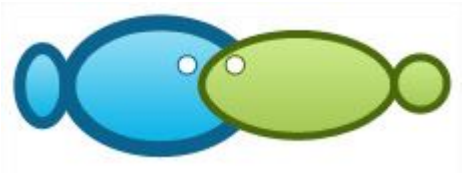

Modified decision support protocol for a small-scale multi-species marine fish hatchery of the Catanduanes State University, Philippines

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Abstract. This paper presents a modified decision support protocol for a multi-species marine hatchery project as an income generating project of the Catanduanes State University (CSU) in tropical Philippines (lat. 13° 53'00"; long. 124° 11'00" to 124° 23'00). An old non-functional fish hatchery-nursery facility of the university was re-developed in support of the expanding opportunities for reducing food insecurity and poverty alleviation in this island province. In the decision support tool, a site selection process for the multi-species fish hatchery facility of the community-based hatchery, nursery and natural food management in support of an aqua-silvicuture program was trialled for possible scaling in other locations with flexibility in the operation in any particular season of the year having extreme weather conditions of storminess, flooding and tidal surges.
Key Words: fish production, fish nursery, aquaculture, community-based hatchery.

Introduction. The designs of hatcheries are highly flexible and are tailored to the requirements of site, species produced, geographic location, funding and personal preferences (Helm & Bourne 2004). These are designed for the production target which can determine the size of the kind of hatcheries being proposed for implementation. In connection with the community-based hatchery project in support of a national aqua-silviculture program in the Philippines, i.e. Philippine National Aqua-silviculture Program or NAP), the search for appropriate designs must be developed to address the problems and targets being pursued. Income generating production initiatives on freshwater and marine waters indicate that these have contributed to scientific knowledge generation serving as inputs and bases of decisions in increasing fish production, including the management and conservation of water resources. Higher education institutions in the Philippines perform the functions instruction, research, extension and production (IREP). The fourth function is pursued in terms of income generating projects (IGP), recognized as a forefront in the national policy of encouraging "self-sufficiency among state institutions" (Philippines DECS Order No. 55, 1995). In recent years, IGPs are now recognized to supplement government subsidy through involvement in productive activities and primarily enhance instruction, research and extension. Activities intended for IGPs include fisheries, aquaculture and fish breeding projects as well as nursery operations of economically important aquatic species such as crabs, prawns and finfishes.

Aquaculture, hatchery and nursery operations are therefore important ventures on food production for reducing human food insecurity and providing low cost protein for the larger population in coastal dwelling communities. Food security program of the Catanduanes State University (CSU) is to assist in achieving the targets to increase fish production or aquaculture. It would be prudent therefore, to carry out studies and explore the profitable breeding and nursery operation. In general, the advancement of aquaculture has often been bottlenecked because of the lack of seed, but once that bottleneck is being overcome there is rapid growth (Phelps 2010). This means that IGP projects of SUCs have to be pursued within the options in the three areas of hatchery

management (brood stock management, induced spawning and larval feeding) to have more meaningful contribution as well as provide solutions to this bottleneck in aquaculture.

Advances in hatchery technology in other countries, include the increased production of sea bream and *Pangasius* and hatchery operations for abalone (*Haliotis* spp.), prawns (*Penaeus*), milkfish (*Chanos*) and mud crabs (*Scylla*) that contributed much to the improvement of aquaculture (Lee 2003; Sim et al 2005). In marine hatcheries, formulated diets have been developed for marine brood fish that are equal or better than the traditional raw fish diets. In crab hatchery and larval feeding, nutrition is still not fully understood and further studies are required in order to develop an optimized diet specifically for hatchery operations using microbound diets (Holme et al 2009). The importance of larval settlement and metamorphosis in oysters hatchery (Teh et al 2012), lipids and their composition in brood fish diets, particularly n-3 highly unsaturated fatty acids (HUFAs) (Lee 2003), and use of plastic sheets in larval attachment (Devakie & Ali 2002) have given the impetus in to the Philippines to embark on more meaningful work on multispecies marine hatchery using fish, mollusks and crustaceans (FMC).

In the light of these advances and trends on hatchery technology, there is a need to focus on feasible, cost-efficient and economically feasible alternative solution through the small-scale multi-species marine hatchery in Catanduanes State University. This becomes a challenge to the university researchers, administrators, fisheries project managers and faculty members to be engaged in economically viable ventures on larval aquaculture, feed formulation, breeding, hatchery management and nursery operations. Developing therefore decision support protocols (DSP) on site selection and other variables was carried out to look into initiatives that will have contribution to the expanding opportunities in the hatchery management. These initiatives will harness the university leading role in community-based projects. In the selection of the best site for a tropical marine hatchery, Alvarez-Lajonchère & Pérez-Roa (2012) stressed that to be able to assess site potential for aquaculture, a characterization is required which includes many important aspects related with the culture system to be applied and the species to be cultured. Originally described by Jamandre & Rabanal (1975), the best system could be a multistage procedure that allows a progression vision and assessment from general aspects to the detailed and particular ones, applying in the last stage a point and multiplying or relative weight factor system. Several authors follow with minor variations on site selection for coastal ponds projects such as Huguenin & Colt (2002) and also Jamandre & Rabanal (1975).

An initial step in the formulation of a decision support protocol for the establishment of small-scale hatchery was the determination of the gaps in the operation of fisheries projects in this state university under study. These are the problems in the breeding and nursery operations with the intent to introduce new themes in multispecies marine hatchery. These gaps focused on (1) insights on the status as to management of fisheries projects in the university; (2) assessment on the existing hatchery project facility; (3) the design of a multi-stage procedure in a DSP with an evaluation tool for selecting the site of multi species marine hatchery project; and (4) some aspects of the initial implementation in the multi-species hatchery.

Material and Method. Initially, the status of existing fish hatchery facilities incorporated with the corporate business operations (CBO) of the IGPs on fisheries and aquaculture in this state university was determined. Based on the analysis, we developed and used a DSP, following and implementing guidelines for the national aquasilviculture program in the Philippines; we also used materials from other authors such as Halide et al (2009) and Sim et al (2005); the FAO Manual on Fish Hatchery (2005); and other earlier papers of Guerrero (1982). A tool for site selection of a community-based multispecies marine hatchery to support fish, mollusk and crustacean (FMC) aquaculture in the island was modified from the work of Alvarez-Lajonchèrea & Pérez-Roa (2012).

The decision support mechanism used was based on the previous works of Jamandre & Rabanal (1975), Huguenin & Colt (2002), Halide et al (2009), Mardle & Pascoe (2004), Salam et al (2005). This mechanism covered various activities starting

from (1) classifying the present site of the hatchery project of CSU, (2) selecting the best site from several site alternatives, (3) calculating the size of the hatchery, (4) determining the sustainable production capacity of the hatchery from a chosen site, (5) appraising the economic aspects of the hatchery, (6) assessing the socio-cultural and anthropological considerations of the hatchery sites, and (7) designing the marine hatchery facility with two other best sites for a single aspect of hatchery management for the project.

Results and Discussion

Status of the fisheries projects at CSU with the breeding, hatchery and nursery operations. Components of the fisheries projects include the (1) Integrated and experimental fishery projects (IEF) of the fishery division of Catanduanes State University (CSU); and (2) Fish breeding, nursery and hatchery projects (FBNHP) of the fishery division, CBO in the main campus of CSU. The integrated fishery projects occupy a sizeable portion of the mangrove-swamp with 3 small breeding ponds, 2 nursery-juvenile ponds; 2 grow-out ponds and a catching/harvesting pond. A concrete hatchery building with both indoor and outdoor circular and rectangular cemented tanks are serviceable connected to adequate water supply and 24-hour electricity aside from a stand-by generator at 20 horse power. Two elevated water reservoir tanks are available with two semi-concrete buildings damaged by typhoons waiting for renovation or for demolition. The FBNHP facility is located in the main campus in the municipality of Virac with small ponds for tilapia, carps, catfishes and freshwater crustaceans and freshwater mollusks. This facility is now the site of the Integrated Rice-Fish Farming study and demonstration facility to imitate for the display of an example of the UN FAO globally important agricultural heritage system (GIAHS).

Problems of the present site. Based on the annual reports of the fisheries projects and interviews conducted, it was discovered that problems of the projects include the (1) suitability of the sites, (2) structural designs of the facility, (3) feeds and feeding regimes and (4) aspects on fiscal policy and technical capabilities, (4) technical capabilities of the staff, (5) weather conditions affecting the projects.

Site suitability. The first component is bottlenecked by several aspects of the site, particularly for the source of sea water (with high salinity at 28 to 30 ppt for marine hatchery. Since the present site of the facility receives water with alluvial materials from the connecting river of Pajo-Sto. Domingo. It is highly likely that low saline water with turbid waters carried by storm waters and run-offs could affect the operation of purely marine hatchery. The second component of the fisheries projects in the main campus is experiencing scarcity of water and drying up the earthen ponds during summer or long duration of the sunny days and also flooding during the rainy season. Although, the location of the second component is in the rapidly urbanizing area, contaminated water or non-point pollutants (NPP) due to excess oil or motor oil spills from vehicles are not yet felt.

Structural designs. The present hatchery building does not pose any serious problem on this aspect. However, water sources for both marine and freshwater need to be re-considered especially at this time when a multispecies marine hatchery is the present focus. Other structural designs like the circular and rectangular tanks render problems as to suitability for the marine hatchery operations. Connecting tubes for water source and aeration appear to be fairly problematic.

Feeds and feeding regime. Critical to the operation and management of hatchery will be the larval and postlarval food to be given to the young animals under inquiry.

The hatchery-nursery project in consideration is currently being re-developed in support of the expanding opportunities for increasing income for CSU and in accordance with the present national and regional initiatives on food security and poverty alleviation

in coastal communities. The gap on suitability of the present site in Palnab, Virac was re-considered and potential sites (Magnesia, Virac; Kalapadan Bay, Bagamanoc; Cabugao Bay, Virac; and Panganiban) in the island province of Catanduanes were evaluated using a site selection tool.

Classifying the present site and other potential sites in the province for hatchery operations. This component has the purpose of classifying the present site of CSC fish hatchery facility in Palnab, Virac, Catanduanes and other potential sites (Magnesia del Sur, Virac; CSU Panganiban, Campus; Moning, Baras; Sagrada, Bagamanoc (Lat 13º53'00" N, Long 124 º 11'00" to 124 º 23'00" E). Classification of the sites was fallen in the following suitability classes: poor (PO), medium (ME) and good (GO. Each class is determined by a set of criteria and sub-criteria adopted from extant literatures Sim et al (2005), FAO (2005), and FAO/UNDP (1982). After making the classification, it appears that the Palnab-Pajo Mangrove Area in Virac, Catanduanes (the present site) ranged from poor to medium.

The comparative importance of criteria and sub-criteria (as used by Halide et al 2009) were determined using a modified questionnaire described in Table 1. The necessary information were collected from the CSU administrators (n=3), present and former director of the CBO (n=2), fishery project manager and assistant manager (n=2), fisheries faculty experts (n=2) fishery project staff (n=3), experts from outside of CSU (n=2).

Table 1

Criteria and sub-criteria used in the classification of existing CSC Fish Hatchery in Palnab, Virac, Catanduanes

Criteria	*Sub-criteria*	*Classification*		
		Poor	*Medium*	*Good*
Hydrometeorology	Water Quality			
	Wave Height	Very high		Very low
	Windiness	Strong		
Soil quality or sediments	Texture	Mud		Sandy
	Redox			
	Organic Matter			
Water quality	Turbidity (secchi)	<2	2-4	>4
	Salinity	5-10 ppt	15-21 ppt	25 -30 ppt
	pH	1 -2 or 13-14		5.5 to 7.5
Economic	Market	Far		Very Near
	Electricity	None		Available
	Road Network	None		Available
Socio-cultural and anthropological	Heritage site (e.g. church)	None	At least 1	Present
	Protection site	None	At least 1	Present
	Religious Groups	None		Present
	Revolutionary groups	None		Present

Subjecting the present site of fish hatchery in Palnab, Virac, Catanduanes, Philippines for the marine hatchery. The objective of this component in the decision support protocol is to determine a suitability score for each of the potential sites chosen by a special group on the proposed hatchery. A modified protocol from Alvarez-Lajonchèrea & Pérez-Roa (2012) was devised for this study. The mentioned protocol for the site selection of a tropical marine multispecies hatchery consisted of a five-phase procedure of site evaluation and selection but was shortened for rapid assessment choosing only the most appropriate components of the evaluation criteria. The applied system was modified according to the planned technologies to be used in the CSU hatchery facility and scoring was also done.

In order to have further empirical data on the choice of the sites for triangulation, we used the scoring method of Halide et al (2009) followed by the verbal interpretations

of 'Good', 'Medium', and 'Poor' based on the criteria and sub-criteria presented in the earlier section for classifying the site. The score was determined by applying a multi-criterion decision analysis tool known as analytical hierarchy process (AHP) used by Halide et al (2009) and previously developed by Saaty (1980). This tool was used in fisheries management (Mardle & Pascoe 2004) and aquaculture site selection (Salam et al 2005) supporting the present study on developing a small scale marine hatchery for income generation. In the trying to modify a mechanism and evaluation tool for the appropriateness of a site for a marine hatchery in Catanduanes, several steps were considered that included discussion and paper scoring.

Table 2 shows the summary of the results of the evaluation of the present site of the hatchery facilities compared to the other sites in the island province.

Table 2

Site evaluation results in the different municipalities

Site	*Municipality*	*Verbal interpretation*
Calatagan (Freshwater)	Virac	Poor-Medium
Palnab	Virac	Poor-Medium
Magnesia del Sur	Virac	Medium-Good
Agojo	San Andres	Medium-Good
CSC Panganiban campus	Panganiban	Poor-Medium
Moning	Baras	Medium-Good
Sabang	Bagamanoc	Medium-Good
Oco (Freshwater)	Viga	Medium

Figure 1. Satellite image (Google) of the evaluated site in Magnesia del Sur, Virac , Philippines (arrow, site of the proposed hatchery).

Calculating the hatchery size and estimated sustainable production of the present hatchery Site in Palnab, Virac, Catanduanes. In calculating the size of the hatchery, FAO Manual on hatchery production (FAO 2005) was used as well as the guidelines contained in CHED BFAR NAP for hatchery facility. Likewise, SEAFDEC model and that of Sim et al (2005) were used in this section during the designing and with the existing hatchery facility re-designing was done. Table 3 shows the production targets for the different species intended for the hatchery.

Table 3
Production targets of the Multi-Species Community-Based Fish Hatchery in Palnab, Virac, Catanduanes, Philippines

Components	*Species*	*Production target*
Brood stock Development/Spawning	*Scylla* spp.	12 breeders/tank
	Abalone	50 sexually mature/tank
	Penaeus spp.	4 breeders/tank
Larval rearing	*Scylla* spp.	120,000/breeder
	Abalone	≥90,000 pieces
	Penaeus spp.	≥320,000 pieces
Nursery	*Scylla* spp.	≥90,000/breeder
	Abalone	≥50,000 pieces
	Penaeus spp.	≥100,000 pieces

Decision support protocol (DSP) for designing a small-scale community-based multi-species marine hatchery. Site selection process for marine hatchery is one of the first essential and critical point in terms of technical, economical aspect and efficiency for this aquaculture enterprise of Catanduanes State University. This will include fry or seed producing facilities, not only for maintaining higher survival rates, but also for good growth performance of the fish, mollusks and crustaceans (FMCs) targeted for this facility. As what Webber (1971) stressed many decades ago, such critical decision should be determined by the most comprehensive analytical mechanisms that can be applied. According to Huguenin & Colt (2002), flexibility has to be included so that possible changes within the definitions, components, species, techniques and intensities as part of the design process can be incorporated. The sequential process in modifying a decision support protocol (DSP) devised in this study consisted of four stages. This was followed in this study so that a new design of the hatchery facility is arrived at following standardized approaches. With this protocol implementation of the CSU Hatchery project is being facilitated.

Stage I. Status determination of the fisheries projects in the university. Inventory of the facility and equipment available; production status of the projects; species cultured in the pond facility, and survey of different ponds in the province as to the areas, species utilized, nature of the production system.

Stage II. Classification of the present site of the Palnab fish hatchery and other sites. Classification of the present site using a six-phase component following the participatory approach of involving the technical expertise at the fisheries projects, planning services, the natural science faculty, the local communities (Barangay, MAO, Mayors, etc.), school administrators, private pond owners and other stakeholders [(1) classifying the present site of the hatchery project of CSU; (2) selecting the best site from several site alternatives; (3) calculating the size of the hatchery, (4) estimating the sustainable production capacity of the hatchery from a chosen site, (5) appraising the economic aspects of the hatchery, and (6) assessing the socio-cultural and anthropological considerations of the hatchery sites)].

Stage III. Economic, socio-cultural and anthropological appraisal of the sites.

Stage IV. Designing and implementation of the community-based marine multi-species hatchery. Design of marine hatchery facility, design for two aspects of the hatchery management, and design for a single aspect of hatchery management for the project.

Based on the results of the decision support and evaluation tool for a small multi-species hatchery, a new design was developed from the existing facility at Palnab, Catanduanes, Philippines.

Economic, socio-politico-cultural and anthropological appraisal of the sites. This component on the socio-economic appraisal of the aquaculture activity/project at the

chosen sites is one of the most critical stages. During this stage in the DSP, several factors were considered, viz.: sustainable productivity estimate, number of seeds to be produced, area of the hatchery, number of larvae to be reared and number of juveniles produced, survival rate of fish seed, cost of seeds produced, feeds utilized during nursery operation, and cost of construction and operation. Field interviews and site observations reveal the following issues and concerns: (1) Land politics as tenure, ownerships and property rights most likely affect the decision for establishing hatchery sites; (2) Resource access or use of the proposed sites; (3) Peace and security in the areas; and (4) Cultural and anthropological considerations.

The socio-cultural or other anthropological components in establishing marine hatchery are not considered in the works of Alvarez-Lajonchèrea & Pérez-Roa (2012), Ford et al (2012) and Melnychuk et al (2012), which we attempted to incorporate for obvious reasons looking into the social components in aquaculture interventions. The success of a community-based marine hatchery will have greater reliance on the sociological factors that will intervene in its operation, similar with community-based mangrove rehabilitation and reforestation. Several authors have attested that human influence in development programs such as habitat restoration in South East Asian (SEA) countries is so great that it becomes a component in community-based restoration schemes (Biswas et al 2009). Successful implementation of community-based initiatives in the face of increasing human and environmental stressors will ultimately depend on the understandig the interactions between people and the coastal resources being tackled. In support of the ecological engineering principle (Lewis 2005; Masagca & Masagca 2009), the incorporation of vital social issues in the development of a community-based hacthery is clearly recognized. Anthropological or the human dimensions form part of this study that intended to develop a modified decision mechanism the selection of the appropriate sites and finally the design of the hatchery facility in Virac, Catanduanes.

Conclusions. The present status of the existing fisheries project in southern town of Virac, Catanduanes island, Philippines considers the problems related to site unsuitability, inappropriate feeding regimes, bad weather conditions, lack of freshwater supply, budgetary/fiscal constraints, lack of technical capabilities and other operation-related gaps are highly likely affecting production targets. Site classification of the present facility found to be poor to medium and other sites as medium to good, necessitate greater opportunities to re-develop and re-design the hatchery systems for greater success in the operation and management of a small-scale community-based multi-species marine hatchery. With the other sites evaluated, further expansion and scaling-up in the said municipalities pose greater challenges for a sustained fish production achieving the development goals of food security and poverty alleviation providing protein sources and income to the local fisher folks and other stakeholders. Following the four-stage DSP designed and followed during the study allowed the smooth and scientifically-based decisions in improving the hatchery facility and ensured the participatory approach as clearly stipulated in governmental statutes and policies of the Philippine government on coastal resources and ocean governance, and at the same time achieving the four-fold functions of state universities. With the use of a modified site selection evaluation tool adopted from other sources and localities, the aim of benchmarking and forecasting to some extent in support of universities sustainable research undertakings, further inquiries can be done as to increasing fish production in income generating programs. The new designs presently implemented by the state university under study provide greater impetus in exerting added efforts to pursue grant-seeking initiatives to support the research and extension components in the hatchery management operations in brood stock development, larval manipulation and nursery management. Further re-development and re-evaluation of some specific components of the said protocol will be intended to look into the other aspects that have bottlenecked fisheries and hatchery projects.

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