

HATCHERY OPERATION AND MANAGEMENT PLAN

For 2013-2014

---- Revised in February 2013 ----

The Promotion of the Grace of the Sea in Coastal Villages (Phase II)

Introduction

This plan is prepared for the Vanuatu-JICA Jointed Project for the Grace of the Sea in the Coastal Villages (Phase II). Although this plan is particularly designed based on the current hatchery condition at Vanuatu Fisheries Department (VFD), Port Vila as of February, 2013, this aims to provide a general idea of shellfish hatchery operation and management. This plan does not make reference to staffing and finance in detail (including the number of staff as well as the availability of staff, and the budget required for the hatchery work), as the primary focus of this plan is to provide technical and practical analysis. Those factors which were excluded from scope of this plan could be important aspects in planning. Therefore, the hatchery must be strictly operated in accordance with the VFD's whole business plan.

Summary

1. Spawning trials for 2013 will be conducted on green snail *Turbo marmoratus* in May and October (additional trial).
2. Spawning trials for 2014 will be conducted on trochus *Trochus niloticus*, green snail *T. marmoratus* and giant clams *Tridacna maxima* and *Tridacna squamosa*. This may be a full scale schedule for the hatchery.
3. Farming trial will be restarted with giant clam *T.squamosa* in May 2013.
4. Aquarium pet shipment of giant clam *T.squamosa* will be restarted in November 2013.
5. Spawning induction on *T.gigas* will be tried in summer months of 2014, if condition permits.

--- Hatchery management planning ---

Procedure regarding the hatchery management planning is shown in Fig.1. This figure indicates the general idea for planning. We discuss about the detail of each article in the following sections.

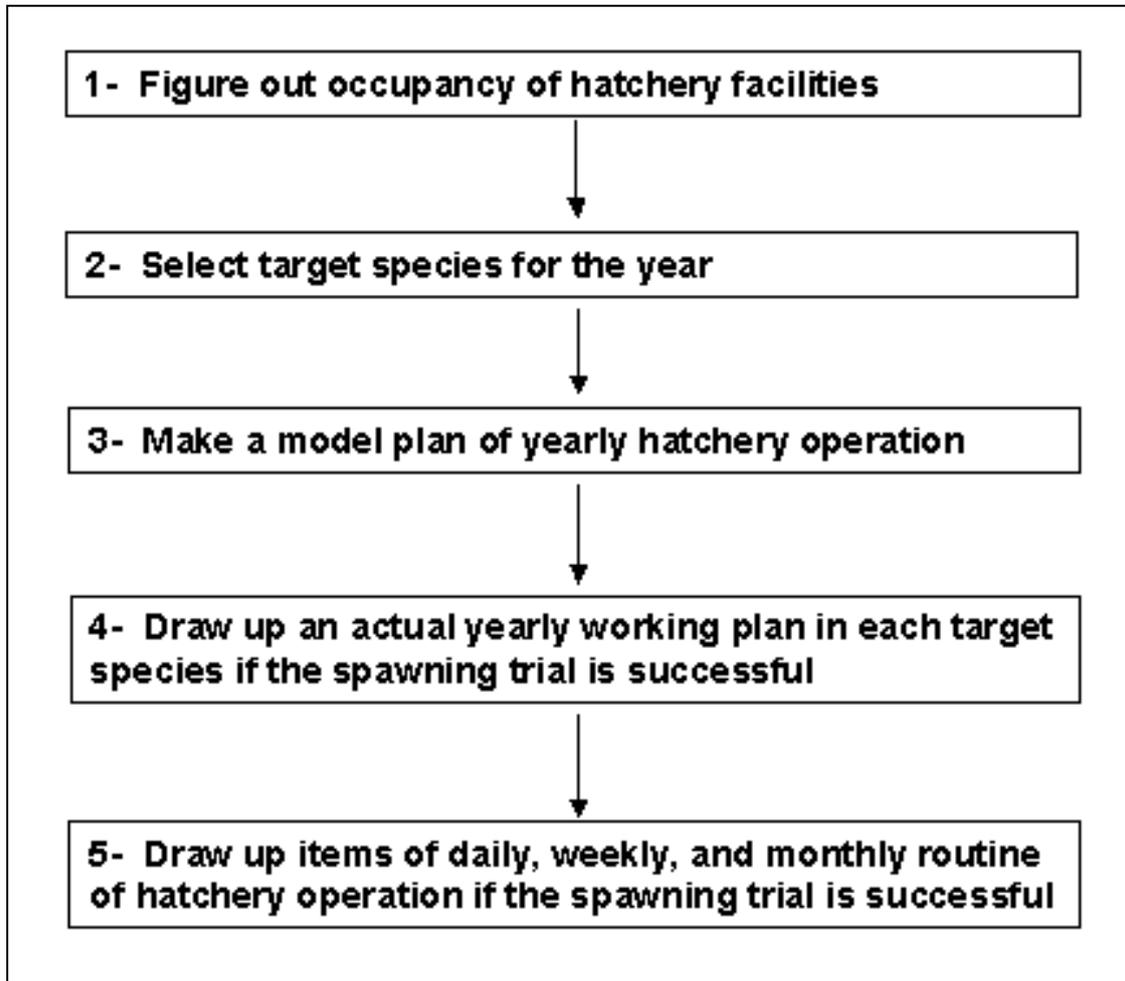


Fig.1. Procedure regarding the hatchery management planning

1. Figure out occupancy (current usage) of hatchery facilities

At the beginning, access an inventory of shellfish stock by tank to keep the record of exact number held at the hatchery. An example from January 2013 assessment is shown in Fig.2. In this assessment, all the stocked animals were counted. It is recommended that the inventory assessment should be done on a monthly basis. This is the most essential part in the management of hatchery. The arrangement and measurements of each tank is shown in Appendix 1.

Hatchery Inventory Form by Rearing Tank					
Date: 14, 15 January 2013		Counted by: Sone, Lency			
TANK #	DOMINANT		SUB		Remarks
	Species	Number	Species	Number	
FRW-1	TM11	956	TM10	57	TM11 on 20 bricks, BTC:2pcs, BTM:4pcs, TRM:24pcs
FRW-2	TM11	1,140	TRM	42	set on 43 bricks, BTM:2pcs
FRW-3	TM11	1,926	TRM	80	set on 52 bricks
FRW-4	TM11	4,475	TRM	57	set on 50 bricks
FRW-5	BMR	40			FRESHWATER
FRW-6					TAP WATER DEPOSIT
CRW-1	TM11	3,087	TRM	33	
CRW-2					Dried up
CRW-3	TS12	1,200	TR12	11	set on 13 bricks
CRW-4	TS12	1,000	TRM	70	water level low-downed
CRW-5	TM12	5,787	TRM	23	
CRW-6	TM11	3,505	TRM	52	
CRW-7					Dried up
CRW-8	TP	100			Fingerlings
CRW-9	MR	1,000			Juveniles
CRW-10					Dried up
CRW-11	MR	35			Grow-out
CRW-12					Dried up
CRW-13	TP	65			
CRW-14	GS07	34	TRM	1	BTS:7pcs
R-1					Dried up
R-2			TRM	22	GREEN SNAIL FOOD ALGAE, BTS:1pc
R-3					Dried up
VRW-0	MR	2,000			Zoea larvae
VRW-1	TS07-2	2	TRM	11	NIMO
VRW-2	MR	1,352			Post-larvae
VRW-3	MR	1,137			Post-larvae
FC1	BTP	8			Females only
FC2	BTP	5			Males only
FC3					Empty

Fig.2. Assessment of hatchery inventory as of January 2013

The inventory kept at each tank should be separately segregated by species. This information is also fundamental to the hatchery management. Refer to Fig. 3 for further detail. Rules of batch identification are shown in Appendix 2.

Hatchery Inventory Form by Species								
Date:	15-Jan-13							
Species	Batch ID	Year	Month	Age	E/A	Number	Size	Remarks
Greensnail	GS07	2007	Sep	5.3	A	34	5-8cm SH	2 groups
Trochus	TRM	Mixed			A	426	3-10cm SD	All born in hatchery
Maxima	TM10	2010	Feb	2.9	A	57	4-6inch SL	Grow-out phase
	TM11	2011	Dec	1.1	A	15,089	3-6cm SL	Land nursery phase
	TM12	2012	Mar	10mos	A	5,787	2-4cm SL	Stock in CRW-5 only
Squamosa	TS07-2	2007	Sep	5.3	A	2	20cm SL	Grow-out phase
	TS12	2012	Oct	3mos	E	11,200	3-10mm SL	Land nursery phase
Crocea	BTC	Wild			A	2		Broodstock
Squamosa	BTS	Wild			A	8		Broodstock
Teardrop	BTdM	Wild			A	0		Broodstock
Maxima	BTM	Wild			A	6		Broodstock
E/A Estimate / Actual								

Fig.3. Example of segregated inventory of hatchery as of January 2013

Above Fig.3 simply shows how many individuals of each species are currently reared in the hatchery.

After the January 2013 inventory, two new batches (TS13 and TR13) were added in the list. They were transferred into post-larval culture phase.

According to Fig.3, the batches of *T. maxima* (TM11 and TM12) became dominant in the hatchery (as of 15 January 2013). TM11 batch must be reduced in number as soon as possible, because it occupies many tanks at the moment. New markets for giant clam yearlings such as food stuff must be explored.

2. Select target species for the year

2.1. Target species

Possible target shellfish species for seed production are listed in Table 1. Production of giant clams *Tridacna* spp. is mainly aimed to sell as aquarium pets (except *Hippopus hippopus*), while commercial gastropods, such as green snail, *Turbo marmoratus* and trochus, *Trochus niloticus*, are cultured for the purpose of restocking of the depleted resources. Pearl oysters and edible oysters have not been examined. Other locally edible bivalves and gastropods seem to have no necessity for artificial breeding in Vanuatu. Target species for the year should be selected by based on the VFD's development strategy.

Table1. Possible target shellfish species for seed production in Vanuatu

Species	Stock status	Purposes of production
<i>Tridacna maxima</i>	Abundant	Aquarium trade
<i>T. noea</i>	Abundant	Aquarium trade
<i>T. crocea</i>	Abundant	Aquarium trade
<i>T. squamosa</i>	Over-fished	Aquarium trade, Tourist attraction, Shell, Restocking
<i>T. gigas</i>	Extinct-reintroduced	Tourist attraction, Aquarium trade, Shell, Food
<i>Hippopus hippopus</i>	Over-fished	Restocking, Food
<i>Turbo marmoratus</i>	Heavily depleted	Restocking
<i>Trochus niloticus</i>	Depleted	Restocking, Hatchery tank cleaner

Note: Compiled results of several surveys conducted during the *Grace of the Sea Project* Phase 1.

Considering the inventories' situation, green snail will be a main concern for the 2013 seed production. Trochus might be added to the target species list to raise the stock in the hatchery, if its natural recruitment is not sufficient. (Note: It was successfully carried out in February 2013).

For 2014 spawning trials, *T.maxima* will be added to diversify the output of aquarium pet species. Try to use highly-valued F1 broodstock (TM10) if it reaches a sexual maturity.

Proposed target species for the 2013-2014 seed production are listed in Table 2.

If VFD has enough time to deal with other species, the first spawning induction of *T.gigas* is recommended to try in summer months of 2014.

Table 2. Proposed target species for seed production in 2013-2014

Year	Proposed target species	Starting time	Target number
2013	Giant clams: <i>Tridacna squamosa</i>	January (successful)	10,000
	Gastropods: <i>Trochus niloticus</i>	February (successful)	1,000
	Gastropods: <i>Turbo marmoratus</i>	May and October	3,000
2014	Giant clams: <i>T.squamosa</i> , <i>T.maxima</i>	October	-
	Gastropods: <i>T.marmoratus</i> , <i>T.niloticus</i>	September	-

2.2. Set a target number of the production in each species

The present hatchery was originally designed to accommodate 3,000 green snails of 2 years old, or 4-5 cm shell height and 3,000 trochus yearlings at once. Meanwhile, the hatchery can accommodate up to 10,000 giant clam juveniles of 6 month old from single spawning (see Fig.4). In order to fully utilize the tank capacity, the target numbers of 3,000 for green snail yearlings will be recommended for the spawning trial of 2013. The target number for *T.squamosa* clams was 20,000, however, it has already achieved half from the 2012 spawning. Further target number for 2014 can not be estimated at this moment, because it is highly depends on the results of 2013 spawning.

Name #	Gross Vol. (t)	Net Vol. (t)	Btm Area (m ²)	Proper Stock Density per Tank
FRW-1	5.2	4.5	7.5	50000 giant clam spats @ first harvest 20000 giant clam juveniles of 1 cm SL 5000 giant clam spats of 2cm SL
FRW-2				
FRW-3				
FRW-4				
FRW-5				
FRW-6				
CRW-1	2.2	1.8	3.6	20000 giant clam spats @ first harvest 10000 giant clam juveniles of 1 cm SL 2000 giant clam spats of 2 cm SL
CRW-2				
CRW-3				
CRW-4				
CRW-5				
CRW-6				
CRW-7				
CRW-8				
R-1	6.2	5.8	9.0	10000 green snail spats @ first harvest
R-2				5000 greensnail juveniles @ 1/2 year old
R-3				
CRW-13	5.6	4.5	7.5	2000 greensnail juveniles @ 2 years old
CRW-14				
VRW-1	2.1	1.8	3.0	3000 greensnail juveniles @ 1 year old
VRW-2				
VRW-3				

Fig.4. Hatchery production capacity by the present rearing tanks

3. Make a model plan of yearly hatchery operation

3.1. Standard schedule for shellfish seed production in Vanuatu

Seed production of marine shellfish must be set as a seasonal activity with a yearly cycle. This cycle consists of three phases, namely preparation phase, spawning trial phase and intermediate culture phase. Spawning trials should be conducted in a spawning season from September to March in the following year, when animals are naturally active in reproduction. Further gonadal studies must be required.

3.1.1. Preparation phase

Prior to the seed production, prepare spawning tanks, larval settlement/culture tanks and other hatchery equipment for the season. If these tanks still hold animals, move all the animals out to other tanks, then empty tanks need to be dried up for a while. Enough number of broodstock are also accumulated and conditioned for spawning induction in this phase.

3.1.2. Spawning trial phase

Start with the spawning induction, followed by the larval and post-larval culture. The post-larval culture will end when spats become visible and can be counted as a first harvest.

3.1.3. Intermediate culture (land nursery) phase

The juvenile intermediate culture will usually start after the first count. This phase finishes at harvest as seeds for releasing or farming are taken. In case of giant clams, this phase is a transition phase to the ocean culture. Since VFD has no ocean culture facilities, it must be careful about the prolonged intermediate culture in the hatchery. Harvest from larval settlement tanks should be given priority and completed before the next spawning season, otherwise the following seed production cannot be started. Giant clams can be also harvested for selling to aquarium fish exporters during this period.

3.1.4. Grow-out culture

Over-aged specimens and broodstock specimens (artificially bred or wild) may be held for demonstration. However, such long-term land based culture sometimes become very hazardous to animals. Number of them must be kept at the minimum for the purposes.

3.2. Proposed yearly hatchery operation plan for 2013-2014

Yearly schedule of hatchery work in 2013 and 2014 are proposed in Fig.5 and Fig.6, respectively. These work schedules are prepared by species and by batches. Red cells in each schedule indicate the timing of spawning trial.

YEARLY SCHEDULE OF HATCHERY WORK		2013											
MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
STANDARD SEASONAL WORK	SPAWNING			INTERMEDIATE CULTURE				SPAWNING					
1. GIANT CLAMS													
1-1. TRIDACNA MAXIMA (TM11)	INTERMEDIATE CULTURE - FOR SALE												
1-2. TRIDACNA MAXIMA (TM12)	INTERMEDIATE CULTURE - FOR SALE												
1-3. TRIDACNA SQUAMOSA (TS12)	INTERMEDIATE CULTURE - FOR FARMING						INTERMEDIATE CULTURE - FOR SALE						
1-4. TRIDACNA SQUAMOSA (TS13)		LARVAL		INTERMEDIATE CULTURE - FOR FARMING & SALE									
2. GREEN SNAIL													
2-1. TURBO MARMORATUS (GS13)*						POST-LARVAL		INTERMEDIATE CULTURE					
2-2. TURBO MARMORATUS (GS13)* IN CASE										POST-LARVAL			
3. TROCHUS													
3-1. TROCHUS NILOTICUS (TR13)**				POST-LARVAL		INTERMEDIATE CULTURE							
4. GROWOUT EXPERIMENT: DEMONSTRATION BATCH													
4-1. TRIDACNA MAXIMA (TM10)	FOR BROODSTOCK (50 PCS IN FRW-1)												
4-2. TRIDACNA SQUAMOSA (TS07-2)	FOR BROODSTOCK (2 PCS IN VRW-1)												
4-3. TURBO MARMORATUS (GS07)	IN CRW-14				RELEASE INTO WILD AFTER SPAWNING EXPERIMENT								
* Batches seed production proposed													
**Batch seed production proposed as cleaners for giant clam larval tanks													

Fig.5. Proposed yearly schedule of hatchery work in 2013 (spawning trials on 3 species).

YEARLY SCHEDULE OF HATCHERY WORK		2014											
MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
STANDARD SEASONAL WORK	SPAWNING			INTERMEDIATE CULTURE				SPAWNING					
1. GIANT CLAMS													
1-1. TRIDACNA MAXIMA (TM14)*												LARVAL	
1-2. TRIDACNA SQUAMOSA (TS13)*	INTERMEDIATE CULTURE - FOR SALE												
1-3. TRIDACNA SQUAMOSA (TS14)*												LARVAL	
2. GREEN SNAIL													
2-2. TURBO MARMORATUS (GS13)*	INTERMEDIATE CULTURE - FOR RELEASE												
2-3. TURBO MARMORATUS (GS14)*												LARVAL/POST-LARVAL	
3. TROCHUS													
3-1. TROCHUS NILOTICUS (TRM)	INTERMEDIATE CULTURE FOR RELEASE & GROWOUT												
3-2. TROCHUS NILOTICUS (TR13)*	INTERMEDIATE CULTURE FOR RELEASE												
3-3. TROCHUS NILOTICUS (TR14)**												LARVAL	
4. GROWOUT EXPERIMENT: DEMONSTRATION BATCH													
4-1. TRIDACNA MAXIMA (TM10+ TM11)	FOR BROODSTOCK (100 PCS IN FRW-1)												
4-2. TRIDACNA SQUAMOSA (TS07-2)	FOR BROODSTOCK (2 PCS IN VRW-1)												
4-2. TRIDACNA SQUAMOSA (TS12)	FOR BROODSTOCK (100 PCS IN FRW-1)												
* Batches seed production proposed													
**Batch seed production proposed as cleaners for giant clam larval tanks													

Fig.6. Proposed yearly schedule of hatchery work in 2014 (spawning trials on 4 species)

3.3. Rearing tank reservation

According to the inventories, rearing tank booking list is prepared as shown in Fig.7. For the spawning trial 2013, the red marked tanks must be reserved for this period.

BOOKING LIST FOR REARING TANKS				2013											
TANK #	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC			
FRW-1	DEMONSTRATION/GROWOUT TANK TM10 & BROODSTOCK CLAMS														
FRW-2	TM11	TS13 LARVAL/POST LARVAL				TS13 INTERMEDIATE									
FRW-3	GIANT CLAM SETTLEMENT TANK TEMPORAL (REMOVABLE) TM11//TS13														
FRW-4	GIANT CLAM SETTLEMENT TANK TEMPORAL (REMOVABLE) TM11//TS13														
FRW-5	FRESHWATER SHRIMP CULTURE														
FRW-6	FRESHWATER DEPOSIT														
CRW-1	TM11 STOCK FOR SALE														
CRW-2	TS13 LARVAL/POST LARVAL				TS13 INTERMEDIATE										
CRW-3	TS13 LARVAL/POST LARVAL				TS13 INTERMEDIATE										
CRW-4	TS12 INTERMEDIATE						TS12 STOCK FOR SALE								
CRW-5	TM12 STOCK FOR SALE						TS12 STOCK FOR SALE								
CRW-6	TM11 STOCK FOR SALE														
CRW-7	GIANT CLAM SETTLEMENT TANK TEMPORAL (REMOVABLE) TS12														
CRW-8	TILAPIA CULTURE														
CRW-13	TILAPIA CULTURE														
CRW-14	GS07 GROWOUT					DRY UP		GREEN SNAIL POST LARVAL							
R-1	DRY UP FOR GS SPAWNING				GREEN SNAIL LARVAL/POSTLARVAL										
R-2	GREEN SNAIL FOOD STOCK					DRY UP		GREEN SNAIL FOOD STOCK							
R-3	DRY UP FOR GS SPAWNING BACKUP														
VRW-0	FRESHWATER SHRIMP CULTURE														
VRW-1	DEMONSTRATION/HOSPITAL TANK														
VRW-2	FRESHWATER SHRIMP CULTURE														
VRW-3	FRESHWATER SHRIMP CULTURE														
	LONG-TERM OCCUPATION														
	TEMPORAL OCCUPATION														
	RESERVATION														

Fig.7. Proposed usage of rearing tanks in 2013

4. Draw up an actual yearly working plan in each target species

If the spawning trial is successfully completed, it is time to draw up an actual yearly working plan for each species. The plan for each species must be summarized on the same time table to balance each workload. These can be prepared by referring to a series of seed production manuals prepared during the Promotion of the Grace of the Sea in Coastal Villages Phase I (see Table 3).

Table 3. List of seed production manuals prepared for the VFD hatchery

Species	Title of Manual
Giant clams	Giant Clam Seed Production Manual; Targeting for the Aquarium Pets Market, Second Edition, October 2008
Green snail	Seed Production Manual of Green Snail, <i>Turbo marmoratus</i> , February 2009
Trochus	Many outside manuals are available, <i>i.e.</i> Trochus Hatchery Seeding Techniques, - A Practical Manual, ACIAR 2002

5. Draw up items of daily, weekly, and monthly routine for hatchery operation

This procedure is almost same as above. If the spawning trial is successfully completed, it is time to draw up contents of daily, weekly and monthly routine for hatchery operation. Most important thing here is not to draw up routine activities itself, but to practice working operational procedures. It is required to decide who is taking responsibility for routine activities. Major routine activities are presented as follows:

--- *Monthly* ---

- *Inventory
- *Measurement and count of each batch
- *Maintenance of water supply system (see Appendix 3 & 4)

--- *Weekly* ---

- *Change of Filter bags during larval/post-larval culture period

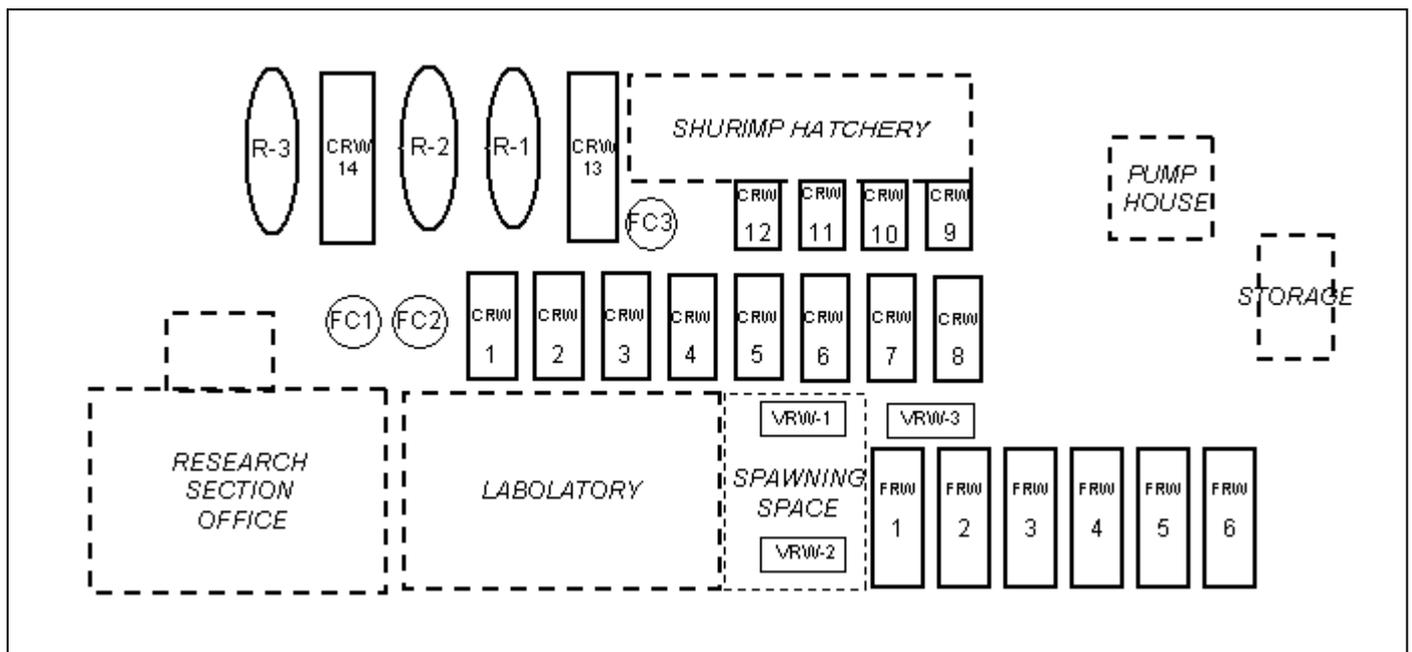
--- *Daily* ---

- *Record of temperature and observation of animal health
- *Check of level, flow rate and quality of rearing water also aeration.
- *Feeding (in case)

--- *Emergency Measures* ---

Refer to Appendix 5.

Appendix 1. Rearing tank arrangement and measurements



1-1. Layout of rearing tanks and facilities at the VFD's hatchery

Hatchery Tank Measurements								
Name #	Made	Type	Gross Vol. (t)	Net Vol. (t)	Length (m)	Width (m)	Depth (m)	Installer
FRW-1	FRP	EKT-5.2/Earth-Japan Raceway	5.2	4.5	5.0	1.5	0.7	JICA 2006
FRW-2								
FRW-3								
FRW-4								
FRW-5								
FRW-6								
CRW-1	Concrete	Raceway	2.2	1.8	3.0	1.2	0.6	ACIAR 2000's
CRW-2								
CRW-3								
CRW-4								
CRW-5								
CRW-6								
CRW-7								
CRW-8								
CRW-9	Concrete	Raceway	1.2	1.0	2.0	1.0	0.6	VFD 2002
CRW-10								
CRW-11								
CRW-12								
CRW-13	Concrete	Raceway	5.6	4.5	5.0	1.5	0.7	1980's
CRW-14								
R-1	FRP	ERT-6.2/Earth-Japan Circular	6.2	5.8	5.0	2.0	0.7	JICA 2006
R-2								
R-3								
VRW-0	FRP	FGV-Local Raceway	2.1	1.8	3.0	1.0	0.7	JICA 2007
VRW-1								
VRW-2								
VRW-3								
Total			91.8	79.0				

1-2. Measurements of the present hatchery tanks

Appendix 2. Animal Identification Rules

2-1. Acronyms and Abbreviations

Species ID	Species
TM	<i>Tridacna maxima</i>
TdM	Teardrop Maxima= <i>Tridacna noae</i>
TS	<i>Tridacna squamosa</i>
TC	<i>Tridacna crocea</i>
TG	<i>Tridacna gigas</i>
HH	<i>Hippopus hippopus</i>
GS	Green Snail= <i>Turbo marmoratus</i>
TR	Trochus (shell)= <i>Trochus niloticus</i>
TP	Tilapia= <i>Oreochromis niloticus</i>
MR	Freshwater Prawn= <i>Macrobrachium rosenbergii</i>
B**	Broodstock: B + Species ID
**M	Mixed batch: Species ID + M

2-2. Batch ID

Batch ID is a combination of the species ID and the spawning year (indicated by the last two figures, see Example 1). If the batches were obtained from other spawning trials, add the batch number after the spawning year (see Example 2).

Example 1

TM09 means the batch of *Tridacna maxima* spawned in 2009.

Example 2

TS07-2 means the 2nd batch of *Tridacna squamosa* spawned in 2007.

2-3. Other IDs

The B mark in front of the ID means adult animals that usually come from wild. If the batches of the same species are mixed up with other age groups, put the M mark after the ID instead of the year.

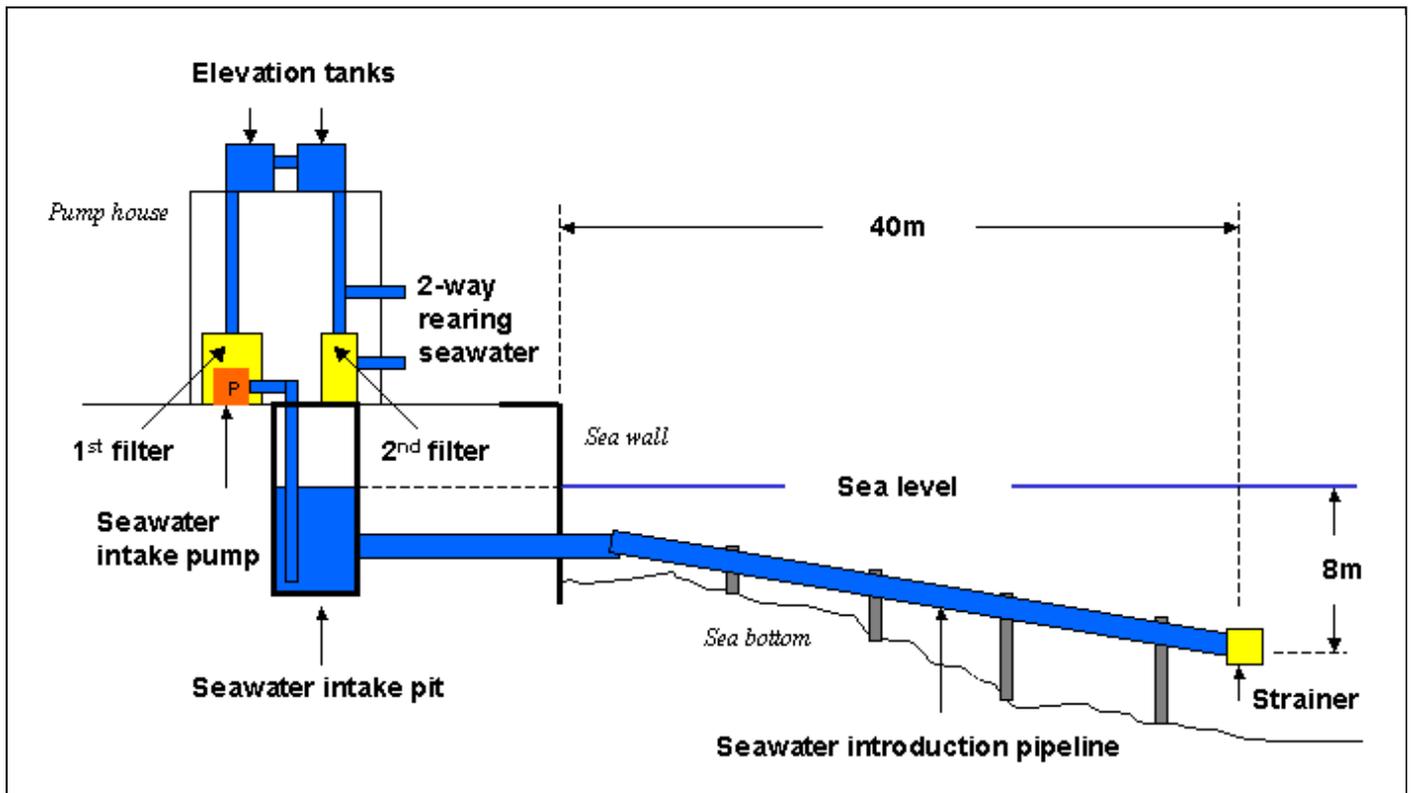
Example 3

BTS means a broodstock clam of *Tridacna squamosa*

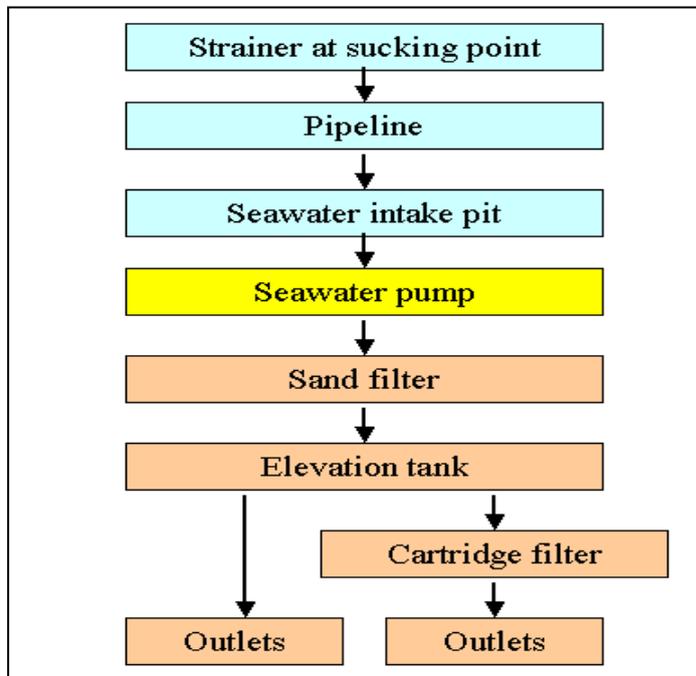
Example 4

TRM means a mixed batch of trochus

Appendix 3. Seawater supply system



3-1 Lateral view of water intake system of VFD's hatchery



3-2 Diagram of seawater intake system

Appendix 4. Maintenance of water intake and supply system

Monthly maintenance

- *Alternate seawater pump with backup pump
- *Wash up seawater pumps with tap water
- *Check generator for oil and fuel
- *Start generator and test electrical supply
- *Inspect and test float switches
- *Wash filter cartridges with tap water
- *Check back pressure on rapid sand filter and back wash if required
- *Check for corrosion of equipment and control box

Bi annually maintenance

- *Check seawater intake pipeline strainers
- *Check sedimentation on the bottom of water intake pit
- *Check sedimentation on the bottom of water preserver tanks

Note:

As of 20 February 2013, one intake pump is under repairing and not yet plumbed.

Appendix 5. Emergency measures against natural disaster

On the alert for cyclone

- *Fill all tanks up to maximum level with full strength seawater.
- *Clear the hatchery place
- *Check fuel for generator.
- *Prepare refuge tanks at the roofed area.

Under affection of cyclone

- *Cover all larval culture tanks with wavy panel and tie up with rope and a heavy load.
- *Stop aeration of flow-through tanks at open area.
- *Check salinity of rearing water frequently.
- *If the salinity drops less than 30ppt, evacuate the animals to refuge tanks