**Best Management Practices for Offshore Aquaculture**

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Offshore aquaculture is a developing industry in the Gulf of Mexico that is receiving substantial public interest, particularly from coastal communities and commercial and recreational fisheries. The environmental sustainability and economic viability of offshore aquaculture will be dependent on appropriate site location, facility design, and operational protocols. This presentation will focus on the potential ecological impacts of offshore aquaculture and the “Best Management Practices” that will minimize and/or mitigate those impacts. The content of this presentation was excerpted from the Gulf and Caribbean Fisheries Institute Special Publication Series #4 (Price and Beck-Stimpert, 2014).

The primary ecological impacts of offshore aquaculture on the marine environment include:

* *Nutrient Enrichment — Water Column*
* *Sediment Accumulation — Anoxia*
* *Wildlife Interactions — Biodiversity*
* *Fish Health*

The ecological effects to water quality can be summarized as:

* *Excessive nutrient loads — Nitrogen and Phosphorus*
* *Increased BOD — Biological Oxygen Demand*
* *Toxicity from net cleaning agents, boat fuel, and equipment*

Best Management Practices to provide a high water quality environment in and adjacent to netpens:

* *Site in deep, well-flushed waters*
* *Avoid excessive net fouling*
* *Establish nutrient and water quality thresholds*, *and tailor monitoring plans to account for threshold concentrations* in *sensitive marine habitats*
* *Discourage the use of chemical anti-foulants and, when possible, employ mechanical cleaning methods*
* *Quickly remove and properly dispose of fish mortalities*
* *Consider the use of integrated multi-trophic aquaculture (IMTA), when practicable*
* *Encourage clean harvest methods and off-site processing* and c*ollect operational waste for off-site disposal*
* *Take measures to prevent discharge of contaminants from farm and develop a chemical spill response plan*
* *Properly maintain and operate farm vessels and equipment to minimize leaks, spills, or waste loss*

The ecological effects to the sediments beneath and adjacent to netpens can be summarized as:

* *Sediment accumulation under farms creating anoxic benthos*
* *Settlement of feces and uneaten food*
* *Detachment of fouling debris from nets or sloughing of antifouling materials*

Best Management Practices to minimize the impact on the sediment and benthic environment beneath and adjacent to netpens:

* *Site in well-flushed area to disperse nutrients and suspended solids — hydrographic study*
* *Monitoring protocols for “footprint of deposition” or “sediment impact zone”*
* *Establish “allowable benthic impacts” using the chemical sediment properties as indicators (DO, sulfides, organic carbon)*
* *Establish and monitor a “Benthic Enrichment Index” (BEI) – forming anoxia*
* *Implement a netpen rotation or fallowing plan*
* *Monitor and mitigate net fouling debris*

What are the ecological and genetic risks of aquaculture fish that escape from netpens?

* *Establishment of exotic species*
* *Interbreeding to the alteration of the gene pools of local crustacean or fish* populations
* *Release of fertilized eggs and larvae*
* *Disease transmission by escapees to wild fish*

Best Management Practices to minimize the ecological and genetic risks of escapes include:

* *Culture local (native or naturalized) species and discourage or prohibit the culture of non-native species*
* *Conduct a risk assessment for non-local species*
* *Develop a broodstock program that conserves genetic diversity (integrated approach) or selects for low wild fitness (segregated approach)*
* *Avoid unintended releases of cultured gametes, eggs, and larvae — harvest prior to sexual maturation*
* *Consider stocking sterile fish, when practicable*
* *Develop and regularly update an escapes reduction and mitigation plan for each farm*
* *Use cage designs that are properly engineered to minimize the possibility of escape*
* *Routinely monitor cages for escapement and properly maintain cage equipment and boat propellers*
* *Establish predator deterrence procedures*
* *Initiate Coast Guard approved warning protocols for non-farm traffic*

Best Management Practices to consider for developing formulated fish feeds of use in offshore netpens:

* *Eliminate raw feed ingredients such as small fish, squid, and fish processing and animal slaughter waste*
* *Provide feed companies with composition, performance and practical feeding requirements (sinking rate, fines, pellet hardness, etc.) for each cultured species*
* *Promote techniques to improve feed conversion ratio and minimize excess feed input*
* *Maintain and analyze records of fish growth, survival, feed used, feeding times, and ration amounts*
* *Encourage feed companies to use feedstuffs from environmentally responsible sources and practice continuous improvement in all aspects of feed formulation and manufacture*
* *Procure feed with an adequate amount of long chain omega-3 fatty acids to produce a final product with equal or greater levels of these fatty acids compared to that of the same species from the wild*
* *Handle and store food appropriately to maintain quality*

What are the impacts of netpen aquaculture on fish health?

* *Without a healthy, clean cage environment fish can soon become stressed or sick, resulting in poor health, impaired growth, and possibly death*
* *Buildup of biofouling organisms on netpens will impede water flow and potentially cause fish abrasions*
* *Inappropriate stocking density can create stress, reduce feeding activity, and impede growth*

Best Management Practices to promote fish health in aquaculture netpens include:

* *Develop a health monitoring plan and implement protocols*
* *Consult and cooperate with aquatic animal health experts or veterinarians at various levels of operation*
* *Develop and employ biosecurity practices and quarantine protocols*
* *Use appropriate stocking densities and employ techniques to minimize physiological stress to cultured organisms*
* *Provide prophylaxis, such as fish vaccination prior to stocking into cages — if available and necessary*
* *Use only FDA-approved drugs, and minimize the use of antimicrobials*

Best Management Practices to minimize the ecological effects of offshore netpen aquaculture interacting with native wildlife:

* *Avoid disruption to native biodiversity, especially protected species*
* *Prevent predator interactions and use non-lethal predator deterrents, when necessary*
* *Use proper cage design to minimize entanglement with marine animals and other protected species*
* *Site farms away from corals, seagrass, mangroves, and other sensitive habitats*
* *Exercise caution when operating vessels to avoid collisions with sea turtles and marine mammals*

The “Human Dimension” will play a considerable role in moving forward with offshore aquaculture:

* *Carry out public input process prior to permit issuance*
* *Conduct economic/market analysis to project local economic effects*
* *Hold informational meetings in local area*
* *Identify potential or perceived conflicts with wild harvest, markets, tourism, recreational use, aesthetic value, cultural activities, or navigation*
* *Provide educational materials and work on outreach issues with local community*
* *Meet community needs when possible/practical (e.g., jobs) — Train/employ local workforce*
* *Consider including tourism and recreational fishing in operations*
* *Avoid traditional fishing areas and areas of aesthetic importance*
* *Avoid flooding local market(s) with cultured fish*
* *Work with local community to market cultured fish when/where possible*

In summary, the Best Management Practices to minimize the ecological effects of offshore netpen aquaculture are:

* *Minimize nutrient accumulation at the site*
* *Optimize feeding protocols*
* *Implement cage rotation or fallowing if nutrient loading exceeds ecological threshold*
* *Employ methods to minimize physical disturbance to habitat and biodiversity*
* *Utilize responsible cage cleaning methods*
* *Be responsive to stakeholders in coastal communities and the maritime industries*

LITERATURE CITED

Price, C.S. and J. Beck-Stimpert (editors). 2014. Best Management Practices for Marine Cage Culture Operations in the U.S. Caribbean. GCFI Special PublicationSeries Number 4. 52 pp.