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Extension Programming in Support of Public Policy for the Management of Aquaculture in Common Water Bodies

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Abstract

Michael A. Rice. 2014. Extension Programming in Support of Public Policy for the Management of Aquaculture in Common Water Bodies. *Aquacultura Indonesiana, 15 (1) : 26-31.* Many countries of Asia, including Indonesia, have experienced the problem of hypoxic fish kills among fish in netpens and fish corrals in various publicly-held water bodies. Fish farming in enclosures in public water bodies attractive because of low overhead costs in comparison to farming the identical species in constructed ponds. But aerobic bacterial degradation of feed and fish feces in common waters can lead to oxygen depletion, thus causing fish kills. Mass-balance and ecological carrying capacity models and education through and extension programming can be used to inform policy makers as to the maximum biomass of farmed fish allowable before risking hypoxia. Economic modeling of social costs and lost revenue in fish kills can also be used to inform and refine public policies. Tools for managing aquaculture carrying capacity might include managing demand for permits by increasing fees, holding auctions for fixed numbers of permits, or using a system of capping, developing offset charges for finfish effluents, and trading of rights to discharge. In this system, holders of finfish netpen permits would pay an offset to nearby aquafarmers conducting nutrient extractive forms of aquaculture (e.g. bivalve or seaweed farming), thus making often desired Integrated Multitrophic Aquaculture (IMTA) systems more economically viable. The important work of translating recommendations from environmental and economic modeling into practical public policy and management practice requires a considerable effort in extension programming and ongoing exchange among the scientific, industry, regulatory and policy-making communities.

Keywords: Aquaculture extension programming; Aquaculture management; Aquaculture policy; Economic modeling; Carrying capacity modeling; Hypoxic fish kills

Introduction

Hypoxic fish kills associated with net pen, fish cage or fish corral aquaculture of finfish in public common water bodies (including coastal seas, estuaries, rivers, lakes and reservoirs) has been a growing problem throughout East and Southeast Asia as the demand for cultured fish grows and the relative profitability of high density fish culture methods in enclosures becomes known. Intensive culture of fish in various types of pens and enclosures in public common waters are popular because overhead costs for culturing fish are often lower than ponds because cost of land and earth moving are avoided, often resulting in higher profitability (Beveridge, 1984; De La Cruz-Del Mundo *et al*., 1997; Naylor *et al*., 2000). Fish kills began in the late 1970s with fish pens located in the Laguna de Bay of the Philippines, then in 1996 in the estuaries of the Dagupan City region, and still later in other areas in the Pangasinan Province of the Philippines (LLDA, 1995; Rice and DeVera, 1998; San Diego-McGlone *et al*., 2008). Over the last four decades, fish kills associated with excessive biomass of cultured fish have also occurred in China (Guo *et al.*, 2012), Vietnam (Nguyen *et al.*, 2013), Malaysia (Anton *et al*., 2008) and Indonesia (Abery *et al.*, 2005). Fish kills remain as an urgent problem in Indonesia; as recently as 15 March, 2014, fish kills occurred in Danau Maninjau, West Sumatra (Bachyul, 2014).

The typical response of policy makers to fish kills has been to completely ban fishpens from local bodies of water, frequently leading to considerable political controversy. For instance the initial responses to massive fish kills in the large freshwater lake, Laguna de Bay, in the Philippines in the mid-1980s included an immediate ban on fish pens and the creation of an intergovernmental commission to oversee and manage fishpen operations and other economic activity in the lake (LLDA, 1995; Guerrero, 1996). Unfortunately pressure to reinstate fish pens in the lake led to a continuing cycle of boom and bust in fish farming punctuated by periodic hypoxic fish kills followed by a period in which all fishpens were banned by public policy. However due to the profitability of fish pen culture of popular market species, political pressure eventually resulted in the return of pens to the lake in such densities that hypoxic fish kills

again occurred. This official response of total banning of fish pen aquaculture resulting from hypoxic fish kills was most recently employed by municipal officials in Dagupan City (Cardinoza and Sotelo, 2013) largely because policy makers and enforcement professionals perceive that they have no other practical options to consider. This paper reviews ongoing efforts to model carrying capacity of fishpen and fish cage aquaculture in common public water bodies and reports on two pilot extension workshops held in the Philippine province of Pangasinan in early June 2013. Municipal and provincial officials were invited to explore use of carrying capacity and economic modeling too manage aquaculture in their jurisdictional water bodies to prevent fish kills by stocking density management rather than by outright aquaculture prohibition.

Value of Environmental and Economic Modeling as Policy Tools

Rice and DeVera (1998) and Abery *et al.* (2005) pointed out that numbers of fish pens and biomass of cultured fish placed into publicly-held water bodies can gradually reach unacceptably high levels because few political decision makers have the knowledge of the concept of excessive biomass loading by fish and feeds, or the more general concept of ecosystem carrying capacity. Additionally in their desire to foster economic growth within their political jurisdictions and to provide funding for worthwhile public works projects, the official issuance fish pen permits is seen as a reliable means for generating funds for public works. Of course when hypoxic fish kills eventually do occur, there are disruptions in local fish markets and municipal generation of permit revenues are hampered, often with unintended economic and political consequences (Holmlund and Hammer, 1999).

But how can fish pens and fish cages be managed in such a way that fish are sustainably harvested from public water bodies and hypoxic fish kills are eliminated? A number of researchers have offered recommendations to manage fish pen aquaculture to reduce likelihood of fish kills. These include: 1) reducing nutrient output by improved FCR through improving feeding strategy and reducing overfeeding (Boyd *et al.*, 2008); improvements in feeds accounting for species specificity and greater digestability and assimilation efficiency (Thorpe and Cho, 1995; Talbot *et al.*, 1999); increasing the stability of pelleted feeds via the use of a good binder or the use of extruded feeds (Cho *et al*., 1994); using nutrients from fish production by extractive species, such as mussels, oysters and/or seaweeds in integrated multitrophic aquaculture in marine and brackishwaters and hydroponics in freshwater (Schpigel *et al.*, 1993); zoning aquaculture into areas away from sensitive habitats and within the local carrying capacity (White and San Diego-McGlone, 2009); and use of carrying capacity modeling to develop public policy capping the numbers, and sizes of cages, and stocking densities and biomass of fish, and use auctions or other economic policy strategies to maximize monetary return from permits issued by official agencies (Rice and DeVera, 1998; Hanley *et al*., 1998; Lowry *et al.*, 2005).

Most of these management strategies require a prediction of how many fish and fishpens can be accommodated in any particular water body. Since Beveridge's (1984) pioneering work on modeling of the effects of effluents from net and pen structures and the effects of those wastes on water quality, a number of other studies have been undertaken to determine maximum biomass stocking densities or production carrying capacity of cultured fish in cages and net pens in a variety of water bodies and water flow regimes (Magdaong and Villanoy, 2003). In most cases, estimates of maximum allowable fish biomass allowable in water bodies is typically derived by using mass-balance to estimate the biological oxygen demand associated with decomposition of excess carbon loading associated with fish feeds (Cromey *et al.*, 2002). Other models focus on excess nutrient (usually nitrogen in marine systems or phosphorus in freshwater systems) loading that promote hypertrophic phytoplankton blooming that may result in diel hypoxic events, occurring usually in the early morning hours (Hall *et al*., 1992; Howarth and Marino, 2006). Legovic *et al*. (2008) have undertaken a major sampling and modeling exercise to calculate carrying capacity in three netpen aquaculture areas in the Philippines and have made a number of strong recommendations for managing the farms for fewer fish kills. But unfortunately few of the recommendations from these numerous studies have been translated into actual management policy and fish kills continue.

Extension Workshops in Carrying Capacity Modeling and Policy Formation

Since the promulgation of the 1986 Philippine Constitution, there has been a greater

emphasis on local governance and this extends to the management of coastal, estuarine, riverine, and lacustrine water bodies within municipal jurisdiction, and this also extends to the assignment of agricultural (including fisheries and aquaculture) extension professionals to individual cities and municipalities who are ultimately responsible to the local mayor and other local elected officials (Lowry *et al*., 2005). One of the consequences of the devolution of the agricultural extension services to the local governments is that extension expertise in various agricultural commodities is diffused throughout the country and the role of the national government is to engage primarily in research and training activities by way of a national extension network in order to keep the locally-based extension professionals up-to-date.

Recognizing this particular nuance of the agricultural extension network in the Philippines, two pilot workshops in aquaculture carrying capacity modeling and aquaculture policy formation that were entitled "Workshops on Modeling Impacts of Aquaculture Production and Use of Common Water Bodies" were held in two locations in Pangasinan. The first was held at the Asian Fisheries Academy located on the grounds of the Bureau of Fisheries and Aquatic Resources (BFAR) National Integrated Fisheries Training and Development Center (NIFTDC) on June 6, 2013 in the Bonuan Binloc District of Dagupan City. The invitees to the NIFTDC workshop included extension professionals, key aquaculture industry representatives, including feed mill representatives, and some fish pen operators and elected municipal officials from Dagupan City and nearby municipalities (San Fabian, Binmaley, Lingayen and Labrador) in the Calmay-Pantal-Agno River estuary system that make up the metropolitan region of Dagupan. The NIFTDC workshop was attended by 89 participants and had a formalized structure with introductory welcome addresses by Dagupan City Mayor Belen Fernandez and the Regional Director of BFAR and the Director of the NIFTDC. The opening ceremonies were covered by local television and there were formal presentations by BFAR and University of the Philippines researchers who undertook fish kill investigations in the Dagupan estuary. Additionally, there were presentations on carrying capacity modeling and IMTA systems including oysters that would be appropriate for the local estuary. The workshop discussion took on a particularly urgent tone as concern was expressed by fish feed manufacturers and some fishpen operators that a complete ban on fishpens in city waters would take place a month later by order of Mayor Fernandez and the Dagupan City Council. The removal of fish pens from city waters began on July 13 (Cardinoza and Sotelo, 2013). After considerable afternoon discussions after the formal presentations, attendees of the workshop agreed to a concluding resolution to be transmitted to the Mayors of all the Local Government Units (LGUs) of the metropolitan Dagupan City area that contained the following six resolves:

1. That BFAR-NIFTDC will provide assistance on water quality assessment that will determine the carrying capacity of the rivers for the production of bangus [milkfish] and other species of fish; and
2. That degraded carrying capacity for fish production be the basis for the moratorium to be implemented by the Local Government Units (LGUs) for at least five (5) years to allow recovery of the estuaries; and
3. That a request be submitted to the Department of Public Works and Highways (DPWH) for the dredging of the Pantal River during the moratorium period; and
4. That prior to granting new fish farming permits after the moratorium period, BFAR-NIFTDC will provide sustained assistance in the re-mapping of rivers of Dagupan City and Binmaley, Pangasinan, and assist LGUs in determining optimal numbers and sizes of pens or cages, fish stocking densities, and placement of fish pens and cages in the estuaries; and
5. That the LGUs develop regulatory standards for feeds when used in fish pens and fish cages in their jurisdictional common waters, (e.g. use of floating feeds that disintegrate slowly in water); and
6. That the LGUs develop policies for promotion of Integrated Multi-Trophic Aquaculture Systems (IMTA) in common waters through appropriate permitting and fee structuring.

A second workshop was held a day later on June 7, 2013 at the BFAR Regional Mariculture Technology Demonstration Center (RMaTDeC) approximately 65 km on the Tambac Bay of Western Pangasinan in the coastal village of Lucap, the gateway to

Hundred Islands National Park in Alaminos City. In the late 1990s after several fish kills occurring in the metropolitan Dagupan City area, netpen culture of milkfish expanded into Northwestern Pangasinan, particularly in the municipal waters of the nearby towns of Bolinao, Anda and Sual that are known to have channels and inlets with good tidal flushing. But despite better flushing rates, fish kills began occurring in the area by 2002. Invitees to the RMaTDeC workshop included agricultural extension professionals, municipal officials and fish pen operators from Alaminos City and several towns in Northwestern Pangasinan that included the island municipality of Anda, and the mainland coastal municipalities of Bolinao, Anda, Agno and Sual. There were 42 attendees at the workshop which was much more informal in nature by being conducted without media coverage and introduction by local dignitaries. After formal presentations on carrying capacity modeling and IMTA, the participants from the municipalities shared the various management strategies for fish pens and fish cages permitted in their municipalities. Most of the fish kill problems in Western Pangasinan since 2002 were largely confined to the primary fish farming areas in the towns of Bolinao and Anda. Ms. Florencia Guanzon, the municipal agriculture officer of the municipality of Sual shared that they have adoped some policies to extend the distance between fish pens such that they are placed in an array in a 10 ha zoned maiculture area with about 40 m separation distance among 18m-diameter circular floating net pens. Additionally, municipal leasing fees are set at a higher rate than other municipalities in order to fund greater numbers of enforcement officers and municipal patrol boats. To be legal, a fishpen must be issued an Environmental Compliance Certificate (ECC) from the town and operate within the confines the zoned mariculture area that was designed to accommodate 50 net pens. According to Ms. Guanzon, fish pen operators are willing to pay for the higher municipal fee of PHP10,000 (US$ 200) based on their knowledge that there is less risk of fish kills in Sual. Despite municipal efforts to manage the numbers and placement of pens, numbers of unregistered floating fish pens in Sual increased to over 700 in the last few years, with many of the pens located outside of the zoned mariculture area, Sual has not yet been plagued by repeated fish kills despite producing about 30 tonnes of milkfish, *Chanos chanos*, on a daily basis. This report of the proliferation of unregistered fishpens proliferating beyond the 50 planned and permitted pens in Sual stand as testimony to the difficulty of enforcing limits on fishpen development once an area gets a reputation for profitability among investors. Interestingly, three months later in September 2013 controversy was generated in Sual when unregistered floating fish net pens were placed to close to the cooling system water intake pipes of a 1,200 MW coal-fired electrical generation station in Sual, shutting down the plant for six hours causing blackouts in the Luzon electrical grid (MST News, 2013). Negotiations among the Pangasinan Governor Amado Espino, Sual Mayor Roberto Arcinue and the power plant manager Ruben Licerio resulted in an agreement to move the fish pens away from the power plant. (Micua, 2013).

Although no formal resolution was generated by the participants of the Lucap RMaTDeC workshop similar to the one generated by the Dagupan City workshop participants, there was considerable sharing and discussion of differing municipal fishpen management strategies and a vigorous discussion of the problem of unlicensed netpens. The two workshops did provide an opportunity to compare two different workshop formats for conveying research information about carrying capacity modeling as a tool for fish pen and fish cage management. And a week after these Pangasinan workshops, a report was given at a meeting on *Carrying Capacity Modeling in Common Water Bodies* for fisheries management professionals from the coastal nations of ASEAN, held at Novotel Ploenchit in Bangkok, Thailand June 10-13, 2013. These representatives of the national fisheries management agencies from coastal countries in the ASEAN Region could possibly adapt these pilot workshops to reach out to their own public policy-makers about carrying capacity models as a means to address their own difficulties with periodic aquaculture-associated fish kills.

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