.41	0.63 ± 0.48	21.52 ± 1.06	23.71 ± 1.18	0.232 ± 0.012	0.318 ± 0.004	103.4 ± 16.7	111.0 ± 9.1	6.79 ± 0.07	0.021 ± 0.006

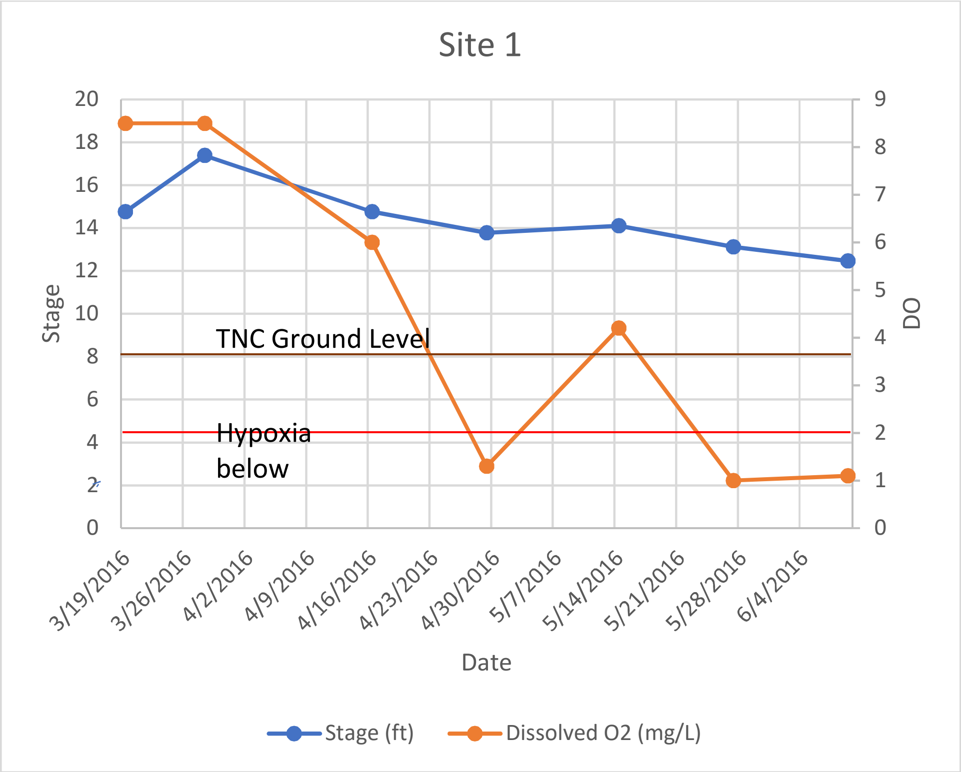

Figure 9. Plot of data from Kong (2017) of stage and DO over the time data was collected for Site 1. See Figure 7 for comparison.

Site 6.

The replot of the Kong data for Site 6 (Figure 10) reveals that for the full study period the site was flooded with at least 4.0 feet of water using a ground elevation determined for this site based on the TNC (2017) data. So, there was a hydrologic connection to a channel somewhere; it was receiving input of Atchafalaya floodwaters. If such is good for the system, then there is obviously something else going on that is driving the oxygen levels down as the flood progresses. If connectivity to a channel and flushing were healthy for this site, then The DO should remain above the hypoxic zone. Kong (2017) states categorically without any justification that there was no hydrologic connection from at least 04/29/2016 onwards. A major conclusion flaw by Kong (2017 - See Figure 8 for comparison). The question at this site becomes what is driving down the oxygen concentrations as the flood progresses?

Site 7.

The replot of the Kong data for Site 7 (Figure 11) reveals that for the full study period the site was flooded with at least 4.0 feet of water using a ground elevation determined for this site based on the TNC (2017) data. It was being flushed by Atchafalaya River flood waters. So, there was a hydrologic connection to a channel somewhere; Atchafalaya flood water was entering the area. If such a connection was ‘healthy,’ then what explains the driving down of dissolved oxygen concentrations as the flood progresses? There is obviously something else going on that is driving down the dissolved oxygen levels as the flood progresses. If connectivity to a channel and flushing were healthy for this site, then the DO should remain above the hypoxic zone. Kong (2017), in contrast to sites 1 and 6 above, that there was no hydrologic connectivity from before 03/19/2016 through 04/29/2016 – a reversal of the other sites and no connectivity while the flood pulse was peaking? Impossible – another major flaw by Kong (2017). The question at this site becomes what is driving down the oxygen concentrations as the flood progresses?

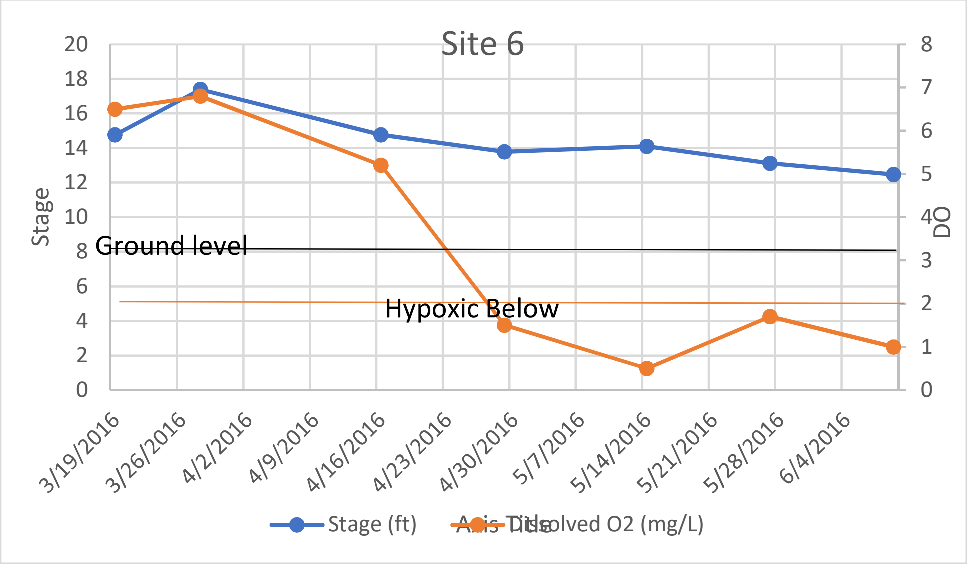

Figure 10. Plot of Kong (2017) stage and DO over the time data was collected for Site 6.

Site 8.

The replot of the Kong data for Site 8 (Figure 12) reveals that for the full study period the site was flooded with at least 4.0 feet of water using a ground elevation determined for this site based on the TNC (2017) data. It was being flushed by Atchafalaya River flood waters. So, there was a hydrologic connection to a channel somewhere. There is obviously something else going on that is driving the dissolved oxygen levels down as the flood progresses. If connectivity to a channel and flushing were healthy for this site, then the DO should remain above the hypoxic zone. Kong (2017) states categorically without any justification that there was no hydrologic connectivity from at least 04/16/2016 onwards. A major conclusion flaw by Kong (2017). The question again becomes what is driving down the dissolved oxygen concentrations as this flood progresses? Obviously, something else is driving down the DO concentrations as the flood progresses.

Note that Kong's Site 9 could have been included in this discussion. It would have mirrored the above sites.

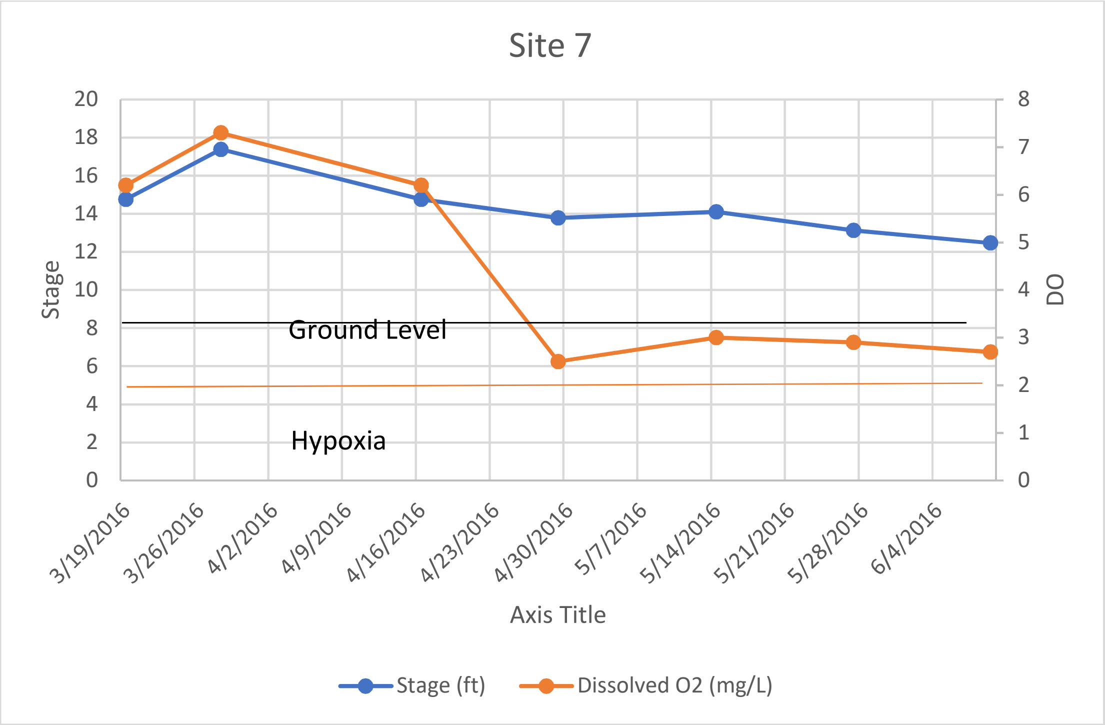

Figure 11. Plot of data from Kong (2017) of stage and DO over the time data as was collected for Site 7. See Figure 7 for comparison.

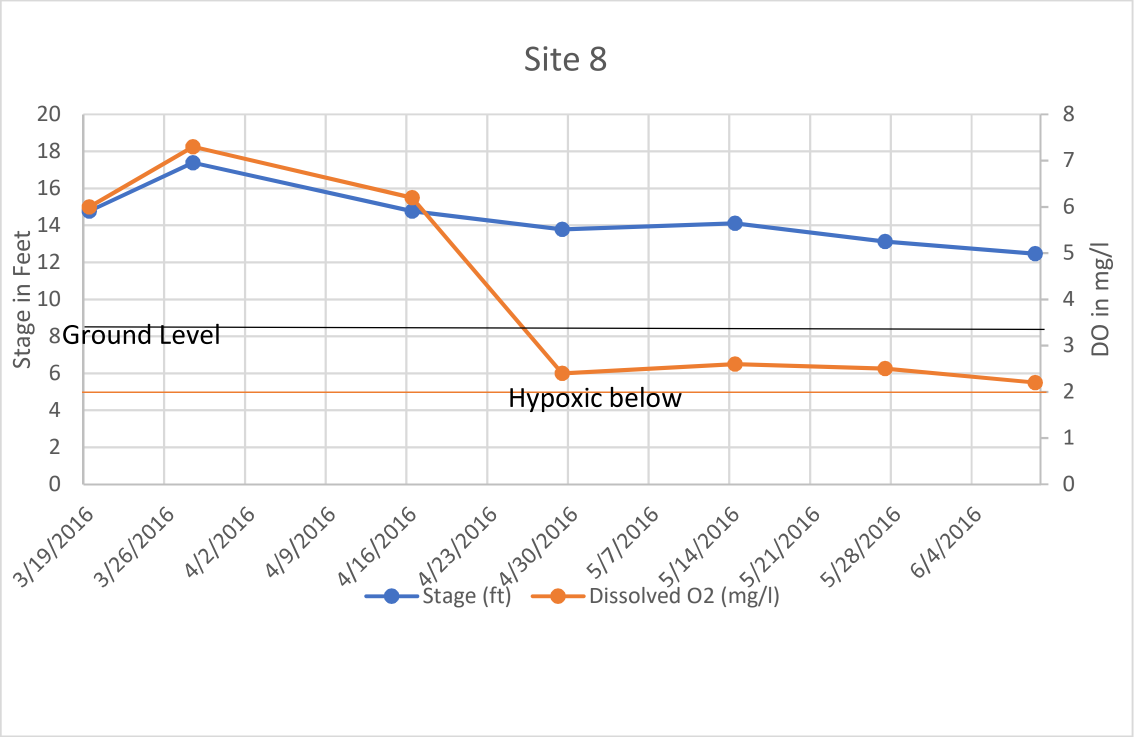

Figure 12. Plot of data from Kong (2017) of stage and DO over the time data as was collected for Site 8. See Figure 7 for comparison.

Turbidity and its role in DO abnormalities in the Atchafalaya Basin.

Turbidity the quality of being cloudy, opaque, or thick with suspended matter; it is “the measurement of turbidity is a key test of water quality"

Human population growth and its associated activities have altered landscapes, hydrologic cycles, and the flux of riverine constituents at accelerating rates over the last several centuries (Galloway and Cowling 2002). Significantly increasing loads of nutrients, particularly nitrogen and phosphorus, have found their way to the coastal ocean, especially during the last half of the 20th century (Figure 13). There are thresholds of nutrient loading above which the nutrient inputs no longer stimulate entirely positive responses from the ecosystem, such as increased fisheries production (Rabalais 2002). Instead changes in land-based sources of nutrients are leading to eutrophication of coastal waters with symptoms of poor water quality, noxious algal blooms, oxygen depletion, and, in some cases, loss of fisheries production (Rabalais et al, 2007). Eutrophication is becoming a major environmental problem in estuarine and coastal waters throughout the world (Nixon 1995), even in inner to mid-continental shelf waters (Rabalais 2005). Estuarine and coastal riverine systems with high water residence time such as the Atchafalaya Basin are susceptible to eutrophication, given adequate light conditions (Cloern 2001). In contrast, coastal ecosystems adjacent to large rivers with swift currents that move materials away from the river delta and that deter the development of stratification are not conducive to the accumulation of biomass or depletion of oxygen, for example in the Amazon River and Orinoco River plumes.

The Mississippi River forms the largest watershed on the North American continent. It discharges on average 580 km^3 of fresh water per year to the northern Gulf of Mexico through two main distributaries: the birdfoot delta southeast of the city of New Orleans, Louisiana, and the Atchafalaya River delta 200 km to the west that carries about one-third of the flow (Meade 1996; Fig. 1). The Mississippi River system discharges sediment yields of $210 * 10^6$ Mg/yr., $1.6 * 10^6$ Mg/yr. nitrogen, of which $0.95 * 10^6$ Mg is nitrate and $0.58 * 10^6$ Mg is organic nitrogen, $0.1 * 10^6$ Mg/yr. phosphorus, and $2.1 * 10^6$ Mg/yr. silica (Milliman and Meade 1983, Meade 1996, Goolsby et al. 1999). The coastal ecosystem is productive (~300 g Cm^2yr^1; Turner and Allen 1982, Lohrenz et al. 1990) and the location of the second largest zone of coastal hypoxia (defined here as dissolved oxygen <2 mg/L) in the world’s oceans (Rabalais et al. 2002).

Figure 13 aptly reveals the uncoupled relationship between the mean annual concentration of nitrate and silicate in the Mississippi River at New Orleans before 1975 and the coherent changes after 1980 (Rabalais 2007). In other words, mean annual concentration of nitrate and silicate in the Mississippi River at New Orleans were not linked in the pre-heavy use of industrial fertilizer in the Mississippi River’s catchment. Once commercial fertilizer use became wide spread the concentrations of these variables became linked, the suspended sediment of the Mississippi River (represented by the silica concentration), and nutrient loading became coupled. The suspended sediment in part is binding the nitrogen!

(1998).

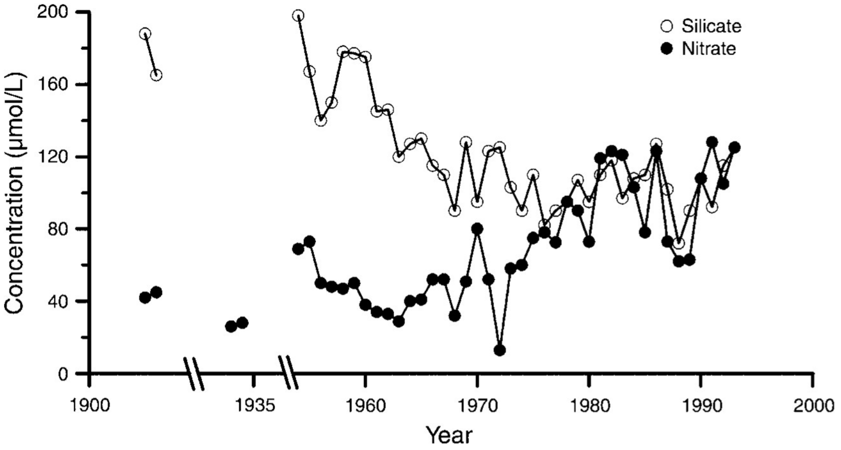

Figure. 13. The mean annual concentration of nitrate and silicate in the Mississippi River at New Orleans. Note the uncoupled relationship between the two variables before 1975 and the coherent changes after 1980 (Rabalais. 2007).

Welch et al (2014) present data related to nutrient loading of the Atchafalaya Basin during the 2011 flood, data that must be considered in evaluating the results presented in Kong's thesis. It is important to note that Welch et al only sampled main river channels and not any swamp sites. They point out that Nitrate composed about 70% of the total Nitrogen Flux and that there were no substantial losses or gains in the Atchafalaya or Lower Mississippi Rivers. But what happens to the nitrogen when it enters the still water of an interior swamp? It has nowhere to go so nitrogen loading of the swamp takes place – a cause of hypoxia. Welch et al (2014) point out that when suspended sediment fluxes increase, agricultural chemicals attached to sediment can be readily transported downstream and may further exacerbate water quality problems in receiving surface-water bodies (See also Figure 13). So, if you increase the discharge of suspended sediments into interior swamps you are going to exacerbate water quality problems and hence potential lowering of oxygen concentrations and hypoxia. Horowitz (2010) concludes that suspended sediments delivers about 85% of the annual phosphorous flux and 30% of the annual Nitrogen flux to the region.

Welch et al (2014) point out that as streamflow was decreasing in the 2011 flood in the Lower Mississippi River - Atchafalaya River sub basin, orthophosphate composed an increasing percentage of the total phosphorous concentration, probably because of return of waters low in oxygen concentration from stillwater areas such as inundated lands, backwater streams, and floodways. These poorly oxygenated waters promote the release of sediment-bound phosphorous into the more readily available dissolved form. So, the data collected by the USGS during the 2011 flood reveal that Atchafalaya River water entering a swamp had a low oxygen concentration that promoted the release of phosphorous. This is a double whammy – the waters that would have entered the interior swamps would have had low oxygen concentrations, and in addition, this condition would have enhanced the release of a nutrient, phosphorous. So instead of improving water quality, we are enhancing hypoxia! It is incredibly important that before one messes with the natural environment that one understands the consequences. For every action there is a reaction.

Kong's Turbidity Data

Kong (2017) used Secchi Disc readings as a measure of turbidity (Table 1). Such is an opaque disk, typically white, used to gauge the transparency of water by measuring the depth (*Secchi depth*) at which the disk ceases to be visible from the surface. If used correctly by the same viewer on all occasions it allows a relative assessment of turbidity as well as being able to give comparisons from one area to another or a time series of change over a given measurement cycle. The lower the number the more turbid the water. In non-turbid swamp stillwater and pond environments Secchi disc reading of a 100 cm are common, In the very turbid suspended sediment laden conditions Secchi disc readings can be as low as 10 cm.

Unfortunately, Kong (2017) only presents means (with standard deviations) for each of her 14 sites utilizing all the readings collected during her 4 months study in 2016 (Table 1). However, the means for the sites under consideration, namely 1, 6, 7, and 8, range from 17.7 to 24.0 cms – very turbid water. By comparison the other cluster mentioned previously, north of Bayou Sorrel, have Secchi disc readings ranging from 95.1 to 103.4 cm. This latter cluster of samples were taken in what is an impoundment because of spoil piles from oil and gas activities and pipelines that effectively seal off this area from freshwater inputs other than the annual rainfall. However, during major floods, this still water location will get some input of suspended sediments and associated nutrient loading. Not surprisingly, these still water areas are hypoxic, compounded in parts that there is an abandoned brine disposal site (and maybe some drilling mud) within the impoundment.

It is thus very easy to explain the impacts of allowing suspended sediment laden flood waters to enter swamp and pond environments, they bring in vast amounts of nutrients that result in a rapid lowering of oxygen concentrations from background levels and lead to hypoxia. Kong's data bears this out very clearly and raises questions about the viability of using channel cuts as a means to flush back swamp environments to improve water quality. This 2016 data set does not support this hypothesis as advocated by groups such as TNC.

One important management consequence of flooding back swamps with suspended sediment laden water that Kong (2017) did not consider is the infilling and eventual loss of these unique forested wetlands.

Crawfish Assessment

Kong (2017) sampled the *Procambarus clarkii* species of crawfish biweekly at her 14 fixed sites during the 2016 and 2017 crayfish seasons. Sex, reproductive form (males only), and standard carapace length were recorded for all captured individuals and catch per unit effort (CPUE) was determined as the number of crawfish per trap. Table 2 presents data on the mean and standard deviation of the carapace length (CL) and the catch per unit effort (CPUE). The data are graphed in Figure 14.

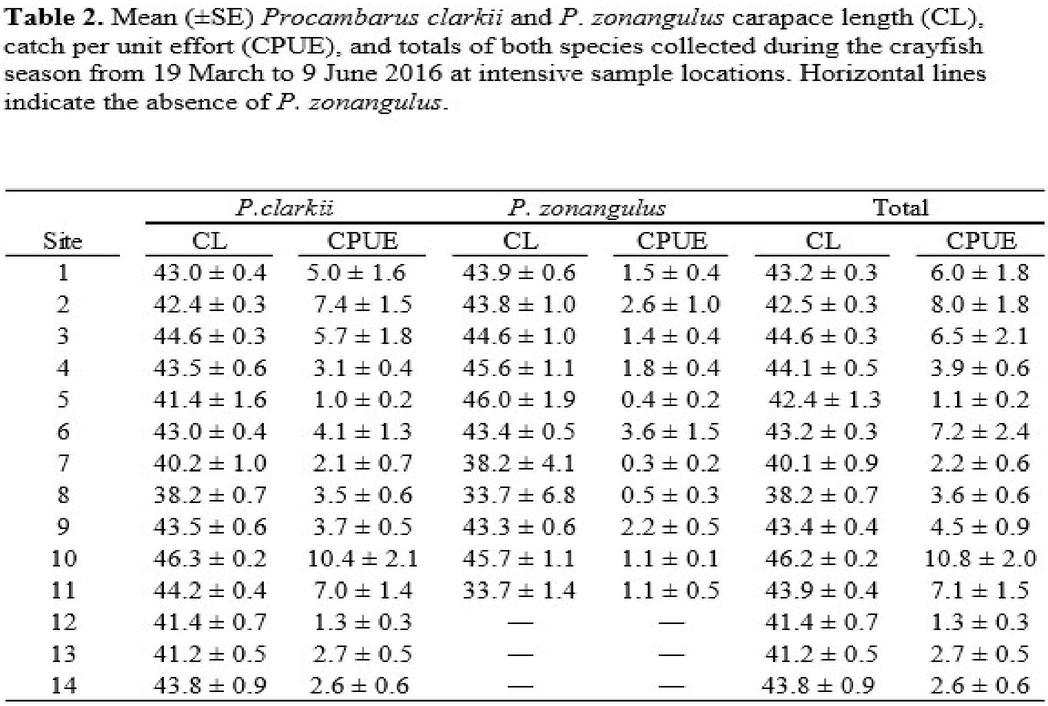

Table 2. Mean (±SE) *Procambarus clarkii* and *P. zonangulus* carapace length (CL), catch per unit effort (CPUE), and totals of both species collected during the crayfish season from 19 March to 9 June 2016 at intensive sample locations. Horizontal lines indicate the absence of *P. zonangulus*.

	P.clarkii		*P. zonangulus*		Total	
Site	CL	CPUE	CL	CPUE	CL	CPUE
1	43.0 ± 0.4	5.0 ± 1.6	43.9 ± 0.6	1.5 ± 0.4	43.2 ± 0.3	6.0 ± 1.8
2	42.4 ± 0.3	7.4 ± 1.5	43.8 ± 1.0	2.6 ± 1.0	42.5 ± 0.3	8.0 ± 1.8
3	44.6 ± 0.3	5.7 ± 1.8	44.6 ± 1.0	1.4 ± 0.4	44.6 ± 0.3	6.5 ± 2.1
4	43.5 ± 0.6	3.1 ± 0.4	45.6 ± 1.1	1.8 ± 0.4	44.1 ± 0.5	3.9 ± 0.6
5	41.4 ± 1.6	1.0 ± 0.2	46.0 ± 1.9	0.4 ± 0.2	42.4 ± 1.3	1.1 ± 0.2
6	43.0 ± 0.4	4.1 ± 1.3	43.4 ± 0.5	3.6 ± 1.5	43.2 ± 0.3	7.2 ± 2.4
7	40.2 ± 1.0	2.1 ± 0.7	38.2 ± 4.1	0.3 ± 0.2	40.1 ± 0.9	2.2 ± 0.6
8	38.2 ± 0.7	3.5 ± 0.6	33.7 ± 6.8	0.5 ± 0.3	38.2 ± 0.7	3.6 ± 0.6
9	43.5 ± 0.6	3.7 ± 0.5	43.3 ± 0.6	2.2 ± 0.5	43.4 ± 0.4	4.5 ± 0.9
10	46.3 ± 0.2	10.4 ± 2.1	45.7 ± 1.1	1.1 ± 0.1	46.2 ± 0.2	10.8 ± 2.0
11	44.2 ± 0.4	7.0 ± 1.4	33.7 ± 1.4	1.1 ± 0.5	43.9 ± 0.4	7.1 ± 1.5
12	41.4 ± 0.7	1.3 ± 0.3	—	—	41.4 ± 0.7	1.3 ± 0.3
13	41.2 ± 0.5	2.7 ± 0.5	—	—	41.2 ± 0.5	2.7 ± 0.5
14	43.8 ± 0.9	2.6 ± 0.6	—	—	43.8 ± 0.9	2.6 ± 0.6

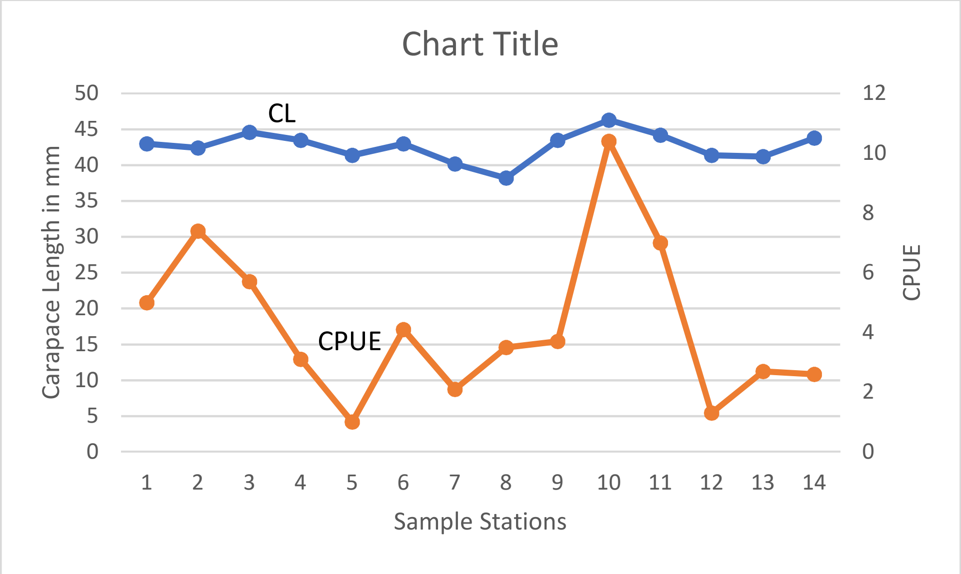

Figure 14. Graph of mean carapace length (CL) and mean catch per unit effort across Kong's study region for the duration of her 2016 study.

These data reveal that crawfish size across the study area, irrespective of each's DO footprint, are the same. It is obviously an age-related characteristic rather than one determined by environment. However, her CPUE reveal that in some hypoxic areas the abundance of crawfish is lower. There are some as yet unexplained spikes in her data. Unfortunately, she does not supply actual data collected on each sample date, which would allow a time-series review. Kong

(2017) does use a lot of statistical 'tests' to try to draw some conclusions as to what her data are indicting but given the fatal flaw of her 3.5 m assumption and at times indicating that there was no connectivity when the data show there was, places all this statistical assessment in question and the validity of her conclusions.

Conclusions

Although missing some of the specific data that Kong (2017) collected (i.e., individual sites did not list all data collected on each date, rather seasonal or location means were presented) the data still allow an assessment of the 2016 flood and its consequences in the Atchafalaya Basin. Specific conclusions are as follows:-

1. The 2016 flood mostly originated on the Missouri (largest tributary) and Missisppi Rivers and as such the Atcahafalaya River would have had significant suspended sediment loads, as compared if the major flood had been from the Ohio River. Thus, floodwaters that would have overflowed river levees and utilized man-made channels and pipeline conduits would carry suspended sediment into these areas.
2. Kong had an apparent major flaw in her study related to a 3.5 m ground elevation estimation. Utilizing data from the TNC allowed the determination of a very represenataive ground elevation at the various study sites. This becomes critical when reviewing the dissolved oxygen data presented by Kong (2017).
3. The sample sites chosen for this evaluation were done so to try to compare her data with that being collected by TNC (Kong sites, 1, 6, 7, and 8). At all these sites she assumes that when low oxygen or anoxic conditions are present that it meant that hydrologic connections to the flooding River and Bayou Sorrel were disconnected; in other words, there was no 'fresh' flow entering her sites. This is a major flaw in this study. At all times that these sites had at least 4.0 feet of flow over ground. The low oxygen concentrations towards the end of the flood as presented by Kong (2017) are not a hydrologic connection issue.
4. Rather, one needs to consider the impacts of suspended sediment and nutrient loading associated with the Atchafalaya floodwaters to explain the lowering of oxygen levels. Fortunately, she does supply some Secchi disc turbidity data that support the conclusion that dropping dissolved oxygen concentrations and resultant hypoxia are a consequence of nutrient load associated with suspended sediment inputs.
5. Kong's data reveal that crawfish size across the study area, irrespective of each's DO footprint, are the same. However, her CPUE reveal that in some hypoxic areas the abundance of crawfish is lower. There are some unexplained spikes in her data. Her statistical study is invalid given some of her assumptions.

As concerns the management of the Basin, this 2016 flood data from Kong 2017 thesis does not support opening or cutting cuts in channel banks and trying to flush swamps with suspended sediment laden flood waters. These actions lead to hypoxia.