

COMMENTS

Precautionary Principle Meets the Protein Problem: How Aquaculture’s Regulatory Uncertainty Undermines the Gulf South’s Food Sovereignty and Other Environmental Goals

Cameron James Cerf*

I.	INTRODUCTION	47
II.	BACKGROUND	49
	A. <i>Louisiana Shrimp</i>	49
	B. <i>Global Shrimp</i>	53
III.	THE LEGAL AND POLITICAL LANDSCAPE OF AQUACULTURE	54
	A. <i>The Precautionary Principle</i>	54
	B. <i>Recent Actions</i>	56
IV.	FUTURES	59
	A. <i>The Protein Problem</i>	59
	B. <i>Sovereignty Through Species Integration</i>	61
	C. <i>Integrated Multi-Trophic Aquaculture</i>	62
V.	CONCLUSION	65

I. INTRODUCTION

Recent advancements in aquaculture—the art, science, and business of producing aquatic plants and animals useful to humans¹—have allowed

* © 2024 Cameron James Cerf. J.D. Candidate 2024, Tulane University Law School; B.A. 2018, Political Science, University of North Texas. The author would like to thank Professor Mark S. Davis for his insights and guidance; the editorial board of the *Tulane Environmental Law Journal*, and all editors of this Comment for their diligence and patience; family, friends, and classmates for their endless support; Emma Lirette for her poignant writing; and most especially his fiancée Da’Mere T. Wilson, without whose grace this Comment would not have been possible.

1. RICK PARKER, *AQUACULTURE SCIENCE* 3 (3d ed. 2011); *see also*, National Aquaculture Policy Act of 1980, 16 U.S.C. § 2802(1) (defining aquaculture as “the propagation and rearing of aquatic species in controlled or selected environments, including, but not limited to, ocean ranching.”).

for the reorganization of resources, capital, and ingenuity toward inland production of seafood and away from suppliers reliant on offshore fisheries or the open sea.² Blue Revolution³ proponents offer that if the world's future nutrition needs are to be met, then aquaculture development is necessary.⁴ While aquaculture's history demonstrates that various methods can severely tax both environmental⁵ and human resources,⁶ the United States is uniquely poised to benefit from aquaculture,⁷ as it could work to mitigate long standing food security⁸ and sovereignty risks,⁹ invigorate the labor market in this sector and region,¹⁰ relieve wild fishery stocks,¹¹ and reduce the trade deficit.¹² To that end, the prior two decades have shown movement in the areas of feed

2. Rosamond L. Naylor, et al., *A 20-Year Retrospective Review of Global Aquaculture*, 591 NATURE 551, 551 (2021), <https://doi.org/10.1038/s41586-021-03308-6>.

3. See KATHRYN WHITE, ET AL., AT A CROSSROADS: WILL AQUACULTURE FULFILL THE PROMISE OF THE BLUE REVOLUTION? (2004) (“[like] the ‘green revolution’ . . . the current ‘blue revolution’ of aquaculture is becoming an industrial mode of food production.”).

4. Benjamin Rigby, et al., *Industrial Aquaculture and the Politics of Resignation*, 80 MARINE POL’Y, 19, 20 (2017), <http://dx.doi.org/10.1016/j.marpol.2016.10.016>.

5. Shaun Moss, et al., *Greening of The Blue Revolution: Efforts Toward Environmentally Responsible Shrimp Culture*, WORLD SOC’Y AQUACULTURE 1, 1 (2001) (noting that habitat destruction, water pollution and introduction of non-native species, among other environmental risks, were identified by researchers).

6. See *infra* note 51, at 580 (noting that child labor, modern slavery and other unlawful practices persist in some regions).

7. Gunnar Knapp & Michael C. Rubino, *The Political Economics of Marine Aquaculture in the United States*, 24 REVS. FISHERIES SCI. & AQUACULTURE 213, 213 (2016), <https://doi.org/10.1080/23308249.2015.1121202>.

8. JESSICA A. GEPHART, ET AL., *Scenarios for Global Aquaculture and its Role in Human Nutrition*, 29 REVS. FISHERY SCI. & AQUACULTURE 122, 122 (2021), <https://doi.org/10.1080/23308249.2020.1782342>.

9. See generally, CATARINA PASSIDOMO & IRENE VAN RIPER, *Autonomy, Coalition-Building, and Cultural Survival: Towards Food Sovereignty in the U.S. South* in PUBLIC POLICIES FOR FOOD SOVEREIGNTY: SOCIAL MOVEMENTS AND THE STATE (Annette Aurelie Desmarais, Priscilla Claeys and Amy Trauger, eds.) (2017).

10. Vanessa J. Blackwell, et al., *Aquaculture Parks in the Coastal Zone: A Review of Legal and Policy Issues in the Gulf of Mexico State Waters*, 36 COASTAL MGMT. 249 (2008), <https://doi.org/10.1080/08920750701682031>.

11. Hope M. Babcock, *Grotius, Ocean Fish Ranching and the Public Trust Doctrine: Ride ‘Em Charlie Tuna*, 26 STAN. ENV’T. L.J. 3, 13 (2007).

12. *Id.*

2024] *AQUACULTURE'S REGULATORY UNCERTAINTY* 49

sources,¹³ nutrient recycling,¹⁴ water recirculation,¹⁵ and integration between species,¹⁶ as well as incorporation of novel tools such as artificial intelligence.¹⁷

This Comment seeks to build on the law's own burgeoning Blue Revolution.¹⁸ It offers a case study of coastal Louisiana's historic position in the seafood market, and reviews how regulatory uncertainty has stalled aquaculture development in the United States in juxtaposition to global investments and new evidence of sustainable production methods. Part I discusses the history of Louisiana shrimping, the cultural context to which it is moored, and where the shrimp market stands today. Part II discusses the legal landscape domestic aquaculturalists face as well as recent political efforts for reform. Part III discusses potential regulatory solutions to promote sustainable domestic aquaculture as well as possible futures for the Louisiana shrimping industry.

II. BACKGROUND

A. *Louisiana Shrimp*

Louisiana's shrimping industry today hardly resembles its nineteenth and twentieth century predecessors. Early modern shrimp cultivation was carried out in Barataria Bay by seine fishing—a labor intensive maneuver of encircling schools with hand-pulled nets.¹⁹ Around the time of Reconstruction, producers²⁰ began drying and canning their

13. Naylor, et al., *supra* note 2, at 551.

14. *See generally*, Ubair Nisar, et al., *A Solution for Sustainable Utilization of Aquaculture Waste: A Comprehensive Review of Biofloc Technology and Aquamimicry*, 8 FRONTIERS NUTRITION 1 (2022), <https://doi.org/10.3389/fnut.2021.791738>.

15. *See infra* note 51, at 585.

16. Thierry Chopin, et al., *Open Water Integrated Multi-Trophic Aquaculture: Environmental Bioremediation and Economic Diversification of Fed Aquaculture by Extractive Aquaculture*, 4 REVS. AQUACULTURE 209, 209 (2012), <https://doi.org/10.1111/j.1753-5131.2012.01074>.

17. *See generally*, Umar Farouk Mustapha, et al., *Sustainable Aquaculture Development: A Review on the Roles of Cloud Computing, Internet of Things and Artificial Intelligence (CIA)*, 13 REVS. AQUACULTURE 2076 (2021), <https://doi.org/10.1111/raq.12559>; *see also*, Matt Whittaker, *Dirty Shrimp Farms are Punching a Huge Hole in the Environment. A.I. Could Cut it in Half*, FORTUNE MAG. (Oct. 24, 2022), <https://fortune.com/2022/10/24/dirty-shrimp-farms-are-punching-a-huge-hole-in-the-environment-a-i-could-cut-it-in-half/>.

18. *See infra* note 82; *see also infra* note 83.

19. EMMA CHRISTOPHER LIRETTE, LAST STAND OF THE LOUISIANA SHRIMPERS 25 (2022).

20. CARL A. BRASSEAU & DONALD W. DAVIS, ASIAN-CAJUN FUSION: FROM THE BAY TO THE BAYOU 31, 37 (2022) (noting that refugees from China's Taiping Rebellion migrated to

catch, and the turn of the century delivered motorized trawlers and long-distance refrigeration.²¹ These advents paved the way for a boom and for the transcendence of a localized industry into a wide-reaching marketplace, all the while maintaining a hold on a niche product.²² Plentiful harvests and expanded canning capacity provided for early surges of intensification in 1930s Louisiana and Mississippi, punctuating the local flavor.²³ Then, with the advents in media technology and advertising of the 1950s, appetite for shrimp exploded.²⁴ But, that which could have made the Gulf of Mexico the “shrimp basket of the nation”²⁵ can also provide the same opportunities to other coastal communities.²⁶

Few other cases exemplify the effects of globalization on local industry as does the case of the gulf shrimpers. Demand for shrimp outpaced what the Gulf of Mexico could supply by the 1970s, and as a result, large-scale agribusinesses capitalized on the relative scarcity of the luxury food by turning toward the aquaculturalists of southeast Asia.²⁷ These producers managed to harvest massive quantities, but the product was often replete with antibiotics and other chemical cleansers.²⁸ Many producers also relied on the forced labor of enslaved persons.²⁹ Despite these circumstances, the U.S. Food and Drug Administration (FDA) permitted the import of foreign shrimp; the price of wild-caught shrimp collapsed and has yet to meaningfully recover.³⁰

southeast Louisiana and founded shrimp drying businesses that by 1873 handled twelve percent of all gulf shrimp).

21. Thomas Aquinas Becnel, *A History of the Louisiana Shrimp Industry, 1867-1961* (Aug. 1962) (M.A. thesis, Louisiana State University) (on file with LSU Historical Dissertations and Theses).

22. Becnel, *supra* note 21, at 27-29; LIRETTE, *supra* note 19, at 24.

23. Becnel, *supra* note 21, at 39; *see generally*, LIRETTE, *supra* note 19; *see also* ROBERT JOHNSON, *DEAD SHRIMP BLUES* (Vocalion Records 1936), <https://robertjohnsonbluesfoundation.org/music/robert-johnson-centennial-collection/>.

24. Walter R. Keithly, Jr. & Pawan Poudel, *The Southeast U.S.A. Shrimp Industry: Issues Related to Trade and Antidumping Duties*, 23 *MARINE RES. ECON.* 459, 466 (2008), <https://www.jstor.org/stable/42629675>.

25. Becnel, *supra* note 21, at 48.

26. LIRETTE, *supra* note 19, at 27-28.

27. *Id.*

28. *Id.* at 27.

29. *Id.* at 28.

30. *Id.* at 27 (noting that the FDA banned Malaysian shrimp in 2013 leading to a comfortable shrimping season in the Gulf in 2014, yet prices cratered once more in 2015); *see also*, Keithly & Poudel, *supra* note 24, at 460 (“[In] 2003 a coalition of Southeast processors filed a petition with the U.S. Department of commerce and the U.S. International Trade Commission alleging that six countries—China, Vietnam, India, Thailand, Ecuador, and Brazil—were unfairly

2024] *AQUACULTURE'S REGULATORY UNCERTAINTY* 51

International aquaculture is not the only culprit, however. Coastal Louisiana is confronted by a multitude of existential crises,³¹ all of which culminate to disincentivize local shrimpers. Much of the coast, including the city of New Orleans, already lies below sea level.³² The coast is precipitously subsiding into the Gulf—a football field's equivalent is overtaken every hour,³³ largely as a result of diking the Mississippi River delta, which prevents up-river sediments from coalescing into new land.³⁴ And the sea rises mercilessly.³⁵ Disastrous hurricanes and floods have battered the delicate estuarine areas, further exacerbating the risk that relatively minor weather events pose.³⁶

What is more, the remedy offered to steer sediments in critical areas is likely to displace the bevy of salt-water creatures out of Barataria Bay and surrounding areas, dramatically transforming the ecology.³⁷ The Mid-Barataria Settlement Diversion Project (MBSDP or the Diversion), authorized by the Army Corps of Engineers in December of 2022, plans to redirect the Mississippi to dump into Barataria Bay.³⁸ The Diversion, once completed, will flush out the gulf's encroached saltwater by

'dumping' product on the U.S. market. After a one-year investigation, a finding of dumping and injury to the domestic industry by means of dumping was affirmed. Antidumping duties, varying greatly by country, were established accordingly.'").

31. See generally, Oliver Houck, *Can We Save New Orleans?* 19 TUL. ENV'T L.J. 1 (2006).

32. LIRETTE, *supra* note 19, at 78 ("We talk about bodies of water, and indeed, they are wholly body: you can feel these waters press against you as they encroach on the land, as they press into the floorboards of your home, as they spill all over your stuff".).

33. Devin Lowell, *Ensuring Consistency: Louisiana Coastal Restoration Through the Lens of the RAM Terminal and the Mid-Barataria Sediment Diversion*, 27 TUL. ENV'T L.J. 299, 299 (2014).

34. *Id.* at 301-02.

35. Houck, *supra* note 31 at 25-26 (noting that the Environmental Protection Agency estimates a forty-inch rise in sea level along the Louisiana coast within this century).

36. Lowell, *supra* note 33, at 302 ("Tropical storms and hurricanes also destroy coastal wetlands . . . Hurricanes Katrina, Rita, Gustav, and Ike destroyed nearly 250 square miles of wetlands between them."); see also, Steve Baragona & Arturo Martínez, *Weathering the Storm: Impact of Climate Change Lingers After a Devastating Year in Louisiana*, VOA NEWS, <https://projects.voanews.com/climate-change/weathering-the-storm/chapter-1-impact-of-climate-change-lingers-after-a-devastating-year-in-louisiana.html> (last visited Nov. 28, 2023).

37. Lowell, *supra* note 33, at 310.

38. OFFICE OF THE GOVERNOR, *CPRA Receives Authorization for Mid-Barataria Sediment Diversion* (2022), <https://gov.louisiana.gov/index.cfm/newsroom/detail/3921> ("Once operational, the project will have the ability to build and sustain up to 26,000 acres of wetlands that will support a stronger, more resilient estuary.").

displacing it with the Mississippi's freshwater.³⁹ For coastal communities that have relied on Barataria's bounty for over a century, it is easy to see how shrimpers might interpret the cure of the Diversion as worse than the disease of erosion.⁴⁰

Despite these challenges, shrimpers of the Gulf South remain inextricably connected to the water.⁴¹

There was no other phrase I heard more often throughout my conversations with both current and former shrimpers than 'it's in my blood'. They used this phrase to explain why, despite all of the hardships and struggles, they continued to try to make it as fishers, and with this simple expression they demonstrated that trawling was not merely a job or a way to earn a living. Rather, it represented the foundation upon which family history had been forged. In that sense, shrimp fishing constituted what they considered to be their genealogical destiny.⁴²

Indeed, intensive shrimping in the Gulf South was in large part carried out by the descendants of French Acadians who, after being displaced from various colonies, were foisted into Louisiana's wetlands.⁴³ The water offered a place to unmoor, or release from, while experiencing a kind of salty liberty absent from terrestrial life.⁴⁴ Families trawled the same waters generation after generation, building on the cultural legacy that gave meaning to one's Cajun identity—not to mention the nutritious and lucrative spoils hauled aboard.⁴⁵ However, as prices bottomed out and storms eviscerated legacy infrastructure, many shrimpers abandoned the

39. Tristan Baurick, *Louisiana's Biggest Land-Building Project Likely to Cause Spike in Shrimp, Oyster Prices*, NOLA.COM (Jan. 16, 2023), https://www.nola.com/news/environment/sediment-diversion-likely-to-trigger-spike-in-seafood-prices/article_ce86b31e-9379-11ed-8c81-d7416bd7b77c.html ("The area likely to be affected by the diversion accounts for a third of the annual value of the statewide seafood catch, but landings have been in a downward spiral. The basin produces about thirty percent fewer shrimp and about half as many oysters as it did twenty years ago.").

40. *See id.*; *see also*, Monica Patrice Barra, *Good Sediment: Race and Restoration in Coastal Louisiana*, 111 ANNALS AM. ASS'N. GEOGRAPHERS 266, 267 (2021), <https://doi.org/10.1080/24694452.2020.1766411> ("The most immediate concern is the impact of the freshwater from the Mississippi River on the salinity levels in the estuaries that support the region's commercial fisheries . . . residents are also concerned that . . . sediment diversions will put several feet of additional water into local wetlands.") (internal citations omitted).

41. *See generally*, LIRETTE, *supra* note 19.

42. *Id.* at 41 (providing a statement from researcher Jill Ann Harrison).

43. *Id.* at 20-21.

44. *Id.* at 7.

45. *Id.* at 6, 7.

2024] *AQUACULTURE'S REGULATORY UNCERTAINTY* 53

trawl for the oil rig or other approximal industries.⁴⁶ Those that kept with the trawl are dwindling, but remain steadfast in their commitment to this unique maritime culture.⁴⁷ The question Lirette poses, “Why shrimp when there is no future in shrimping?,” may be answered in this cultural context; the Diversion, however, will ask: how does one shrimp when the last of them are gone?⁴⁸

B. *Global Shrimp*

As capture fisheries' output peaked in the mid-1990s, aquaculture boomed, especially in southeast Asian ponds and estuarine habitats.⁴⁹ Following three decades of rapid growth, aquaculture now accounts for over half of the world's seafood consumption,⁵⁰ outweighing global beef production in terms of total biomass,⁵¹ and continues to expand by eight percent annually.⁵² At present, up to ninety percent of U.S. seafood consumption by value is imported, at least half of which is derived from aquaculture.⁵³ Chief among those imports, shrimp and salmon accounted for \$6.5 billion and \$3.5 billion in 2017, respectively.⁵⁴ Today's market is largely dominated by Asian producers both in terms of total output and diversity of cultured species.⁵⁵ Since 2000, China has maintained its role as the single largest producer, processor, and trader of fish—furnishing nearly sixty percent of global supply in 2017.⁵⁶

46. *Id.* at 8.

47. *Id.* at 6-8.

48. Baurick, *supra* note 39 (“Sediment will smother oyster beds while the added freshwater will cause shrimp to grow slower and move to saltier water. That’ll likely cripple many small coastal communities that depend on the fishing industry.”).

49. Ben Belton, et al., *Not Just for the Wealthy: Rethinking Farmed Fish Consumption in the Global South*, 16 GLOB. FOOD SEC. 1, 1-2 (2018), <https://doi.org/10.1016/j.gfs.2017.10.005> (namely China, Indonesia, Vietnam, Thailand, India, and Myanmar).

50. Manuel Luna, et al., *A Conceptual Framework for Risk Management in Aquaculture*, 147 MARINE POL’Y 1, 1 (2023); *see also*, CONG. RSCH. SERV., R45952, U.S. OFFSHORE AQUACULTURE REGUL. AND DEV., 2 (2019), <https://crsreports.congress.gov/product/pdf/R/R45952>.

51. Claude E. Boyd, et al., *Achieving Sustainable Aquaculture: Historical and Current Perspectives and Future Needs and Challenges*, 51 J. WORLD AQUACULTURE SOC’Y 578, 579 (2020), <https://doi.org/10.1111/jwas.12714>.

52. Mimako Kobayashi, et al., *Fish to 2030: The Role and Opportunity for Aquaculture*, 19 AQUACULTURE ECON. & MGMT. 282, 283 (2015), <https://doi.org/10.1080/13657305.2015.994240>.

53. Knapp & Rubino, *supra* note 7, at 214.

54. MARSHAK, *supra* note 50, at 34.

55. Naylor, et al., *supra*, note 2, at 552.

56. *Id.* at 552-53.

Noticeable growth can also be seen in Africa and South America, with growth rates exceeding that of Asia during the past two decades.⁵⁷ Europe as well boasts a growing aquaculture sector with the support of large investments⁵⁸ and tailored regulations.⁵⁹ Yet little compares to the value chains that have been erected in southeast Asian freshwater aquaculture communities.⁶⁰ This hegemony, however, is reliant on ever-increasing intensification whereby few regulations exist or are otherwise unenforced,⁶¹ and poorer families are often displaced when resources are depleted and producers move to consolidate.⁶²

III. THE LEGAL AND POLITICAL LANDSCAPE OF AQUACULTURE

A. *The Precautionary Principle*

In order for an idea to bridge the gap between science and legal policy, the idea must often pay a toll to the precautionary principle.⁶³ The principle is a normative one, and offers that caution, rather than risk-taking, is preferred in the environmental context—especially when there exists a dearth in scientific understanding on the matter.⁶⁴ It also presents its own quandary: even if it were reasonable to take caution rather than to act, the conditions could worsen since the problem *required* action.⁶⁵ Thus, defining exactly what, or whose, problem is at issue and by what means it could be remedied are key to a proper application of the

57. *Id.*

58. Jordi Guillen, et al., *Aquaculture Subsidies in the European Union: Evolution, Impact and Future Potential for Growth*, 104 MARINE POL'Y 19, 20 (2019), <https://doi.org/10.1016/j.marpol.2019.02.045>.

59. Tamás Bardócz, et al., *Aquaculture in BLUE INDUSTRIES AT SEA: 'BLUE GROWTH' AND THE NEW MARITIME ECONOMY* 28 (Kate Johnson, Gordon Dalton & Ian Masters eds., 2018) (“Aquaculture is an integral part of the reformed Common Fisheries Policy.”) (internal citations omitted).

60. Naylor, et al., *supra* note 2 at 553.

61. *Id.* at 559.

62. *Id.* (“In China, aquaculture pollution accounts for more than twenty percent of the total input of nutrient into freshwater environments in some provinces.”).

63. Matthais Kaiser, *Fish Farming and the Precautionary Principle: Context and Values in Environmental Science for Policy*, 2 FOUNDS. SCI. 307, 309 (1997), <https://doi.org/10.1023/A:1009679923315>.

64. *Id.*; *see id.* at 313 (listing criteria of the precautionary principle).

65. Richard A. Epstein, *Too Pragmatic by Half*, 109 YALE L.J. 1639, 1646-47 (2000) (reviewing Daniel A. Farber, *ECO-PRAGMATISM: MAKING SENSIBLE ENVIRONMENTAL DECISIONS IN AN UNCERTAIN WORLD* (1999)).

2024] *AQUACULTURE'S REGULATORY UNCERTAINTY* 55

principle. Further, the various methods of risk calculation offer little certainty for producers.⁶⁶

The longstanding application of the precautionary principle, and uncertainty more broadly, has been identified as a key roadblock to the development of aquaculture in the United States, keeping output stagnant at 400,000 metric tons per year.⁶⁷ Considering the slipshod beginnings of modern aquaculture, disruptions to livelihoods by way of offshoring, and the United States' recent history of fishery depletion, it is more than understandable that attitudes toward the practice remain negative, or at least one of dour caution—although a few American farmers have taken the first steps.⁶⁸

This, however, cannot be squared with Americans' demands. By the late 1980s, every finfish harvested from waters of the United States was caught at or above its capacity to replace itself.⁶⁹ As predicted, domestic appetite for seafood nevertheless increased and these externalities have been passed on to the Global South in the form of aquaculture-derived pollution and habitat degradation.⁷⁰ Thus, reticence on the part of American lawmakers and judges to regulate and expand domestic aquaculture has exacerbated the underlying concerns related to the environment and has precluded the development of sustainable and equitable production methods.⁷¹ Notably, these concerns largely rest on

66. Luna et al., *supra* note 50, at 1 (“On the one hand, the production process presents a high complexity and uncertainty due to the broad range of technical, biological, environmental, and economic factors that influence its results. On the other hand, the aquaculture industry is heterogeneous as it comprises companies that vary greatly in size, production systems, species, environmental conditions and locations. This characteristic makes especially difficult the generalization of risk models.”).

67. See Michael C. Rubino, *Policy Considerations for Marine Aquaculture in the United States*, 31 REVS. FISHERIES SCI. & AQUACULTURE 86, 86-89, 91 (2023), <https://doi.org/10.1080/23308249.2022.2083452>; see also, Michael A. Rice, *Sustainability and the Precautionary Principle*, AQUACULTURE MAG. (Aug.-Sep. 2019) <https://web.uri.edu/wp-content/uploads/sites/16/Sustainability-Precaution-2019.pdf> (“[T]he precautionary principle has frequently been abused/used as a tool by opponents to halt aquaculture project development, not on environmental grounds per se, but often for other ulterior political reasons”).

68. Nebraska Public Media, *Shrimp Farming | What If... | NET Nebraska*, YOUTUBE (Apr. 9, 2021), <https://www.youtube.com/watch?v=CoZTT2EE-hw> (“[W]e recycle all of our water and we can raise shrimp antibiotic-free.”).

69. Ronald J. Rychlak & Ellen M. Peel, *Swimming Past the Hook: Navigating Legal Obstacles in the Aquaculture Industry*, 23 ENV'T L. 837, 838 (1993).

70. *Id.*; Rubino, *supra* note 67, at 86-87.

71. Rubino, *supra* note 67, at 86 (“By consuming imported seafood, Americans indirectly miss out on the benefits of local production: creating domestic jobs in coastal and agricultural

the misunderstanding that aquaculture is an exclusively offshore affair (mariculture), when in fact contemporary development has prioritized inland and nearshore development.⁷² The question presented by the precautionary principle is mooted then, since American consumers *already* suffer the consequences of unsustainable production acutely,⁷³ as well as in the larger context of global climate change and ecological degradation.⁷⁴

B. Recent Actions

That said, it is worth detailing how the United States has attempted to regulate aquaculture and identify drivers that so far have led to their failure. Congress passed the Sustainable Fisheries Act in 1996 to amend the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) in order to help replenish wild stocks.⁷⁵ The amendment reclassified aquaculture as fishing, and as a result, any aquaculture operations touching an essential fish habitat (EFH) became subject to enforceable conservation measures.⁷⁶ The agency tasked with

communities and growing seafood under U.S. laws and regulations designed to ensure food safety, protection of the environment, and worker health and safety.”)

72. CONG. RSCH. SERV., R45952, U.S. OFFSHORE AQUACULTURE REGUL. AND DEV. 2 (2019), <https://crsreports.congress.gov/product/pdf/R/R45952>; *see also*, Naylor et al., *supra* note 2, at 553 (“Of the 11,625 articles published in English between 2000 and 2020 with marine or freshwater aquaculture (or farming) in their titles, three-quarters focused on mariculture and sixty-eight percent on high-valued mariculture. These metrics do not include the vast literature published in Asia, particularly in China, where freshwater aquaculture has a long and vibrant tradition.”) (internal citation omitted) (endnote omitted).

73. *See* Press Release, Bill Cassidy, Senator, U.S. Senate, *Cassidy Stands Up for Louisiana Shrimpers, Energy Producers at Senate Finance Hearing* (Mar. 24, 2023), <https://www.cassidy.senate.gov/newsroom/press-releases/cassidy-stands-up-for-louisiana-shrimpers-energy-producers-at-senate-finance-hearing>; *but see* Tess Petesch, *Impacts of Disease in Shrimp Aquaculture on U.S. Capture Fishery Prices* 21 (Apr. 28, 2017) (Master’s Project, Duke University) (on file with Duke University Libraries) (“Market integration suggests that trade restrictions primarily lead to changes in trade patterns with little price benefits for domestic producers. In spite of antidumping duties in place on farmed shrimp from Thailand and Ecuador during much of the time period considered here, prices in the Gulf largely mirror those of the global culture market.”) (internal citations omitted).

74. Charles Moore, *Rapidly Increasing Plastic Pollution from Aquaculture Threatens Marine Life*, 27 TUL. ENV’T L.J. 205, 205 (2014).

75. Erin R. Englebrecht, *Can Aquaculture Continue to Circumvent the Regulatory Net of the Magnuson-Stevens Fishery Conservation and Management Act?* 51 EMORY L.J. 1187, 1188 (2002); *see also* BRASSEAU & DAVIS, *supra* note 20, at 359 (noting that the amendment was intended to replenish depleted fishery stocks).

76. Englebrecht, *supra* note 75, at 1188-89.

2024] *AQUACULTURE'S REGULATORY UNCERTAINTY* 57

designating EFH and enforcing the act, the National Marine Fisheries Service (NMFS), however, was initially reluctant to enforce regulations on aquaculture, and it limited the authority of NMFS and eight regional management councils to regulate state waters.⁷⁷

The Gulf of Mexico Fishery Management Council advanced a fisheries management plan (FMP) in 2009.⁷⁸ The NMFS finalized that rule in 2016 for the establishment of an FMP to regulate and issue permits for offshore aquaculture in the federal waters of the Gulf of Mexico.⁷⁹ Holding that the Magnuson-Stevens Act did not confer NMFS the authority to regulate offshore aquaculture,⁸⁰ the Fifth Circuit halted development in the Gulf.⁸¹ In this first test case for marine aquaculture, the majority interpreted the MSA to “unambiguously preclude” any regulation of aquaculture by NMFS.⁸²

Fresh bills offering comprehensive aquaculture reform have been steadily introduced since 2006, yet none have been enacted. Introduced by Senators Roger Wicker and Marco Rubio in 2018, the Advancing the Quality and Understanding of American Aquaculture Act (AQUAA) proposed the establishment of an Office of Marine Aquaculture to coordinate development between stakeholders as well as again re-classify

77. *Id.* at 1189-90.

78. *Gulf Fishermans Ass'n v. National Marine Fisheries Services*, 968 F.3d 454, 458 (5th Cir., 2020).

79. *Fisheries of the Caribbean, Gulf, and South Atlantic; Aquaculture*, 81 Fed. Reg. 1762 (Jan. 13, 2016) (to be codified at 50 C.F.R. pts. 600, 622).

80. *See Gulf Fishermans Ass'n*, 968 F.3d at 454 (noting that the FMP would authorize permits for up to twenty facilities and a cumulative maximum total of sixty-four million pounds of native species annually); *see also infra* note 81.

81. Haley Gentry, Note, *Gulf Fishermens Association v. National Marine Fisheries Service: The Fifth Circuit Halts Offshore Aquaculture in the Gulf of Mexico by Determining that the National Marine Fisheries Service Has No Authority to Regulate It*, 34 TUL. ENV'T L.J. 357, 369 (2021).

82. *Id.* at 363 (quoting *Gulf Fishermens Ass'n v. Nat'l Marine Fisheries Serv.*, 968 F.3d 454, 460 (5th Cir. 2020)); *contra* Mary Eliza Baker, *Plenty of Fish in the Sea: An Analysis of the Fifth Circuit's Refusal to Bite on Aquaculture in the Gulf*, 10 LSU J. ENERGY L. & RES. 163, 178 (2022) (noting that “[t]he court’s *noscitur a sociis* approach to statutory interpretation severely restricted the scope of the MSA” and ignored more expansive language of the MSA such as the definition of fishing to include “any other activity which can be reasonably expected to result in the catching, taking, or harvesting of fish; or any operation at sea in support [thereof].”) (alteration in original) (quoting 16 U.S.C. § 1802(16)).

aquaculture to not be considered fishing under the MSA.⁸³ The bill failed to get out of committee, but was reintroduced in the House in 2021.⁸⁴

Two competing bills were introduced in 2019. Introduced by Senator Cindy Hyde-Smith of Mississippi and co-sponsored by Senator John Kennedy of Louisiana, The Commercial Fishing and Aquaculture Protection Act (CFAP) was designed to amend the Magnuson-Stevens Act “to provide assistance to eligible commercial fishermen and aquaculture producers” in the event of loss due to algal bloom, freshwater intrusion, adverse weather, bird depredation, or another condition determined by the Secretary of Commerce.⁸⁵ Alternatively, The Keep Finfish Free Act aimed to deny aquaculturalists the permits required to produce finfish in the Exclusive Economic Zone (EEZ) until a comprehensive regulatory framework is enacted.⁸⁶ Like the aquaculture bills introduced in sessions prior, the CFAP and Keep Finfish Free acts also withered on the congressional vine.⁸⁷ Thus, despite the passage of the Sustainable Fisheries Act, the National Aquaculture Act of 1980, as well as an Executive Order by President Trump,⁸⁸ confusion over regulatory authority and lack of leadership continue to stymie aquaculture development.⁸⁹ The Biden-Harris administration, however, has recently unveiled the Ocean Climate Action Plan (OCAP), which touts sustainable aquaculture practices as a key tool for meeting overarching climate

83. Elan Lowenstein, *Regulating the Blue Revolution: A Sea of Change for the United States' Offshore Aquaculture Industry or a Missed Opportunity for Increased Sustainability*, 26 U. MIAMI INT'L & COMP. L. REV. 473, 485 (2019).

84. Patty Keough, *The AQUAA Act – Bad for Our Oceans, Bad for the Fishing Industry, Bad for Fish*, ENV'T, NAT. RES. & ENERGY L. BLOG (June 16, 2022), <https://law.lclark.edu/live/blogs/190-the-aquaa-act-bad-for-our-oceans-bad-for-the>.

85. Commercial Fishing and Aquaculture Protection Act of 2019, S. 2209, 116th Cong. (1st Sess. 2019).

86. Keep Finfish Free Act of 2019, H.R. 2467, 116th Cong. (1st Sess. 2019).

87. CONG. RSCH. SERV., R45952, U.S. OFFSHORE AQUACULTURE REGULATION AND DEVELOPMENT 2 (2019), <https://crsreports.congress.gov/product/pdf/R/R45952>; for the current status of these bills, see Keep Finfish Free Act of 2019, H.R.2467, 116th Cong. (2019), <https://www.congress.gov/bill/116th-congress/house-bill/2467/actions>; see also Commercial Fishing and Aquaculture Protection Act of 2019, S.2209, 116th Cong. (2019), <https://www.congress.gov/bill/116th-congress/senate-bill/2209/actions>.

88. Promoting American Seafood Competitiveness and Economic Growth, Exec. Order No. 13921, 85 Fed. Reg. 28,471 (May 7, 2020).

89. Passidmomo & Riper, *supra* note 9, at 1; but see generally NAT'L OCEANIC & ATMOSPHERIC ADMIN., U.S. DEP'T COM., GUIDE TO PERMITTING MARINE AQUACULTURE IN THE UNITED STATES (2022), <https://media.fisheries.noaa.gov/2022-07/Guide-Permitting-Marine-Aquaculture-United-States-June2022.pdf>.

2024] *AQUACULTURE'S REGULATORY UNCERTAINTY* 59

targets.⁹⁰ OCAP specifically outlines aquaculture's potential to attain national food security, sequester carbon,⁹¹ restore degraded habitat, and protect coastal communities.⁹² Grouping these initiatives together, OCAP calls for "climate-ready fisheries."⁹³ After decades of uncertainty, one thing has become clear: domestic aquaculture is becoming one of the few climate-related initiatives that attracts bipartisan support.

IV. FUTURES

A. *The Protein Problem*

Hunger and malnutrition, particularly a lack of protein,⁹⁴ remains a principle obstacle for all types of development globally, including America's Gulf South region.⁹⁵ Hunger cuts in multiple directions, one of which has been termed *food sovereignty*.⁹⁶ More specific than food security, or access to nutrition,⁹⁷ food sovereignty can be defined as "the right of each nation or region to maintain and develop their capacity to

90. OCEAN POL'Y COMM., OCEAN CLIMATE ACTION PLAN 4, 13 (Mar. 2023), https://www.whitehouse.gov/wp-content/uploads/2023/03/Ocean-Climate-Action-Plan_Final.pdf.

91. See Rob Hotakainen, *House Chair Outlines Goals on Fisheries, NOAA, Aquaculture*, E & E DAILY (Feb. 7, 2023, 6:19 AM), <https://subscriber.politicopro.com/article/eenews/2023/02/07/house-chair-outlines-goals-on-fisheries-noaa-aquaculture-00081328> (statement by Republican Representative Cliff Bentz, Chair of the House's subcommittee on Water, Wildlife and Fisheries) ("If life gives you lemons, you make lemonade . . . [a]nd if life gives you an ocean that has a higher level of CO₂, why aren't we harvesting that CO₂ with seaweed?").

92. OCEAN POL'Y COMM., *supra* note 90, at 57.

93. *Id.* at 56; see also, Valerie Cleland, *Diving into the Ocean Climate Action Plan*, NAT'L RES. DEF. COUNCIL: EXPERT BLOG (Mar. 29, 2023), <https://www.nrdc.org/bio/valerie-cleland/diving-ocean-climate-action-plan> ("With this plan, the White House is making a coordinated effort to explore and then deploy our vast oceans as part of the solution to the climate crisis. This is an enormously welcome step.").

94. See P.V. Sukhatme, *The Protein Problem, Its Size and Nature*, 137 J. ROYAL STAT. SOC'Y 166, 166 (1974), <https://www.jstor.org/stable/2344547> ("It is widely held that insufficiency of good-quality protein in the diets of the people is at the heart of the nutrition problem in the developing countries.").

95. See Liddell et al., "You Got to Drive Thirty Miles to Get an Apple": *Indigenous Food Sovereignty, Food Deserts, and Changing Subsistence Practices in the Gulf Coast*, 2-232 SN SOC. SCI., (2022), <https://doi.org/10.1007/s43545-022-00530-5>.

96. Passidomo & Van Riper, *supra* note 9, at 183.

97. Ashley Chaifetz & Pamela Jagger, *40 Years of Dialogue on Food Sovereignty: A Review and a Look Ahead*, 3 GLOB. FOOD SEC. 85, 87 (2014); see also U.S. DEP'T COM., U.S. DEPARTMENT OF COMMERCE STRATEGIC PLAN (2018-2022): HELPING THE AMERICAN ECONOMY GROW 9 (2018), https://www.commerce.gov/sites/default/files/us_department_of_commerce_2018-2022_strategic_plan.pdf ("A strong U.S. marine aquaculture industry will serve a key role in U.S. food security and improve our trade balance with other nations.").

produce basic food crops with corresponding productive and cultural diversity.”⁹⁸ As such, simple attainment of nourishment *a la* food security has been criticized for paying little respect to the politics, cultures, and identities formed in part through cultivation, whereas notions of self-sufficiency better capture the “big picture.”⁹⁹ Food sovereignty also conveys how a society or social stratum gripped by hunger is effected by dependency on imported foods. These concepts are also directly tied to theories of environmental justice, of which *food justice* is a necessary component.¹⁰⁰ What has been used as a framework for exploring solutions to resolve food injustice is a framework termed *indigenous food sovereignty*, which prioritizes the role of subsistence in examining wellness of indigenous peoples more broadly.¹⁰¹ This lens highlights how access to food is not necessarily congruent with nutrition, as exemplified by repeated histories of indigenous peoples experiencing wide-ranging health disparities as original diets were replaced with those of colonial communities.¹⁰²

As it pertains to the Gulf South, the history of food for the region’s residents is punctuated by a turbulent and violent past wherein food production was used as a means, *inter alia*, of labor to which indigenous peoples were largely displaced and enslaved persons were chained.¹⁰³ Sharecropping replaced plantation systems, though often without significant distinction.¹⁰⁴ Later, Jim Crow and Black Code legal systems reinforced disparities in terms of food production, distribution, and quality.¹⁰⁵ Today, as evidenced by food deserts, disparities in food access and nutrition persist in the Gulf South.¹⁰⁶

98. Chaifetz & Jagger, *supra* note 97, at 85.

99. Samantha Noll & Esme G. Murdock, *Whose Justice is it Anyway? Mitigating the Tensions Between Food Security and Food Sovereignty*, 33 J. AGRIC. & ENV’T ETHICS 1, 4 (2019), <https://doi.org/10.1007/s10806-019-09809-9>.

100. *Id.* at 1, 8-11 (suggesting that the terms ‘food sovereignty’ and ‘food justice’ can be used interchangeably).

101. Liddell et al., *supra*, note 95, at 3-4 (“Food sovereignty topics have been less researched from the perspective of members of state-recognized tribes, especially those in the Gulf Coast, who experience unique challenges related to their lack of federal recognition, and the impact of climate change and oil company exploitation on the area.”).

102. *Id.* at 4.

103. Passidomo & Van Riper, *supra* note 9, at 183.

104. *Id.* at 185.

105. *Id.*

106. See generally J. Ashleigh Ross & Lydia Zepeda, *Wetland Restoration, Environmental Justice and Food Security in the Lower Ninth Ward*, 4 ENV’T JUST. 101, 102 (2011), <https://doi.org/10.1089/env.2010.0008>.

2024] *AQUACULTURE'S REGULATORY UNCERTAINTY* 61

Applying the framework of indigenous food sovereignty to the Gulf South's shrimping industry reveals a multitude of negative outcomes.¹⁰⁷ While some ingredients have persisted,¹⁰⁸ such as shrimp, unsustainable practices and globalization have undermined food sovereignty to the point that basic staples are unattainable and culturally-rich foodstuffs become imports rather than exports. These roadblocks to sovereignty will persist until suitable adaptations that meet the needs of the residents now and into the future are instituted. Some have proffered aquaculture as that solution.¹⁰⁹ Critics of aquaculture's potential in this sense identify the asymmetrical result these food systems have had historically—highlighting the fact that many producers in the Global South do not see the nutritional benefits of aquaculture, and instead face a changing landscape built around intensive cultivation.¹¹⁰

B. *Sovereignty Through Species Integration*

To address this disparity, Gephart, *et al.*, advances a systems approach that analyzes the nutritional contributions of seafood distribution and the economic value derived from the supply chain therein.¹¹¹ The authors set three criteria to define nutrition-sensitive aquaculture as:

107. See Liddell et al., *supra* note 102, at 1, 9.

108. Morgan Randall, *The Native-American Origins of Gumbo*, ATLAS OBSCURA: GASTRO OBSCURA (Aug. 7, 2020), <https://www.atlasobscura.com/articles/native-american-gumbo> (noting that ground sassafras leaves, called filé, was used as the dish's thickening agent long before Cajuns popularized a flour-based paste called roux).

109. Kayla Devault, *Combining Old and New: Aquaponics Opens the Door to Indigenous Food Security*, YES! MAG. (May 31, 2022), https://www.yesmagazine.org/environment/2022/05/31/aquaponics-indigenous-food-security?utm_medium=email&utm_campaign=YESDaily_20220606&utm_content=YESDaily_20220606+CID_b97cc16a82e502b44341837a165fa3d1&utm_source=CM&utm_term=Read%20the%20full%20story (“[The] project is restoring sustainable and fresh foodways by rejuvenating harmonious techniques similar to the ancient ahupua‘a method, which utilizes the water flowing from the mountains to the sea to grow plants and fish[.]”).

110. Susan C. Stonich & Conner Bailey, *Resisting the Blue Revolution: Contending Coalitions Surrounding Industrial Shrimp Farming*, 59 HUM. ORG. 23, 23 (2000), <https://www.jstor.org/stable/44126663> (“The potential of aquaculture to improve the nutrition and incomes of the poor has been impeded by the emphasis on the cultivation of high-value, carnivorous species destined for market in industrial nations.”).

111. Gephart et al., *supra* note 8, at 123, 125 fig. 1 (charting each scenario against an X-axis of regionalized/globalized and a Y-axis of endless growth/doughnut economics); see also Kate Raworth, *A Doughnut for the Anthropocene: Humanity's Compass in the 21st Century*, 1 LANCET PLANETARY HEALTH e48, e48 fig. 1 (2017) (modeling the spectrum of human needs against resource availability).

a food system that (i) supports public health outcomes through production of diverse seafood, (ii) provides multiple, rich sources of essential, bioavailable nutrients, and (iii) supports equitable access to nutritionally adequate, safe, and culturally acceptable diets that meet food preferences for all populations, without compromising ecosystem functions, other food systems, and livelihoods.¹¹²

Under that thesis, the authors identified four scenarios that may support nutrition-sensitive aquaculture: aquatic chicken, aqua-nationalism, food sovereignty, and blue internationalism.¹¹³ Here, a future of food sovereignty within aquaculture is framed as a region-specific set of industries that recirculate resources between one another and is thereby marked by small-scale production.¹¹⁴ Given the relatively low presence of aquaculture development in the Gulf South—as well as serious concerns for residents' overall health, cultural moorings and economic futures as it relates to seafood cultivation—it follows that a food sovereignty approach is necessary in planning and executing new food systems. In order to secure food sovereignty along these lines, producers and policy makers should also be keenly aware of the abundance of scientific literature and creativity within aquacultural systems, so as to support key species (cash crops), as well as secondary or tertiary cultivars, so as to preserve sovereignty.

C. *Integrated Multi-Trophic Aquaculture*

In contrast to traditional protein production methods such as Intensively Fed Monoculture (IFM), which focuses on a single species, polyculture methods incorporate multiple complimentary species.¹¹⁵ While terms such as polyculture, integrated aquaculture (IA), and integrated multi-trophic aquaculture (IMTA) have varied in meaning and popularity over time, IMTA has received favorable treatment in recent years for its flexibility in that IMTA encompasses open-water, land-based, and aquaponics systems.¹¹⁶ Chopin, *et al.*, define the practice as

Integrated multi-trophic aquaculture (IMTA) is the farming, in proximity, of aquaculture species from different trophic levels, and with complementary ecosystem functions, in a way that allows one species'

112. Gephart et al., *supra* note 8, at 125 fig. 1.

113. *Id.* at 127-32.

114. *Id.* at 130.

115. Boyd et al., *supra* note 51, at 616.

116. *Id.* at 617.

2024] *AQUACULTURE'S REGULATORY UNCERTAINTY* 63

uneaten feed and wastes, nutrients and by-products to be recaptured and converted into fertilizer, feed and energy for the other crops, and to take advantage of synergistic interactions between species.¹¹⁷

When cultured by themselves, a species might tolerate man-made conditions but will inevitably struggle to survive if conditions do not adapt over time. For example, shrimp nibble at feed pellets rather than swallowing them whole.¹¹⁸ As a result, up to forty percent of the feed ends up at the bottom of the enclosure, worsening the water quality, since they are high in nitrogen and phosphorous.¹¹⁹ This build up over time traditionally requires further intensification, such as relocating the shrimp from one enclosure to another or treating the water with additives or chemical cleansers.¹²⁰ Under IMTA conditions, however, certain bacterium called biofloc that consume nitrogen-rich wastes can also convert that matter into edible protein.¹²¹ By allowing for just one additional trophic level such as bacteria, the water media can essentially filter itself and provide nourishment for the cultivated species.¹²² Bivalves such as mollusks, clams, and oysters, as well as various aquatic plants, are also part and parcel to IMTA, all filtering the water as they feed.¹²³ In doing so, they lower overall turbidity, or the amount of suspended material, thus allowing light to penetrate the enclosure and allow for bacteria to grow via photosynthesis.¹²⁴ Traditional shrimp farming has

117. Chopin et al., *supra* note 16, at 209; *see also* María Fraga-Corral et al., *Aquaculture as a Circular Bio-Economy Model with Galicia as a Study Case: How to Transform Waste Into Revalorized By-Products*, 119 *TRENDS FOOD SCI. & TECH.* 23, 27 fig. 1 (2022) (diagram of nutrient cycling under IMTA conditions).

118. Kaitlyn McGarvey et al., *Environmental Impacts of Shrimp Aquaculture and Integrated Multi-Trophic Aquaculture (IMTA) as a Solution*, *DEBATING SCI.: BLOG* (Apr. 19, 2017), <https://blogs.umass.edu/natsci397a-cross/environmental-impacts-of-shrimp-aquaculture-and-integrated-multi-trophic-aquaculture-imta-as-a-solution/>.

119. *Id.*

120. McGarvey et al., *supra* note 119; *see also*, LIRETTE, *supra* note 19 at 27-28.

121. Nisar et al., *supra* note 14, at 5.

122. *See id.* at 2.

123. McGarvey et al., *supra* note 119; *see also*, Robin Kundis Craig, *Re-Valuing the Ocean in Law: Exploiting the Panarchy Paradox of a Complex System Approach*, 41 *STAN. ENV'T L.J.* 3, 70 (2022) (“Thus, not only does aquaculture of these [bivalve] species impose little pollution burden on the marine environment, but these species can actually reduce nutrient pollution in marine environments while providing tasty human food, regardless of whether the pollution comes from fed finfish aquaculture or other sources, such as fertilizer runoff from upstream agriculture.”).

124. McGarvey et al., *supra* note 119; *see also* Christopher A. Lang, *Integrated Multi-Trophic Approaches in Seaweed Farming: Prompting Native Sea Vegetable Production and Consumption to Ameliorate Hypoxia in the Gulf South*, *HOMOCHRYALIS* (2018) (Ph.D. candidate, U.C. Santa Cruz, unpublished writing) <https://static1.squarespace.com/static/577ea7a0414fb58>

specifically been documented as a destructive force against estuarine vegetation such as mangroves.¹²⁵ In a turn of events, shrimp-mangrove integration is garnering attention as a workable model for sustainable cultivation.¹²⁶

Likewise, integration between rice and fish has already undergone several decades of cultivation, research, and intensification.¹²⁷ Other permutations of IMTA involve poultry, whose wastes serve as nutrients for the shrimp.¹²⁸ In addition to ecological benefits, IMTA has also been credited with multiple economic advantages compared to traditional monoculture techniques. Fundamental to the nature of IMTA, production is diversified across species, thus allowing for mitigation of individual price volatilities and overall supply stabilization.¹²⁹ Second, IMTA offers employment for both highly skilled labor and lesser trained talent.¹³⁰ Overall, new aquaculture development in the Gulf South should prioritize integration as a means to achieve ecological and economic sustainability, security, and sovereignty.

acbaef921/t/6192d7d38f98624785b9517a/1637013459310/Chris+Lang+Seaweed+OFRF+Proposal+FINAL.pdf (proposing the study of seaweed integration within aquaculture operations in Louisiana and Texas).

125. Nesar Ahmed et al., *Integrated Mangrove-Shrimp Cultivation: Potential for Blue Carbon Sequestration*, 47 *AMBIO* 441, 442 (2018), <https://doi.org/10.1007/s13280-017-0946-2> (“Among deforested mangroves, 1.89 million [hectares] (52%) were lost to coastal aquaculture, of which 1.4 million [hectares] is attributed to shrimp culture and 0.49 million [hectares] to other forms of aquaculture.”).

126. Ifthakharul Alam et al., *Mangrove Forest Conservation vs Shrimp Production: Uncovering a Sustainable Co-Management Model and Policy Solution for Mangrove Greenbelt Development in Coastal Bangladesh*, 144 *FOREST POL’Y & ECON.* 1, 4 fig. 3 (2022), <https://doi.org/10.1016/j.forpol.2022.102824> (sketching four models of integrated shrimp-mangrove cultivation).

127. Nesar Ahmed et al., *Community-Based Climate Change Adaptation Strategies for Integrated Prawn–Fish–Rice Farming in Bangladesh to Promote Social–Ecological Resilience*, 6 *REVS. AQUACULTURE* 20, 31 (2014), <https://doi.org/10.1111/raq.12022> (“Integration of prawns and fish in rice fields is a practical means to sustainable intensification of agriculture, producing more food from the same area of land without worsening environmental impacts.”).

128. See generally Harsha S.C. Galkanda-Arachchige et al., *Success of Fishmeal Replacement Through Poultry By-Product Meal in Aquaculture Feed Formulations: A Meta-Analysis*, 12 *REVS. AQUACULTURE* 1624, 1624 (2019).

129. Duncan Knowler et al., *The Economics of Integrated Multi-Trophic Aquaculture: Where Are We Now and Where Do We Need to Go?* 12 *REVS. AQUACULTURE* 1579, 1580-81 (2020).

130. *Id.* at 1581.

2024] *AQUACULTURE'S REGULATORY UNCERTAINTY* 65

V. CONCLUSION

As domestic producers and consumers watch the precipitous decline in wild stocks and prices, it seems as though the shrimping industry serves as an exemplar in how environmental and economic forces can collide to upend the livelihoods of communities rooted in a resource and/or labor practice. If there were hope for a panacea, perhaps in the form of aquaculture, then the United States lies far behind most of the world regarding aquaculture infrastructure development as well as the legal, social, and political mores with which to uphold it.

But rather than rejigger the nation's food supply, threaten the delicate interplay between global producers and consumers, or dot the coastline with mass intensification of mariculture systems, food sovereignty requires inward development that is focused on protection of communities made vulnerable by environmental and economic plunder. Under that framework, development can grow at a reasonable rate as well as accommodate local needs and adapt to changing circumstances more efficiently. The Gulf South is uniquely poised to tackle this problem given that the region has a rich history of shrimp cultivation and especially since shrimp account for the single largest seafood import by value.¹³¹

In sum, while precaution may have been wise for much of aquaculture's modern history—that lesson is not mutually exclusive to the litany of other legal considerations applicable to such a broad notion like nourishment. Here, the case study of Gulf South shrimp cultivation shows that without urgent movement toward sustainable and integrated aquaculture, livelihoods, culture, nutrition, and the opportunity to pursue happiness will take leave along with the Barataria shrimp.

131. CONG. RSCH. SERV., R45952, U.S. OFFSHORE AQUACULTURE REGUL. AND DEV. 34 (2019), <https://crsreports.congress.gov/product/pdf/R/R45952>.