MEMORANDUM

To: Cyndhia Ramatchandirane, Erin Gaines, and Mike Brown, Earthjustice

From: Dr. Terence Palmer

Re: Summary of my opinions relating to the proposed onshore pipeline for the Blue Marlin oil export project

Date: September 21, 2021

---

1. Summary of credentials

I am an Assistant Research Scientist at the Harte Research Institute for Gulf of Mexico Studies (HRI) at Texas A&M University-Corpus Christi (TAMUCC), where I have worked since 2006. Most of my time at HRI has been spent conducting scientific investigations of estuaries and coasts along the length of the Texas coast, although I have conducted investigations on seafloor habitats on both coasts of Florida, in Louisiana, and in the Gulf of Mexico (including relating to the Deepwater Horizon spill). I have also been involved in marine environmental monitoring at McMurdo Station, Antarctica for twelve years, leading the sampling and data analysis for most of those years. I have a diverse range of research interests within estuarine and marine habitats. Notably, most of my research involves studying the effects of humans on water quality and benthic organisms, including oysters in Gulf of Mexico estuaries such as Sabine Lake on the border of Texas and Louisiana. My role at HRI reflects my broad range of interests, and wide-ranging skills and knowledge. In addition to my on-the-ground field experience in all major estuaries along the Texas coast, much of my time is also spent mentoring graduate students, conducting statistical analyses, and scientific writing. Evidence of my success are the 38 peer-reviewed scientific journal articles that I have authored or co-authored (see CV in Attachment A). These articles are relevant and pertinent to the proposed Blue Marlin onshore pipeline project as they all address anthropogenic disturbances, benthic organisms, and/or estuarine environments.

My specific work history related to this project includes conducting research on oyster reefs in Sabine Lake, studying anthropogenic effects on Gulf Coast estuarine habitats more broadly for many years, and having a sound knowledge of estuarine processes and sea-floor ecology, especially related to oyster reefs.

2. Documents reviewed for this submission

To inform my comments below, I reviewed the following documents:

- Portions of the Blue Marlin Joint Permit Application (JPA) to the Louisiana Department of Natural Resources pertaining to the onshore pipeline crossing Sabine Lake
- Portions of the Blue Marlin application to the Maritime Administration (MARAD) to construct a deepwater port pertaining to the onshore pipeline crossing Sabine Lake
- The comment letter submitted by Earthjustice and Healthy Gulf to the Louisiana Department of Natural Resources (LDNR) related to the Coastal Use Permit dated July 6, 2021

- The comment letter submitted by the Louisiana Department of Wildlife and Fisheries (LDWF) to the Louisiana Department of Natural Resources (LDNR) related to the Coastal Use Permit dated July 7, 2021

3. Summary of conclusions

- Oysters and oyster reefs in Sabine Lake are distinctive because they are unfished, unlike most places in the world.
- A unique and productive community of fishes and invertebrates inhabit the subtidal oyster reefs in Sabine Lake.
- Oysters provide many quantifiable economic benefits (e.g., oyster filtration) in addition to their commercial market value.
- Oysters and oyster reefs will likely be impacted from direct burial of oysters, reduction in filter-feeding and respiration efficiency from suspended sediments, and the inability of oyster larvae to settle and grow new oysters.
- The largest obstacle to the recovery of oyster reef in the proposed pipeline area is the loss of hard substrate for new oysters to settle and grow
- The Sabine Lake estuary floor is directly and indirectly relied upon by recreationally and commercially important fish and invertebrates (e.g., shrimp and blue crabs).
- The recovery time from the direct and indirect destruction of oysters and soft sediment communities by dredging and dredge placement, excess suspended sediment, and oil spills can take decades.

4. Impacts of concern from the proposed onshore pipeline crossing Sabine Lake

4.1. Harm to important Sabine Lake aquatic habitats

4.1.1. Oysters/oyster reef

Oyster reefs are ecosystem engineers that provide many useful functions, such as unique habitat for resident benthic[1] and nekton[2] communities, prey for recreationally and commercially important fish species, water filtration, habitat stabilization and carbon sequestration (see Nevins et al. 2014, p227). However, oyster reefs are among the most degraded habitats on Earth, with an estimated global loss of 85% (Beck et al. 2002). Oyster reefs along the Texas and Louisiana Gulf coast have suffered from overfishing, habitat destruction, changing climate conditions, pollution, freshet events[3], storm impacts, etc. Oyster populations in northern Texas estuaries, particularly Galveston Bay, are in the worst condition of all Texas estuaries that contain oysters because of overharvest and changes in water quality (HRI 2019). Louisiana oyster reefs have also been degraded by natural and man-made disturbances, such as hurricanes and overharvest (Gelpi 2019). Both Texas and Louisiana oyster reefs are suggested to be in

[1] Occurring on the bottom of a body of water, e.g., clams, worms
[2] Organisms, such as fish, that can move independently of currents
[3] A flood of freshwater in a brackish or saline water body such as Sabine Lake

the greatest danger of degradation of all North American states (Kirby 2004, p13099) so need to be carefully managed.

Oyster reefs in Sabine Lake are unique amongst all North American oyster reefs in that they have not been harvested for at least 100 years (Gelpi 2019). As such, oyster reefs in Sabine Lake are less fragmented, contain larger oysters and greater mussel densities than comparable fished Louisiana oyster reefs (Beck and La Peyre 2015, p333). Unfished oyster reefs at Sabine Lake also have greater environmental services because they have higher relief and more structurally complex habitat for fish and invertebrates, greater sediment stabilization, higher filtration rates, and increased nitrogen regulation than fished reefs (see Nevins at al. 2014, p235).

According to the geotechnical surveys provided in Blue Marlin's MARAD application, approximately 57 acres of oyster reef[4,5] will be destroyed (converted to soft-bottom habitat) from the construction of the onshore pipeline, specifically during the side-casting and trenching process, which involves the displacement of approximately 1,073,231 cubic yards of sediment.[6] The destruction of oyster reef from the construction of a pipeline like Blue Marlin can occur directly from the burial of oysters and loss of hard substrate, and indirectly from the reduction in filter-feeding and respiration efficiency from suspended sediments and the inability of oyster spat[7] to settle, which can occur with as little as 1-2 millimeters (0.04-0.08 inches) of sediment deposition (Wilber and Clarke 2010). The loss of any acreage of oyster reef in Sabine Lake is concerning because of the overall degradation of oyster reefs in the region, the unique nature of these reefs, and the many ecosystem services they provide.

The largest obstacle to the recovery of oyster reef in the proposed pipeline area is the loss of hard substrate for new oysters to settle and grow. This loss would be exacerbated by the lower salinity conditions in this area of the lake relative to other areas closer to the mouth of Sabine Lake and areas in other Gulf of Mexico estuaries because the low salinities can inhibit recruitment, survival, and growth of oysters (La Peyre et al. 2013). The presence of live oysters have been demonstrated to facilitate oyster recruitment better than areas with no live oysters (Atwood and Grizzle 2020), which is another reason why the loss of live oysters will slow recruitment and replacement.

4.1.2. Other aquatic organisms (fish, invertebrates, other)

Aside from containing possibly the largest unfished oyster reef in North America (Moore 2008), Sabine Lake oyster reefs provide refuge for a unique assemblage of fauna (Nevins et al. 2014, p235) that contains more species and overall abundances than the subtidal areas away from the reefs (Gelpi 2019). Sabine Lake is also rich with several commercially and recreationally important species including red drum, Atlantic croaker, spotted sea trout, white shrimp, brown shrimp, and blue crab. Two of these

---

[4] 45.3 acres of buried shells, shell hash, or reef, and 11.5 acres of exposed shell were identified within the survey area of 500 feet and 1500 feet of the proposed pipeline in Texas and Louisiana waters, respectively. Ground truthing was not conducted; therefore, accurate live and dead oyster density estimates within both of the 45.3- and 11.5-acre areas are unknown.

[5] Blue Marlin, Deepwater Port License Application, Vol. IIb, TR04, Aquatic Resources, at p. 4-6 (Table 4-2) (Sep. 2020), *available at* https://www.bluemarlinnepaprocess.com/.

[6] Blue Marlin, Deepwater Port License Application, Volume IIa – App. D, Essential Fish Habitat Assessment at p. 6-43 (Table 6-1) (Sep. 2020), *available at* https://www.bluemarlinnepaprocess.com/.

[7] Larvae that have permanently attached to a surface, e.g., another oyster shell.

species (white shrimp [*Litopenaeus setiferus]* and inland silverside [*Menidia beryllina*]) are more common in Sabine Lake than most other Texas estuaries (Fujiwara et al. 2019).

Direct and indirect impacts of the dredging from the side-casting and trenching process will destroy both soft-sediment and oyster habitats, which will in turn reduce food resources for the important fish and invertebrate species in Sabine Lake. The dumping and excavation of sediment on the estuary floor will destroy benthic invertebrate communities, which are composed of sedentary or sessile species. Death of soft-sediment benthic invertebrates has been documented in as little as 2 centimeters (0.8 inch) of sediment in estuarine environments (Thrush et al. 2004).

Therefore, even though the important fish species are motile and can largely avoid the proposed impacted area, they directly or indirectly feed on benthic fishes and invertebrates that occupy oyster reefs and/or soft sediment habitats and thus will be harmed by the loss of oyster reef and soft sediment habitats in Sabine Lake. For example, changes in the abundance of three predatory fish (spotted seatrout, red drum, and southern flounder) along the Texas coast are associated with changes in shrimp populations (Fujiwara et al. 2016), which feed on benthic invertebrates.

Sabine Lake is dominated by soft-sediment communities, where the three most dominant macroinvertebrate fauna (50% of total) include *Balanus* sp. (barnacles), *Streblospio benedicti* (polychaete worm), and *Rangia cuneata* (clam; Calnan et al. 1981). Barnacles are associated with hard substrates (e.g., oyster reefs), but both *Streblospio* and *Rangia* are associated with soft sediment environments. The recovery of soft sediment communities in Corpus Christi Bay, Texas that were subjected to dredge spoil being deposited on them was approximately one year (Wilber et al. 2008). However, changes in sediment grain size, which often occur after dredging, can lead to a slower recovery because invertebrate communities are often associated with different sediment types (Gray 1974) and the physical recovery of sediment can take years. Some opportunistic soft-sediment species, such as *Streblospio benedicti*, occupy both Corpus Christi Bay and Sabine Lake, and would be expected to recover at a similar rate in both locations. However, the recovery of the entire benthic community in Sabine Lake will take longer than in Corpus Christi Bay because Sabine Lake contains more abundant long-lived species (e.g., Rangia, oysters, barnacles) than Corpus Christi Bay, which is dominated by short-lived opportunistic soft sediment communities. Common, long-lived species in Sabine Lake, such as *Rangia cuneata*, take several years to recover. A common age of Rangia collected from Sabine Lake by Black and Heaney (2015) was determined to be 6-9 years old. Rangia are important because they are consumed by many fish and invertebrates, such as blue crabs, black drum, spot, and blue catfish (LaSalle and de la Cruz 1985).

Therefore, the loss of oyster reefs, soft sediment habitats, and benthic organisms in Sabine Lake from dredging will harm recreational and commercially important fish species and even with mitigation of these impacts, the recovery could take several years. This disruption may in turn affect local recreational and commercial fishermen.

4.2. Oil spill impacts in Sabine Lake

With up to 2 million barrels per day transported across the lake and the potential risk of oil spills, the oil spill impact on Sabine Lake can be substantial because hydrocarbons are often persistent, are toxic to fauna, and can take years to decades to recover in estuarine systems. Polycyclic aromatic hydrocarbons

(PAHs)[8] and other contaminants are known to accumulate in bivalve mollusks, e.g., mussels and oysters (Pittinger et al. 1985, Sericano et al. 1995, Sanders 1995). Deep sea recoveries from the Deepwater Horizon (DWH) spill have been estimated to range from years to decades depending on the community size and taxa group (e.g., microbes, corals, macrofauna, demersal fishes; Schwing et al. 2020). The DWH spill had negative effects on the heavily oiled marshes of Barataria Bay, LA, which will likely last for decades (Turner et al. 2019). PAH concentrations increased in seafood (e.g., fishes, shrimps, crabs, and oysters) after the DWH spill, with PAH concentrations being shown to inhibit shrimp growth and blue crab larvae survival, and was toxic to amphipods (crustaceans; see Beyer et al. 2016). Managing any potential oil spill in Sabine Lake would be difficult, as proved in Barataria Bay after the DWH spill. In an effort to avoid negative effects from DWH-derived coastal oiling, authorities chose to flood Barataria Bay with Mississippi River freshwater, but this prolonged exposure to freshwater was detrimental to species, such as oysters and periwinkles, that are sensitive to sudden changes in salinity (Murawski et al. 2020). This example is important because it shows that in the case of an oil spill in Sabine Lake, it would be difficult to mitigate the spill effects; a freshwater release into Sabine Lake could also have a similar detrimental effect to similar species.

4.3. Oyster Mitigation conditions

The LDWF submitted several, potential mitigation conditions for the project in a July 2021 letter. First, I note that the LDWF letter does not recommend mitigation for the other aquatic resources that will be harmed by this project, such as fish and invertebrates (see Section 4.1.2 above), mitigation for oil spill impacts (see Section 4.2 above), or post-construction impacts.

For oysters, taken alone, the conditions are not sufficient to assure that the applicant would fully compensate for the loss of oyster resources from the project. For one, as outlined in Section 4.1.1, Sabine Lake's oyster reefs are unique, because they are about 100 years old, unfished, and provide more environmental services than fished reefs. LDWF's mitigation conditions refer to compensation for damage to "oyster seed grounds," seemingly referencing areas whose purpose it is "to provide oysters for transplanting to leased water bottoms for cultivation" (Banks et al. 2016, p48). The conditions do not explain how they would account for the loss of unique habitat in Sabine Lake specifically. In addition, the mitigation measures would allow the applicant the option to pay into the "Public Oyster Seed Ground Development Account," rather than perform onsite or nearby mitigation. It is not clear from this condition whether LDWF would spend these Account funds to repair damages to Sabine Lake's unfished reef, or whether the funds might instead be spent on building habitat in other parts of the state that may not have the same ecological value.

The oyster mitigation conditions outlined by the LDWF, especially condition number two, also includes an option for mitigation based on planting cultch relative to the density of oysters impacted. The three-tiered approach, whereby three different volumes of cultch are planted based on three general categories of oyster density impacted, appears to be appropriate conceptually. However, it's unclear whether the amount of cultch matches the amount of hard substrate and live oysters that will be lost. It is important to at least replace the same three-dimensional structure (especially height) of the impacted reef, rather than just a thin layer of hard substrate during any mitigation efforts. Even if the agencies

[8] A harmful group of pollutants found in fossil fuels, including crude oil, that can cause cancer in humans and have "toxic effects, such as immunotoxicity, embryonic abnormalities, and cardiotoxicity, for wildlife including fish, benthic organisms, and marine vertebrates" (Honda and Suzuki 2020).

were to assume, inappropriately in this instance, that Sabine Lake's reefs should be treated the same as fished or seed-ground reefs, they still would need to require more cultch to replace the value of lost habitat. In my experience along the Texas coast, depositing shell or other cultch material approximately 12" high uniformly along the bottom will successfully allow a reef to rapidly restore itself, presuming that there is minimal cultch sinking (as occurs in muddy or silty substrates), the water quality remains appropriate, and there is sufficient spat in the water column. However, Texas Parks and Wildlife Department biologists overseeing oyster restoration efforts claim to have created successful harvestable oyster reef[9] after creating reef uniformly only 3" high. Creating a reef 3" high will require at least 3" deep of cultch deposited, with more cultch being needed if the material sinks because of muddy or silty underlying sediment. Regardless of whether you use what I consider appropriate (12" high), or what TPWD biologists consider suitable (3" high), the volume of cultch material required by LDWF for reef areas (187 cubic yards per acre; average 1.4" vertical deposition) is insufficient to restore living oyster reefs. The agencies instead should require that between 403 cubic yards per acre (3" high with no cultch sinking) and 1613 cubic yards per acre (12" high) to restore dense oyster reef, or even more cultch material if the existing oyster reef is of greater height than 12". An alternative approach to creating a flat layer of cultch used by TPWD in Sabine Lake (in 2014 and 2020) and Aransas Bay in 2020 is to create unharvestable mound reefs 24" high[10]. The success of this approach is unknown or not well documented[11] but that approach still uses more than twice as much cultch (436 cubic yards per acre) as recommended by LDWF (187 cubic yard per acre). LDWF does not define "supportive area" and "reef area", but they should ensure that the areal extent of the new added substrate is larger than the area of hard substrate destroyed to ensure the recovery of the lost oysters and reef habitat.

Finally, neither the payment in lieu option nor the planting of cultch option proposed by LDWF includes mitigation for the loss of ecosystem services from the oyster reefs. For the payment option in lieu of planting culch material, LDWF appears to set the replacement value of oyster reefs based on the cost of replacing the cultch plus, for live oysters, the three-year average of their market price (LDWF2019). LDWF must instead set the replacement value of a live oyster at the market price, plus the value of the ecosystem services that they provide, such as for the 50 gallons per day that an oyster can filter. For the planting of cultch option, even if the amount of cultch were appropriate, it does not account for the lost ecosystem services of the reefs while the reef is recovering, which as noted above, could take several years because of the low salinity levels in Sabine Lake. Indeed, intact oyster habitat as well-preserved as Sabine Lake's provides significant economic value that the applicant would need to compensate to fully mitigate the project's impacts. Oyster reefs generate $2,200-$40,000 per acre in the form of enhanced water quality, shoreline protection, seagrass populations, and recreational fishing (Grabowski et al. 2012). Oyster reefs can also increase fish and crustacean production by $4,123 per hectare per year (Peterson et al. 2003; Grabowski and Peterson 2007). Oyster reef benefits to recreational fishing are estimated at $2 million (Henderson and O'Neil 2003). In Texas, a 57-acre restored oyster reef in Matagorda Bay is estimated to provide annual economic benefits of $691,000 to Texas' GDP and $1.273 million in overall economic activity (Carlton et al. 2016). Failing to include these significant ecological

[9] Comparable to unrestored reef
[10] Mounds 10' in diameter and 2' high, spaced 10' apart from each other.
[11] I am currently participating in a scientific study comparing mounded and flat reef types in Aransas Bay, which will likely be finished in 2022.

benefits of live oysters in the state's damages calculation would mean that the state could lose value in allowing destruction or harm to this resource.

References

Atwood R.L. and R.E. Grizzle. 2020. Eastern Oyster Recruitment Patterns on and Near Natural Reefs: Implications for the Design of Oyster Reef Restoration Projects. *Journal of Shellfish Research* 39(2): 283-289. https://doi.org/10.2983/035.039.0209

Banks, P., S. Beck, K. Chapiesky and J. Isaacs. 2016. Louisiana Oyster Fishery Management Plan, Louisiana Department of Wildlife and Fisheries, Office of Fisheries https://www.wlf.louisiana.gov/resources/category/marine-fishery-management-plans/oyster

Beck, S. L., and M. La Peyre. 2015. Effects of oyster harvest activities on Louisiana reef habitat and resident nekton communities. *Fisheries Bulletin* 113: 327–340. https://doi.org/10.7755/FB.113.3.8

Beyer, J., H.C. Trannum, T. Bakke, P.V. Hodson, T.K. Collier. 2016 Environmental effects of the Deepwater Horizon oil spill: a review. *Marine Pollution Bulletin*, 110(1): 28-51, https://doi.org/10.1016/j.marpolbul.2016.06.027

Black, B.A. and M. Heaney. 2015. Rangia Clam Investigations. Report to: Texas Water Development Board, Austin, TX, Contract # 140001711, August 2015

Calnan, T., R. Kimble, and T. Littleton. 1981. Distribution of benthic macroinvertebrates-Beaumont-Port Arthur area. Bureau of Economic Geology, The University of Texas at Austin, TX. Available online at: http://www.beg.utexas.edu/files/publications/cr/CR1981-Calnan1_QAe6854.pdf .

Carlton, J.S., A. Ropicki and B. Balboa. 2016. The Half Moon Reef Restoration: A Socioeconomic Evaluation. Texas Sea Grant Publication TAMU-SG-16-211. https://texasseagrant.org/publications/2016-publications.html

Fujiwara, M., Martinez-Andrade, F., Wells, R.J.D. et al. 2019. Climate-related factors cause changes in the diversity of fish and invertebrates in subtropical coast of the Gulf of Mexico. *Communications Biology* 2: 403. https://doi.org/10.1038/s42003-019-0650-9

Fujiwara, M., C. Zhou, C. Acres, and F. Martinez-Andrade. 2016. Interaction between penaeid shrimp and fish populations in the Gulf of Mexico: importance of shrimp as forage species. *Plos ONE* 11(11): e0166479. https://doi.org/10.1371/journal.pone.0166479

Grabowski, J.H., R.D. Brumbaugh, R.F. Conrad, A.G. Keeler, J.J. Opaluch, C.H. Peterson, M.F. Piehler, S.P. Powers and A.R. Smyth. 2012. Economic Valuation of Ecosystem Services Provided by Oyster Reefs, BioScience, 62(10): 900–909, https://doi.org/10.1525/bio.2012.62.10.10

Grabowski, J.H. and C.H. Peterson. 2007. Restoring oyster reefs to recover ecosystem services. Pages 281–298 in Cuddington K, J.E. Byers, W.G. Wilson and A. Hastings, eds. Ecosystem Engineers: Plants to Protists. Elsevier. https://doi.org/10.1016/S1875-306X(07)80017-7

Gray, J.S. 1974. Animal-sediment relationships. *Oceanography and Marine Biology: An Annual Review* 12: 223–261.

Gelpi, C. 2019. The History and Ecological Value of the Sabine Lake Oyster Reef. *Texas Saltwater Fishing Magazine*

Harte Research Institute for Gulf of Mexico Studies (HRI). 2019. Texas coast ecosystem health report card. Harte Research Institute for Gulf of Mexico Studies, Texas A&M University-Corpus Christi https://www.harte.org/project/texas-coast-ecosystem-health-report-card

Henderson J. and L.J. O'Neil. 2003. Economic Values Associated with Construction of Oyster Reefs by the Corps of Engineers. US Army Engineer Waterways Experiment Station, Engineer and Research Development Center. Technical Note no. ERDC TN-EMRRP-ER-01 https://erdc-library.erdc.dren.mil/jspui/handle/11681/4023

Honda, M. and N. Suzuki. 2020. Toxicities of Polycyclic Aromatic Hydrocarbons for Aquatic Animals. *International Journal of Environmental Research and Public health* 17(4): 1363. https://doi.org/10.3390/ijerph17041363

Kirby M.X. 2004. Fishing down the coast: historical expansion and collapse of oyster fisheries along continental margins. *Proceedings of the National Academy of Sciences of the United States of America* 101(35): 13096–13099. https://doi.org/10.1073/pnas.0405150101

Kuhn, N.L. and G. Chen. 2005. Freshwater inflow recommendation for the Sabine Lake Estuary of Texas and Louisiana. Texas Parks and Wildlife, Austin, TX. 71pp.

La Peyre, M.K., B.S. Eberline, T.M. Soniat, and J.F. La Peyre. 2013. Differences in extreme low salinity timing and duration differentially affect eastern oyster (Crassostrea virginica) size class growth and mortality in Breton Sound, LA. *Estuarine, Coastal and Shelf Science* 135, 146-157.

LaSalle, MW., and A.A. de la Cruz. 1985. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Gulf of Mexico) -- common Rangia. U.S. Fish Wildlife Service. Biological Report 82(11.31). U.S. Army Corps of Engineers, TR EL-82-4. 16 pp.

Louisiana Department of Wildlife and Fisheries (LDWF). 2019. LDWF Compensation Rates for Impacts to Water Bottoms on Public Oyster Seed Grounds, Public Oyster Seed Reservations, and Public Oyster Tonging Areas. http://www.dnr.louisiana.gov/assets/OCM/permits/LDWF_comp_rates_oyster.pdf

Nevins, J.A., J. Beseres Pollack, and G.W. Stunz .2014. Characterizing nekton use of the largest unfished oyster reef in the U.S. in comparison to marsh edge and nonvegetated estuarine habitats. *Journal of Shellfish Research* 33: 1-12.

Moore, C. 2008. Sabine Lake: Louisiana eyeing oyster reef. *Texas Fish and Game* 23:C70.

Murawski, S.A., J.P. Kilborn, A.C. Bejarano, D. Chagaris, D. Donaldson, F.J. Hernandez, T.C. MacDonald, C. Newton, E. Peebles, and K.L. Robinson. 2021. A synthesis of deepwater horizon impacts on coastal and nearshore living marine resources. *Frontiers in Marine Science* 7. https://doi.org/10.3389/fmars.2020.594862

Peterson, C.H., J.H. Grabowski and S.P. Powers. 2003. Estimated enhancement of fish production resulting from restoring oyster reef habitat: Quantitative valuation. *Marine Ecology Progress Series* 264: 249–264.

Pittinger, C.A., A.L. Buikema, S.G Hornor and R.W. Young. 1985. Variation in tissue burdens of polycyclic aromatic hydrocarbons in indigenous and relocated oysters. *Environmental Toxicology and Chemistry* 4: 379-387.

Sanders, M. Distribution of polycyclic aromatic hydrocarbons in oyster (Crassostrea virginica) and surface sediment from two estuaries in South Carolina. *Arch. Environ. Contam. Toxicol*. 28, 397–405 (1995). https://doi.org/10.1007/BF00211620

Schwing, P. T., P.A. Montagna, S.B. Joye, C.B. Paris, E.E. Cordes, C.R. McClain, et al. 2020. A synthesis of deep benthic faunal impacts and resilience following the Deepwater Horizon oil spill. *Frontiers in Marine Science* 7:560012. https://doi.org/10.3389/fmars.2020.56001

Sericano, J.L., Wade, T.L., Jackson, T.J., Brooks, J.M., Tripp, B.W., Farrington, J.W., 1995. Trace organic contamination in the Americas: an overview of the us national status & trends and the international "mussel watch" programs. *Marine Pollution Bulletin* 31, 214–225.

Thrush, S., J. Hewitt, V. Cummings, J. Ellis, C. Hatton, A. Lohrer, and A. Norkko. 2004. Muddy waters: Elevating sediment input to coastal and estuarine habitats. Frontiers in Ecology and the Environment 2 (6): 299–306. https://doi.org/10.2307/3868405

Turner RE, Rabalais NN, Overton EB, Meyer BM, McClenachan G, Swenson EM, Besonen M, Parsons ML, Zingre J. Oiling of the continental shelf and coastal marshes over eight years after the 2010 Deepwater Horizon oil spill. *Environ Pollut.* 2019 Sep;252(Pt B):1367-1376. https://doi.org/10.1016/j.envpol.2019.05.134

Wilber, D and D. Clarke. 2010. Dredging activities and potential impacts of sedimentation and resuspension on oyster reefs. Western Dredging Association Conference, San Juan, Puerto Rico, 61-69.

Wilber, D., G. Ray, D. Clarke and R. Díaz. 2008. Responses of Benthic Infauna to Large-Scale Sediment Disturbance in Corpus Christi Bay, Texas. *Journal of Experimental Marine Biology and Ecology*, 365: 13-22. https://doi.org/10.1016/J.JEMBE.2008.07.029