Integrating Aquaculture into Caribbean Development: Environmental Impact Assessment

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ABSTRACT

An Environmental Impact Assessment (EIA) is a multifaceted review process that involves consideration of all aspects of development activities and how that development will affect and blend into the existing environment. It also acts as a link between the concerns of governmental bodies/regulatory agencies and the needs and priorities of the developer. For aquaculture development, an EIA can also be a tool in discerning the most appropriate species, system design, and management practices for ensuring that the environment needed for a successful culture venture remains sustainable.

Some of the unique environmental concerns faced by aquaculturists in the Caribbean include limited freshwater supply, sensitive island habitats, oligotrophic waters, and coral reefs. Therefore, when reviewing the environmental impact issues for aquaculture development in the Caribbean, it is important to cover potential habitat loss, resource depletion, introduction of non-native species, and eutrophication from nutrient waste. Developing appropriate Terms of Reference along with mitigation and monitoring procedures will aid in governmental guidelines and regulatory parameters, while incorporating the aquaculture developer's needs for production. An environmental matrix that incorporates the culture species and systems considerations can be used for evaluating aquaculture development environmental impact issues, while providing an assessment guide for the government and the aquaculture developer.

KEY WORDS: Environmental impact assessment, Caribbean aquaculture

Acuacultura que Integra en el Desarrollo del Caribe: Impacto en el Ambiente

Un gravamen del impacto al ambiente (EIA), es un proceso de la revisión de facetas multiples que implica la consideración de todos los aspectos de las actividades del desarrollo y cómo ese desarrollo afectará y entremezclará en el ambiente existente. También actúa como acoplamiento entre las preocupaciones de las agencias gubernamentales y de las necesidades y las prioridades de ésos que desarrollan un negocio de la acuacultura.

Para el desarrollo de la acuacultura, un EIA también puede estar de uso en

la determinación del la mayoría de la especie apropiada, el diseño del sistema y las prácticas de gerencia más apropiados para asegurarse de que el ambiente necesitó para un restos acertado de la empresa de la cultura sostenible.

Algunas de las preocupaciones ambientales por el agricultor en el Caribe incluyen agua dulce limitada, habitat sensibles de la isla, oligotrophic aguas, y filones coralinos. Por lo tanto, cuando el repaso de las consecuencias para el medio ambiente publica para el desarrollo de la acuacultura en el Caribe es importante cubrir pérdida potencial del habitat, el agotamiento del recurso, la introducción de la especie extranjera, y el eutrophication de la basura del alimento. Establecer Términos de la Referencia junto con la mitigación y de los procedimientos de la supervisión ayudarán en pautas gubernamentales y parámetros reguladores, mientras que incorporan las necesidades de produccion de el agricultor de acuacultura. Una matriz ambiental que incorpora la especie de la cultura y las consideraciones de los sistemas se pueden utilizar para evaluar el desarrollo de la acuacultura que las consecuencias para el medio ambiente publican, mientras que proporciona a una guía del gravamen para el gobierno y al revelador de la acuacultura.

PALABRAS CLAVES: Acuacultura, desarrollo del Caribe, impacto en el ambiente

INTRODUCTION

Environmental Impact Assessments (EIA) are typically used as part of the government evaluation process in determining whether a given development is suitable for a particular area. This multifaceted review involves consideration of all aspects of a development's activities including how the development will affect the existing environment, whether it complies with local planning and regulatory measures, and whether the socio-economic benefits are substantial enough to warrant the changes made by the development. In short, will the particular development maximize the potential use of a given resource (whether land, sea, harvestable product, human resource, or otherwise) in a sustainable manner.

For aquaculture related developments, there are a number of specific issues that should be addressed within the EIA. These include type of culture species, source of seed stock, site selection, rearing system, nutrition/feed sources, diseases, economics, and marketing. These issues are also the same concerns of any serious aquaculture developer. Depending upon the above parameters, some of the impacts to the marine and terrestrial environments can include habitat loss/degradation, changes in biodiversity, introduction of species, water quality problems, and natural resource depletion. Social impacts can be positive including creation of employment opportunities, enhanced infrastructures or services, and better utilization of the labor resource pool. Monitoring, management and mitigation measures may amend for some impact issues, or lead to alternative plans. Defining the parameters, issues, impacts and mitigation measures in a qualitative / quantitative summary aids both the developer, EIA specialist and the decision maker in addressing issues and refining appropriate alternatives for sustainable development.

ENVIRONMENTAL IMPACT ASSESSMENTS – A BRIEF REVIEW

In most countries, a potential developer is asked to submit an EIA in the initial stages of the development application process. This EIA is usually done by a team of scientists approved by the government. The governing body in charge of this process then issues a Terms of Reference (TOR) to the EIA team for that development. The TOR acts as a guideline and format for the issues that need to be addressed in the EIA.

A typical TOR includes:

i) Executive Summary,
ii) Introduction that outlines areas of assessment, scoping, and methodology,
iii) Description of the Environment to be Affected,
iv) Description of the Development,
v) Potential Impacts of the Development (Marine, Terrestrial and Social),
vi) Monitoring, Management, and Mitigation Measures,
vii) Alternatives/Recommendations,
viii) Conclusion,
ix) Appendices including reference materials, CV's of EIA team members, and other relevant info.

The EIA team scientists are responsible for collecting baseline data on the existing environment. Both quantitative and qualitative analyses are used to describe the immediate and surrounding areas under consideration for development. The three main sections for assessment are Marine, Terrestrial and Social. The Marine and Terrestrial sections are then further divided into descriptions of the Physical and Biological/Ecological Environments. The social sections typically include current demographic information, available infrastructure, and human resource components.

The Terrestrial Physical aspects would include topography, hydrology, climatic and other physical characteristics of the site, including inland water/wetland features. The Marine Physical would include information on coastal and oceanic parameters such as winds, tides, currents, waves, bathymetry, and water quality. The Biological/Ecological aspects of both Terrestrial and Marine would include quantitative analysis of the existing flora and fauna with particular emphasis on endemics, rare, commercial or endangered species, ecologically sensitive habitats, and conservation/preservation areas.

A description of the development under consideration then follows for reference within the potential impact section. This information is usually provided by the developer for inclusion within the EIA and should include construction and operation phase activities with expected time frames. Since almost all type of developments will have both construction and operation phases, it is often useful to delineate between the two when addressing associated impacts. The construction phase often deals with acute physical and biological changes with social influxes of employment and infrastructure needs not associated with the ongoing operations phase.

Impacts can then be addressed separately based on the particular phase and

the type of activity involved. Physical impacts may include changes to the topography, hydrology or other terrestrial features, or in the case of marine, littoral changes, or even aesthetics of an area. Biological/Ecological impacts for terrestrial and marine can include habitat degradation, loss, fragmentation, isolation; reduced species population or changes in biodiversity; pollution of air, water and land via specific factors such as sedimentation and run-off of sewage, fresh and grey water or hazardous chemicals; increased use of resources/ resource depletion. Social impacts may include changes to the demographics of an area, employment and infrastructure impacts, and such things as stress bearing levels on local recreation areas. Impacts are often described in terms of whether they may be cumulative or synergistic, positive or negative, direct or indirect, immediate or long-term, and unavoidable or irreversible.

All of this information can then be used to identify areas where monitoring, management or mitigation is needed or in some cases where alternatives / recommendations may be suggested. Where possible, impacts should be defined in financial terms showing losses/gains for comparison. Otherwise, a summarization of the potential impacts, ranking of their estimated level of impact (eg., positive/negative-- high, medium, low,) is often helpful to decision makers in their review process. These findings then can be compiled for short review in an Executive Summary and Conclusions.

ISSUES/CONFLICTS FOR AQUACULTURE DEVELOPMENT

All potential aquaculture developments face the same set of parameters when establishing their plans. What species to culture and where? What type of system to use, and where will the seed stock come from? What are the nutritional requirements, is a feed source readily available, and what are the disease concerns? Finally, what and where are the markets, and is this whole venture going to be economically viable? These same criteria are also questions when evaluating an aquaculture venture from an EIA standpoint.

Identifying an appropriate ***culture species*** that will grow well in a given area is a chief priority of the developer, but is cause for concern if the species is non-native and has the potential to become introduced. Although rearing systems and culture techniques may alleviate the problem, introduction of species, particularly in small island environments, is of grave concern.

The ***site selection*** process for the developer usually incorporates such factors as water accessibility, soil suitability, access to needed infrastructure, security, and real estate values. From another viewpoint, government would want to ensure that there are no conflicts with other developments in the area, particularly in coastal regions, where often high-dollar tourism development may pose more opportunities to the local economy. For offshore culture systems, there may be conflicts with usage of the “queen’s bottom” where navigation / recreation for the general populace is an issue or possibly overlap with conservation/preservation areas. Both onshore and offshore ventures need to take into account any environmentally sensitive habitats, such as coral reefs, mangroves, seagrass beds, wetlands, and salinas. As island biogeography dictates, island ecosystems are often rife with “bio-hotspots” where endemics

abound and preservation of this genetic biodiversity is a chief concern.

Source of reliable ***seed stock*** is another culture parameter that has to be addressed in every business plan. If seed is derived from local natural sources, the government must ensure that it does not conflict with local fisheries. Proof of "biological neutrality", stock enhancement or "put back programs", may be needed to mitigate for taking from local reserves.

The type of ***rearing system*** is also a major constituent in the development plan. Is it intensive or extensive culture, open or closed system, land or sea based or a combination of all? For impact evaluations, the primary concerns would be water sources and effluent controls. Well designed systems with frequent monitoring and good management plans are necessary for both the viability of the venture as well as to ensure the sustainability of the environment.

Nutritional requirements of the candidate species and the availability of the feed source is another major consideration for the aquaculturist. Negative implications, again, include effluent disposal and the threat of eutrophication in surrounding areas. A positive attribute is if local fisheries products or by-products can be utilized. ***Disease*** introduction is another problem for consideration, as well as the use of antibiotics in feed and/or water resources.

Overlaying all culture components is the need for economic viability of the operation. Having a successful development is a priority, in particular for small island governing agencies, where land and resources are limited and must be utilized to their maximum potentials. Realistic business plans with good market potentials for local consumption or export, are important issues for consideration by both parties. Socio-economic impacts are often positive with the creation of employment opportunities and training, as long as it does not take away or compete with other local enterprises or traditional means. Other impacts may include increased use or enhancement of existing infrastructure, expansion of local markets, and opportunities or competition of the same.

INTEGRATING AQUACULTURE INTO ENVIRONMENTAL IMPACT ASSESSMENTS

Integrating aquaculture into the EIA process can most easily be accomplished by categorizing the issues into the areas of potential impact. In doing so, one can more clearly define the issues/conflicts and potential losses and gains associated. These can then be quantified for comparison with other developmental activities or alternatives to the project design. Table 1 summarizes the aquaculture parameters, issues/conflicts and the associated impacts/ risks for each. This section deals with operation phase impacts (not construction phase) only for aquaculture impacts.

The evaluation can be expanded to include whether the impacts are cumulative or synergistic, positive or negative, direct or indirect, immediate or long-term, and unavoidable or irreversible. Monitoring, management, and mitigation measures also need to be evaluated in terms of reducing impact implications and levels. A more complete overall analysis would include these measures and differentiate between impact levels for both positive and

negative impacts and whether they can be considered as high, medium or low impacts. The positive and negative impact levels can also be given numeric values for a final tally of overall impacts when comparing differing scenarios.

Table 2 illustrates a hypothetical aquaculture scenario where spiny lobsters are to be grown in cages offshore. The site chosen is in a remote area with few employment opportunities, yet has seagrass beds in the culture site and reefs nearby, posing risk and degradation to sensitive vital habitats. Seed will have to be taken from the wild but a put-back program is planned. By-products from the local fishery will be used for a feed source. Effluent control could definitely pose problems, but strict monitoring protocols will be in place. Also, the economic viability is still uncertain, so plans are to begin with a pilot scale project that can be easily removed or expanded if it is successful. Employment opportunities and enhancement of local infrastructure is necessary to begin the project.

In evaluating this scenario, it is obvious there are a number of risks involved. Probable habitat degradation and loss, possibly increased effluent problems, with a combined risk of non-proven economic viability. Monitoring and mitigation plans do aid in reducing these risks, i.e. starting with a pilot scale venture to minimize expected impacts with the opportunity of rectifying potential problems (e.g., effluent controls) as they come on line. It is at this point that the EIA specialist may propose further recommendations / alternatives to reduce impacts. In this scenario, the specialist may recommend to the developer and government that a cage rotation management plan be implemented to help reduce deterioration of seagrass beds due to shading, and that the offshore site be moved further from the nearby coral reefs with a 1:1 habitat restoration plan for mitigating losses.

Another scenario, shown in Table 3, examines impacts for shrimp culture in ponds. In this plan, the species of shrimp used are non-native, yet other wild species of shrimp exist in the area posing potential introduction of species and possible disease risks. The site for the pond facility is already impacted with non-endemics, but a freshwater source is needed for diluting the saltwater systems an is from a local limited groundwater supply. Effluent disposal is also a problem and could possibly contaminate the groundwater supply if not properly handled. All seed and feed is imported, but the economic viability is good and easily supports import costs. There are a few employment opportunities, some local market competition with expansion into exports viable, but will add stress to local infrastructure. This scenario also has a number of potential impact problems, but with a few positive gains. Recommendations / alternatives could further reduce those impact risks; for instance, consideration of a closed recirculating system to minimize introduction of species and disease potentials, as well as more complete effluent control.

Table 1. Aquaculture Parameters, Issues and Associated Impacts

Aquaculture Parameter	Issue/Conflict	Impact/Risk
Species Selection	Native or non -introduction of species	Reduced species population -changes in biodiversity
Site Selection	Conflicts with other development Use of common land/water Use of conservation area	Habitat loss, degradation, fragmentation, isolation Biodiversity implications if in areas of endemics Social implications if in conflict with other user groups
Seed Source	Conflict with fishery resources or balance of natural systems	Reduced species population –changes in biodiversity
Rearing System	Competition for water resources Water Quality -effluent disposal	Increased use of resource – resource depletion Pollution of water, land
Nutrition/Feed	Water Quality – effluent disposal Positive use of local by-products	Pollution of water, land
Disease	Introduction of disease to natural populations Use of antibiotics or other treatments	Reduced species population –changes in biodiversity Pollution of water, land
Economics/ Market	Viability for sustainability Employment opportunities Local or export potentials Staff/labor force Infrastructure needs	Appropriate use of resources Enhance and expand local economy Changes in demographics Increases in infrastructure or over utilization of existing

Table 2. Aquaculture Impact Scenario 1- Spiny Lobster in Cages

Parameter	Criteria / Issue	Monitoring/Mitigation	Impact Level
Species	Spiny Lobster - native	No intro of species	0
Site Selection	Primarily offshore Remote area	No competition for land or sea space	0
	Nearby reefs	Risk habitat loss/	-1
	Over seagrasses	degradation	-2
		Probable Habitat loss/ degradation	
Seed Source	Collect local pu-	Competes with local fishery	-1
	erulus	Plan put back program	+1
Rearing System	Cages/effluent control	Monitoring Plan	-1
Nutrition/Feed	Local by-products	Pos use of by-products	+1
	Effluent Control	Monitoring Plan	-1
Disease	Not known in cul-	Monitor	-1
	ture		
Economics/Market	Viability unproven	Pilot scale first-easily re-	0
	Market – export	moved	+1
	whole live	No compete/expands mar-	+1
	Employment for	ket	
	depressed area	Need Employment	+1
	Enhance local		
	infrastructure	Need Enhanced Infra	
Totals			-7/+5

Table 3. Aquaculture Impact Scenario 2- Shrimp Culture in Ponds

Parameter	Criteria / Issue	Monitoring/Mitigation	Impact Level
Species	Shrimp -introduced	Risk intro of species	-1
Site Selection	Land already im-	No bio impacts	0
	pacted	Risk resource use prob-	-1
	Freshwater from local source	lems	
Seed Source	Import	No bio impacts	0
Rearing System	Pond culture	Effluent control/disposal-- monitoring	-1
Nutrition/Feed	Import Feeds	No compete	-1
		Effluent control--monitoring	
Disease	Several	Risk intro of disease to local	-1
Economics/Market	Viability Proven	Positive economics	+1
	Market – local and export	Competes local but ex- pands export	0
	Employment	Positive	+1
	Use local infra- structure	Strain on local infrastruc- ture	-1
Totals			-6/+2

If the two scenarios were compared as they are, it would appear that even though there are more risks for the spiny lobster culture (-7), there are also more gains (+5). But unfortunately, not all scenarios are as simplistic and straightforward as these, nor are environmental and economic issues given the same weight in priority in most cases. Rather, a combination of needs and other interests (e.g., a 5 star resort at the site) will weigh into the balance. But by performing a complete EIA with thorough impact analysis, both the aquaculturists and approving agencies can better define the issues and impacts with opportunities to make adjustments or mitigate, while weighing the hazards and benefits to both.

CONCLUDING REMARKS

To responsibly integrate aquaculture into the Caribbean, guidelines and protocols should be established that protect both the environment and the communities that rely upon it. The Environmental Impact Assessment process technically evaluates the pros and cons of differing developmental activities and is one way in which aquaculture developments can be responsibly addressed. The information detailed above summarizes the EIA process, attempts to pinpoint issues and impacts specific to aquaculture development and, describes a method for evaluation in an effort to guide both developer and decision maker in understanding and assessing the aquaculture development's potential benefits and losses.

Most aquaculture endeavors rely upon a healthy environment to be productive and thereby economically viable. Government and regulatory agencies are also seeking to achieve a healthy economy without over-utilization of their resources. Unlike many other types of developments, in aquaculture both the developer and decision maker are striving for a balance between economic and environmental health, which in itself can be considered a positive and beneficial impact.

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