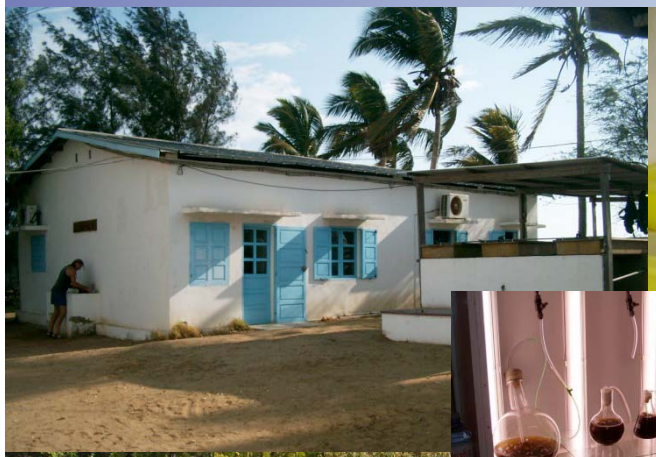
Development of sea cucumber farming as an alternative livelihood in SW Madagascar

Georgina Robinson and Benjamin Pascal

Project background

- 1999-2008: Development of sandfish hatchery & nursery at the Institute of Marine Science (IHSM) in Tulear (Aqualab)
- Development of *in vitro* spawning technique (IH.SM, University of Mons-Hainaut and Free University of Brussels)



Gonad extraction & *in vitro* fertilisation

3-4 weeks

Settlement in larval rearing tanks

1-2 months

Transfer to nursery at 8mm

2-3 months

Transfer to sea pens at 6cm (15g)

Evolution of sea ranch based farming

Intensive vs. Extensive

BOTTLENECK
Space

DRIVERS
Overfishing & lack of economic alternatives
Livelihood creation & poverty alleviation
Diversification

2007-2008: Pilot studies on rearing juveniles in sea pens (BV, IHSM, Copefrito SA + Women's Association of Andavadoaka)

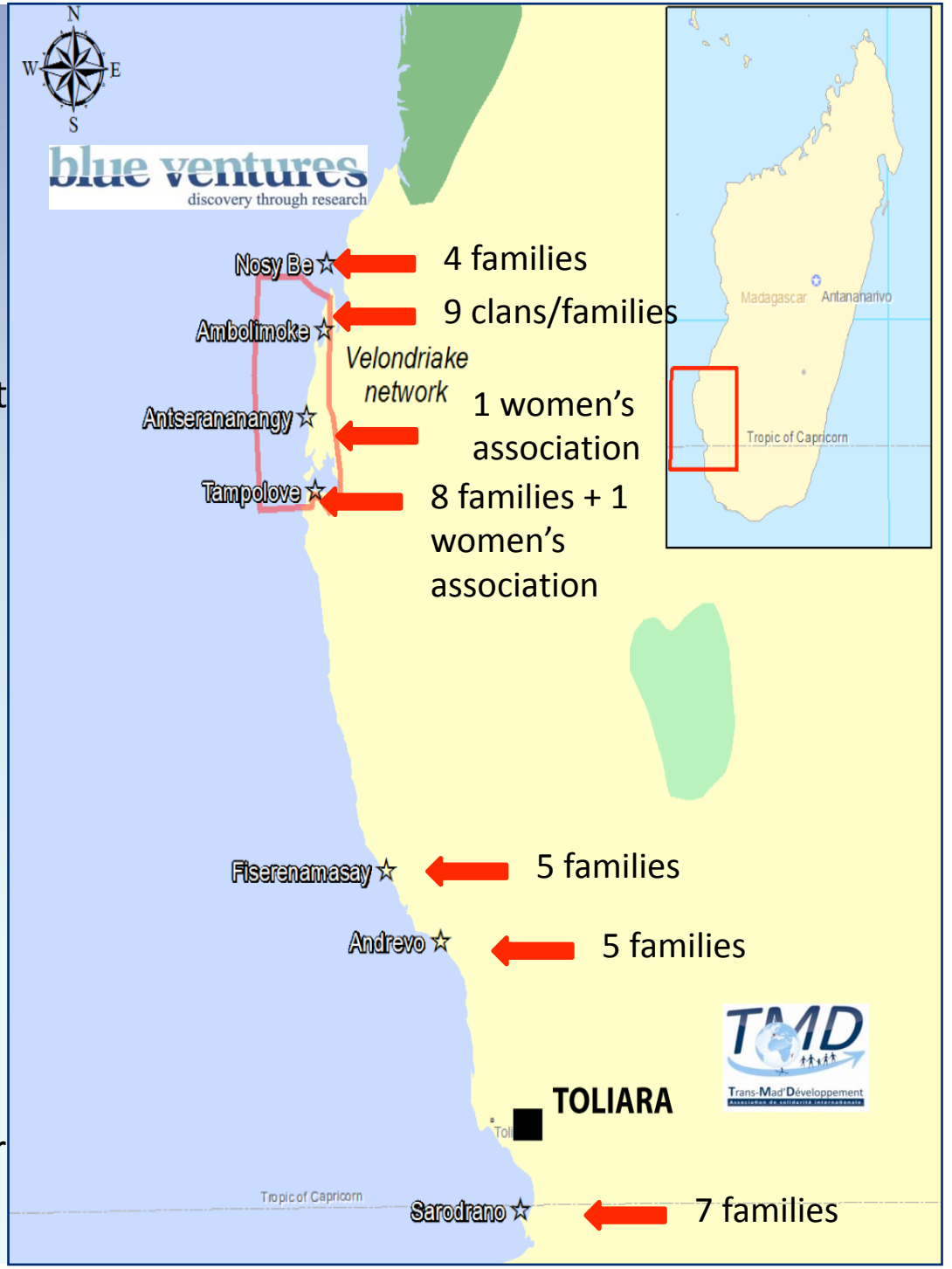
March 2008: Creation of private company Madagascar Holothurie SA (MH.SA)
-exclusive use of *in vitro* spawning technique (patent-protected)
-expansion of hatchery production to 100 000 juveniles/yr
-supply of juveniles for community based farming with exclusive buy-back rights

2 yr project to demonstrate the commercial viability of village- based sea cucumber farming
(Sept 2008-2010)

BV & TMD: training & technical support
MH.SA: supply of juveniles, purchase of market-sized sandfish for procesing/export
ReCoMaP: financial aid, technical support
7 villages along 200km coast
40 families/groups

Business model

- Sea pens: 625 – 900m^2
- Stock 300 – 450 juveniles quarterly
- Juveniles supplied on credit
- Juvenile cost subsidised by project
  Farmer price = US$0.20, actual US$0.54
- MHSA purchase >300g ~ US$1 per piece
- 20-50% of farmer profits used to reimburse juvenile costs
- Pen materials fully funded
- Net revenue: US$720-1000 per pen per yr



Production model

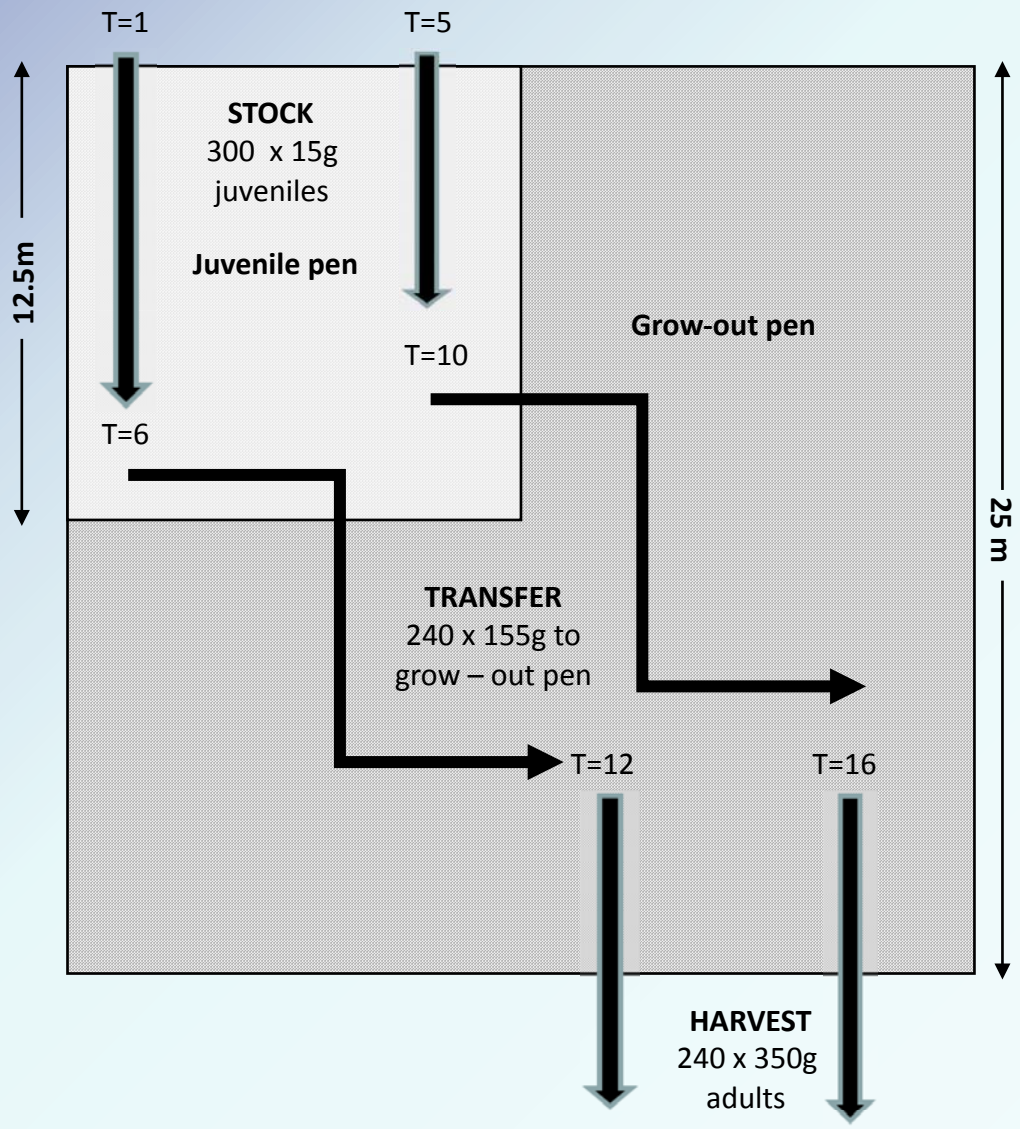
Low-density production model based on a carrying capacity of 250gm^{-2}

Assumptions

- Grow-out cycle 12 months
- Inputs of 300 juveniles every 4 months
- Average weight juvenile = 15g
- Average harvest size= 350g
- Mortality = 20%

Linear growth (no seasonal variation)

Harvest size individuals in 12 months



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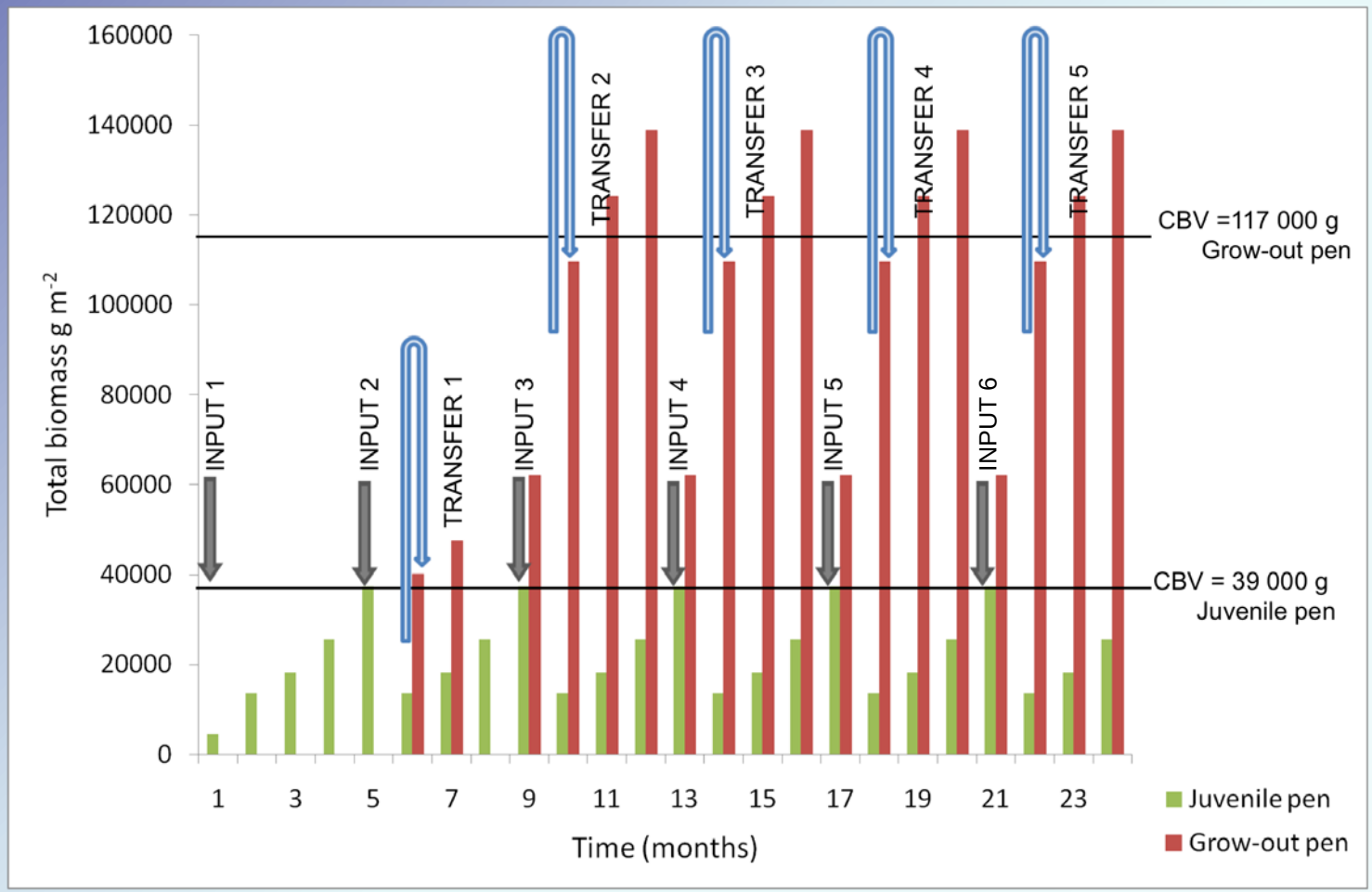
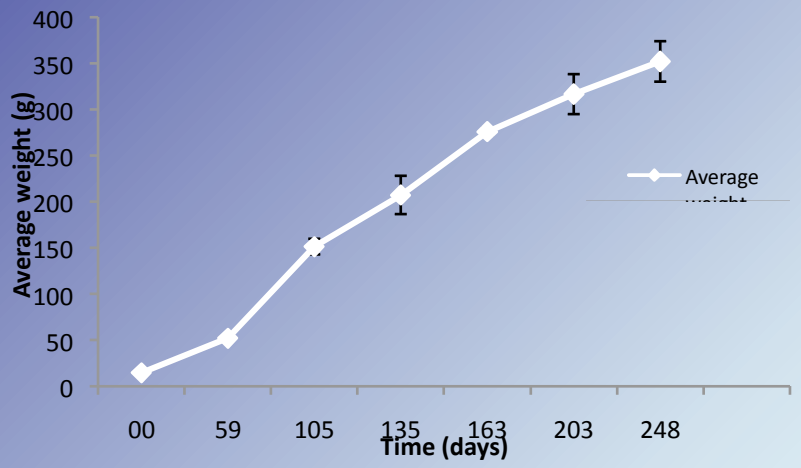
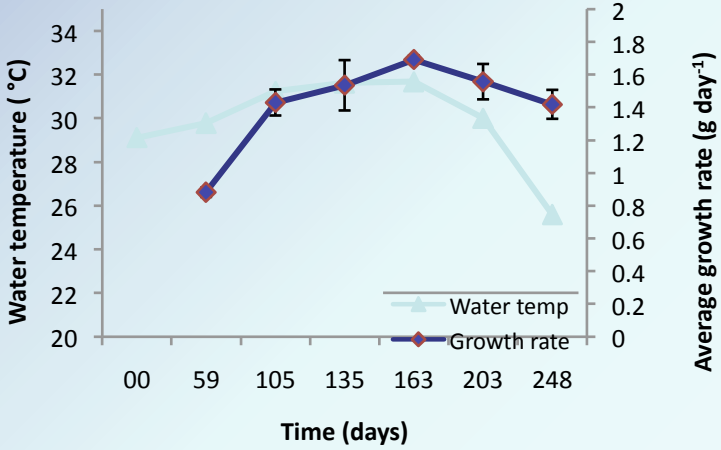
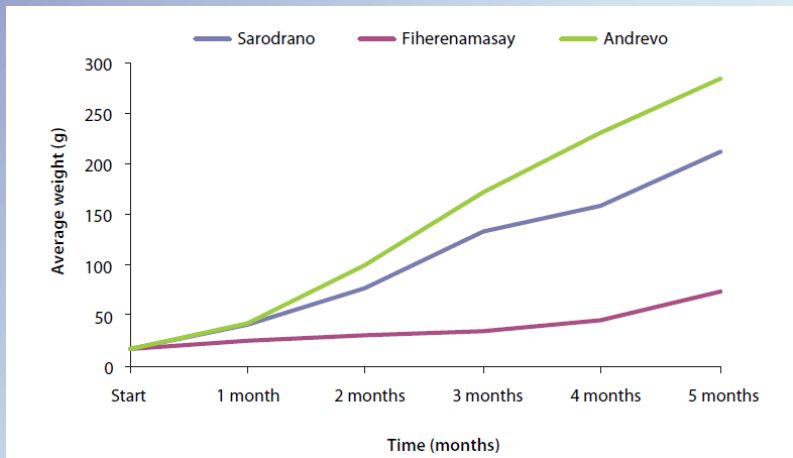
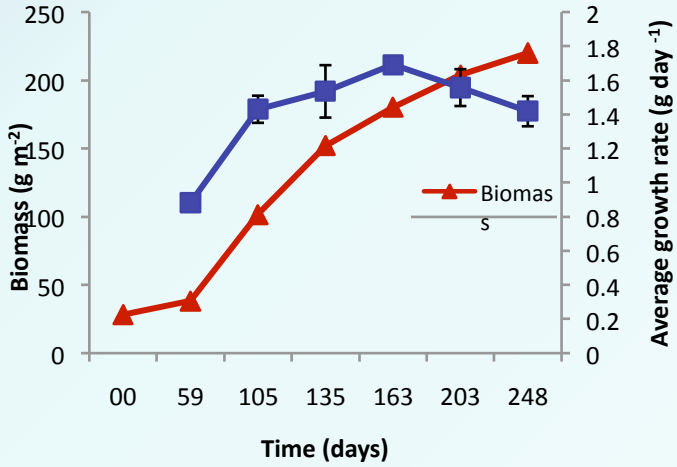


Growth rates and time to harvest









- Variable growth rates 0.23 – 1.8 g day^{-1} due to seasonal & density dependant factors
- Rapid growth at low densities (45gm^{-2}) with sandfish reaching 300g in 5 months

Project status & fate of sea cucumbers after 2 years

SITES	No of pens Current (*past*)	INPUTS No. juveniles (no of inputs)	MORTALITIES DURING TRANSPORT/ INPUT	SOLD No.	REPORTED AS STOLEN No.	REMAINING IN PENS No.	LOSSES UNACCOUNTED FOR
NOSY BE	4 (4)	4800 (4 inputs)	1532	144	?	15	65%
AMBOLIMOKE	Abandoned (9)	9900 (5 inputs)	1529	98	183	36	81%
ANDAVADOAKA	Abandoned (1)	650 (2 inputs)	0	0	?	150	77%
TAMPOLOVE	9 (9)	11900 (5 inputs)	630	1100	929	3882	45%
FIHERENAMASAY	2 (5)	6800 (3 inputs)	minimal	26	1150	912	69%
SARODRANO	4 (5)	7650 (4 inputs)	minimal	807	234	2185	57%
ANDREVO	6 (7)	12400 (4 inputs)	minimal	1258	671	1637	47%
TOTAL	**25**	**54100**	**3691**	**3433**	**3167**	**8817**	**34992**
%	**(40)**	**100%**	**7%**	**6%**	**6%**	**16%**	**65%**

Problems encountered & solutions

Transport & acclimation of juveniles

1) Boat or car: pilot studies
2) By boat: Large quantities (>3000), long (12-18hrs), frequent delays, physical damage to juveniles in bad weather, sub-optimal stocking conditions
3) By car in oxygenated plastic bags. Short transit time (6hrs), minimal mortality,

Acclimation
-water changes ashore to minimise discharge of transport medium into sea & olfactory detection by predators
- Period of rest and recovery post-transport to improve the burrowing response of juveniles after release

Monitoring and input of juveniles

•Transition from using project staff for juvenile input and monitoring to participatory methods

•Increased margin for human error & decrease in reliability and quality of data

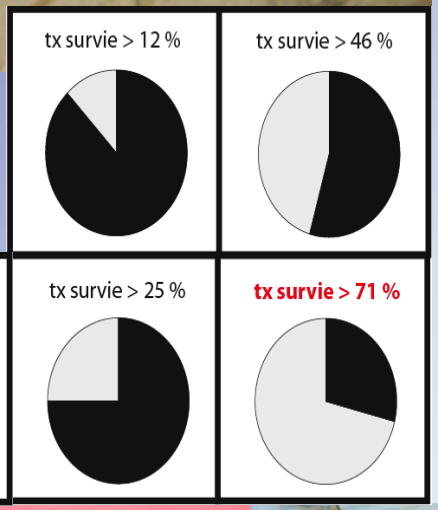
•Trampling of juveniles??

Pen materials

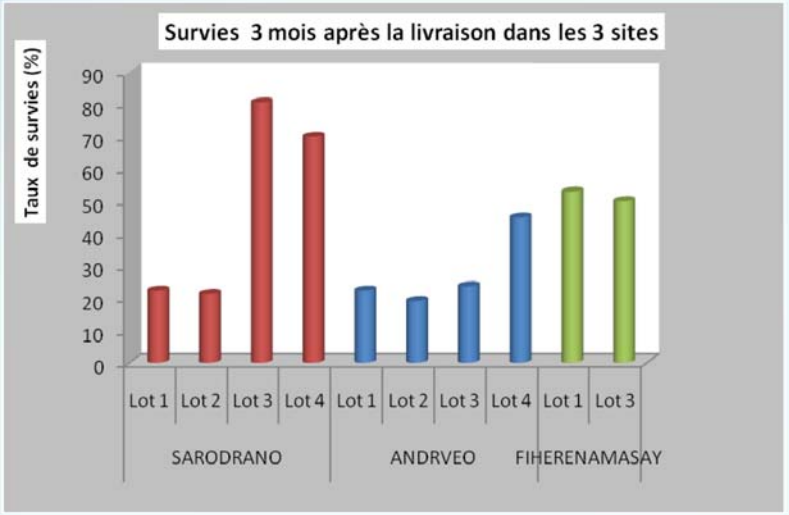
- Insufficient pen height => juveniles **swept out of pens** during input=> addition of net to increase pen height
- Iron rebar used to bury net=> expensive=> replaced with wood
- Larger mesh size used for grow-out section => **ghost fishing** & **crabs ripping holes in nets** => all removed and plastic meshed ordered
- 8 month delay => overstocked juvenile pens => **escape of juveniles**, **density-dependant mortality**??
- Reconstruction of pens with imported HDPE plastic mesh

Local vs. imported

Predation

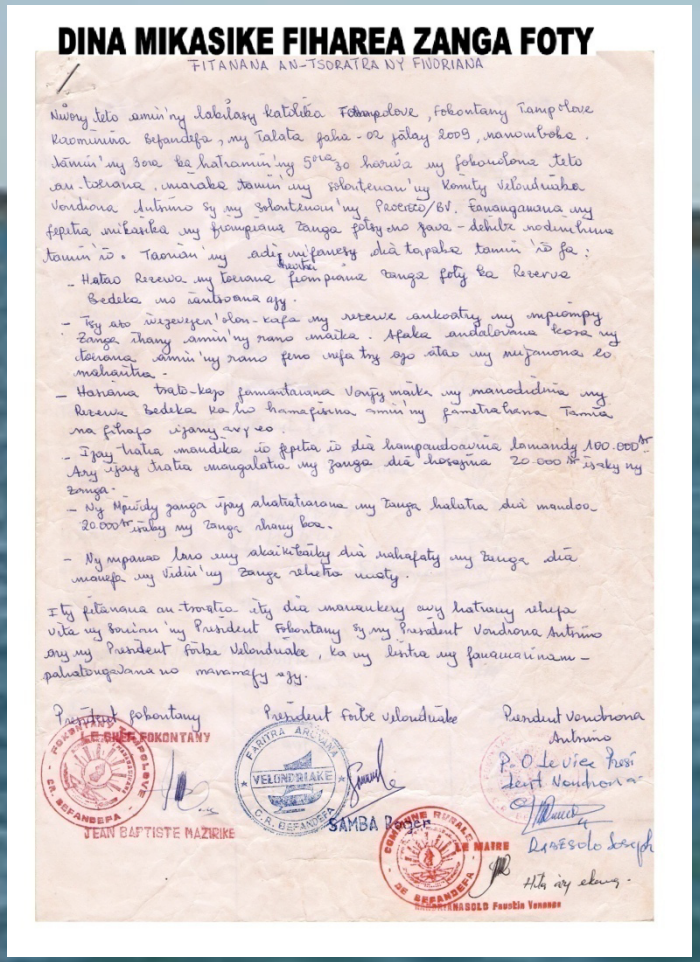


Effect of nursery pens (protective enclosures) to increase survival post-release



Theft (pre-emptive)

- Nightly surveillance program during spring low tides
- Creation of *dinas* (local by-laws) to regulate theft
- Creation of 'reserves' to limit access to farming access
- Incorporation of mariculture zones into MPA zonation plan
- Traditional ceremonies, blessings, sacrifices…
- Compensatory measures for the wider community (% of profits paid into a community fund)



DINA MIKASIKE FIHAREA ZANGA FOTY

FITANANA AN-TSORATRA NY FIDIRIANA

Village	Reserve area (ha)
Nosy Be	2.32
Ambolimoke	4.56
Antseragnasoa	1.13
Tampolove	1.64
TOTAL	**9.66**

Additional measures to combat theft…

- Intensification of surveillance program - **all** low tides at night
- Inter-familial fines for non-attendance during surveillance
- Construction of elevated guard platforms adjacent to pens
- Suspension of juvenile deliveries by MH.SA following spate of thefts
- Mobilisation of government authorities to provide support
- System of traceability for wild and farmed sandfish (certificates of origin)
- Collaboration with local traders to record and report suspicious sales of large quantities of *H. scabra*
- Establishment of protocols to deal with cases of theft in collaboration with village and district authorities

THEFT REMAINS THE MAIN RISK TO THE SUCCESS OF VILLAGE-BASED SEA CUCUMBER FARMING

Constraints and bottlenecks

- Lack of vertical integration complicated logistics and operations
- Rapid scaling of the project => lack of control over key stages (juvenile transport, input, monitoring) & increased human error
- Prices paid by MH.SA (US$1) only marginally higher than beach prices for *H. scabra* => more profitable for to sell produce to local traders => internal theft
- MHSA required 2 weeks notice before they would travel to buy => majority of thefts occurred in the interim period
- Lack of *in situ* processing => loss of value addition for communities in the value chain & lower product quality (yield ~ 3%)

Lessons learned

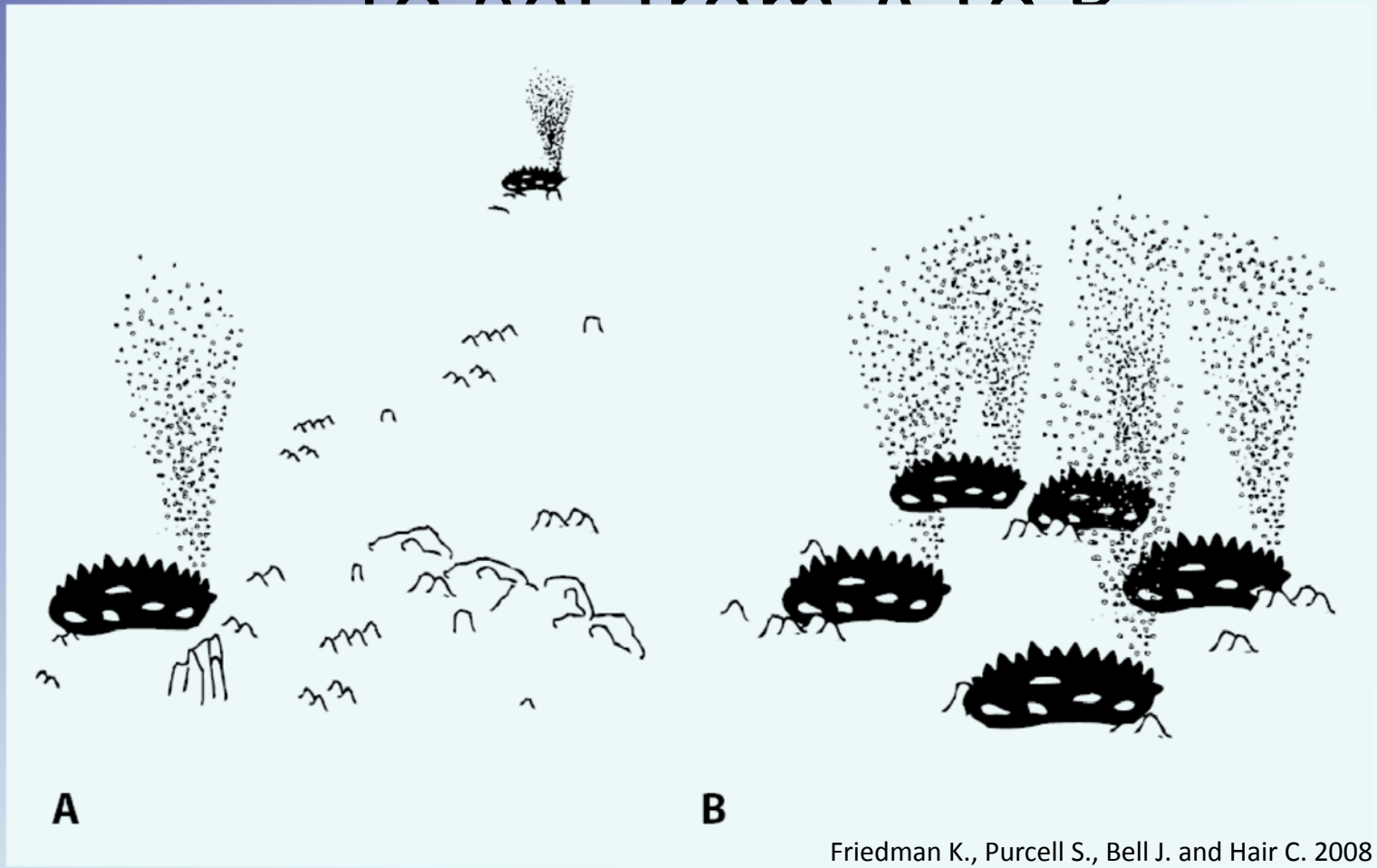
- Pre-site testing is necessary to fully assess suitability of sites for sandfish farming (predation pressure, growth rates, carrying capacity of sites)
- Carrying capacity of some sites exceeds 250gm^{-2} (up to 700gm^{-2})
- Low stocking densities can produce market size sandfish in 5-8 months
- Survival of juveniles post-release can be improved by using protective enclosures (nursery pens) until juveniles reach 50g
- Selection of farmers is critical => average of 7 people/group is optimal
- Business model needs careful consideration => famers need to take some risk to engender responsibility and ownership. Microfinance?
- Small steps – complete one rearing cycle before scaling up to demonstrate benefits and level of effort needed to farmers before scaling up
- Level of security and surveillance to prevent theft may be beyond the scope of communities and local authorities in the Western Indian Ocean

The wider context

Can sea pen mariculture contribute towards restocking efforts?

Objective of restocking…

to get from A to B



Friedman K., Purcell S., Bell J. and Hair C. 2008

Create multiple groups of spawners to supply recruits to the fishery

Management solutions & their effectiveness

Conventional approaches

- Technical measures – size limits, closed seasons
- Effort limitations
- Gear limitations
- Moratoriums

Active management interventions (Bell *et al.* 2008)

- restocking no-take zones with hatchery-reared juveniles
- aggregating remnant wild individuals in no-take zones
- sea pen rearing of wild caught juveniles
- sea pen grow-out of hatchery produced juveniles

Can sea pen mariculture provide a solution? (from Bell *et al.* 2008)

Population densities

Need 10-50 individuals per hectare over substantial areas to avoid depensation

Densities: 0.5 – 3.5m $^{-1}$ with 0.25-0.56 ha pens/village

Spawning

Need groups of > 10 sea cucumbers with 5-10m between individuals for fertilisation

30-67% of stock always above size of sexual maturity

Pen size

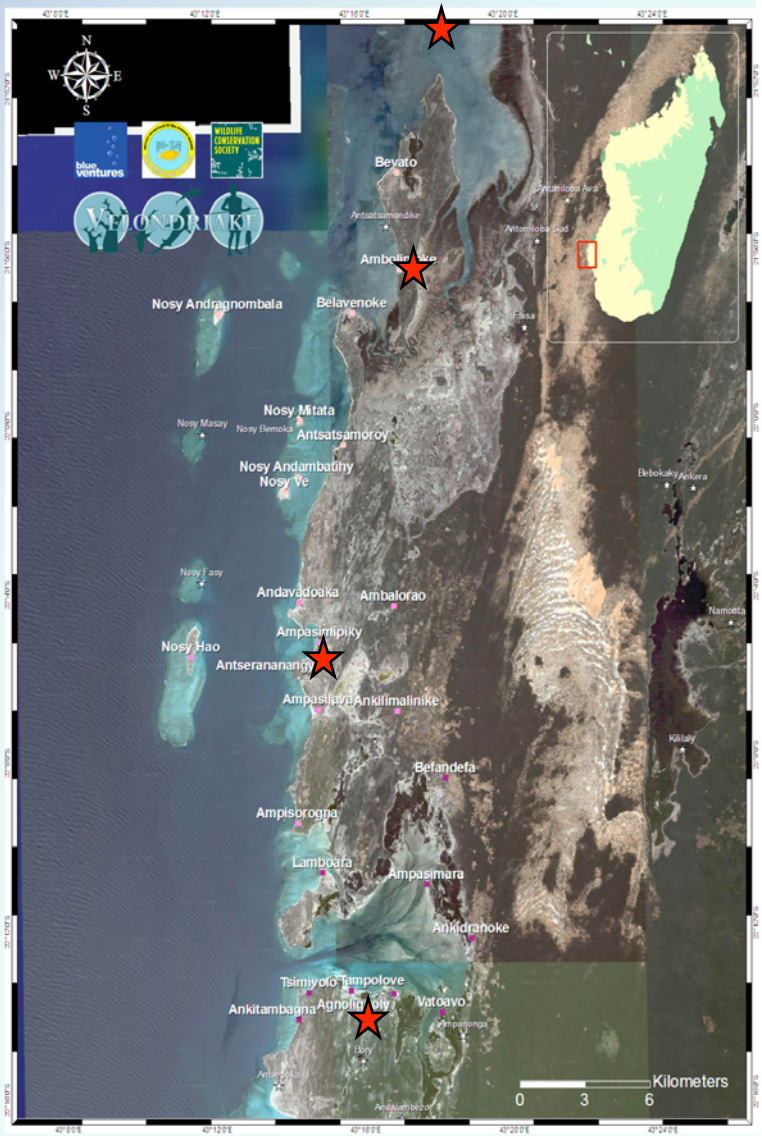
Need minimum 100m^2

625 - 900m^2

Connectivity

Scale of recovery = tens of kilometres

10 – 20km between villages



Result = network of protected spawning biomass

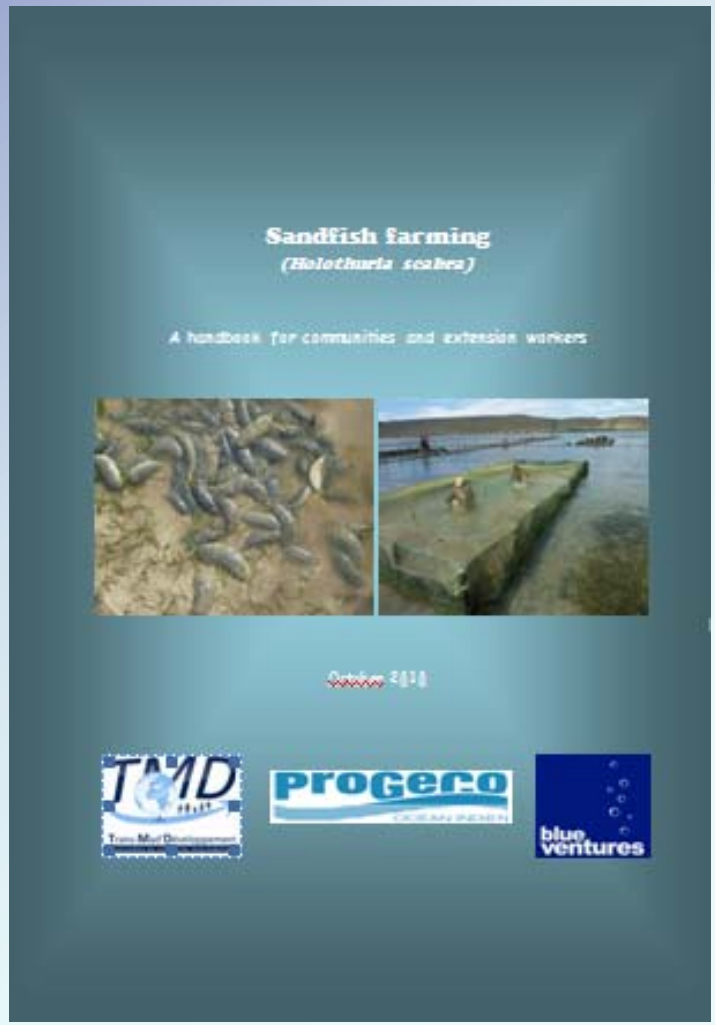
Advantages of sea pens

- Pens allow greater flexibility and control over the fate of juveniles...
  - -nursery pens can improve survival of juveniles post-release by providing protection from predation until 50g
  - -happa nets and/or nursery pens can be used to decrease the average size of release and lower hatchery production costs
  - -small units facilitate monitoring and allow for replication
- Cost-effective option as juveniles costs can be offset by communities
- Well designed network of pens can have a wide spatial impact
- Easier to establish user rights and ownership of pens
- Direct flow of benefits to communities and more rapid returns
- Greater community acceptance …….sea pens more tangible than NTZ's

How can sea pen farming contribute to re-stocking efforts?

- Use broodstock of sufficient number (30-45) which originate from planned release sites to prevent in-breeding and genetic homogenisation.
- Ensure stocking densities are sufficient for spawning and fertilisation
- Maximise connectivity between sea cucumber farming areas to promote gene flow
- Set minimum harvest size (> 350g) well above size of 1st sexual maturity
- Use cyclical stocking (quarterly) to maximise percentage of sexually mature adults present throughout the year
- Otherwise, plan harvesting to occur after peak spawning periods
- Gather evidence…monitor stock for synchronous spawning & areas around pens for recruitment of juveniles ….this has already been observed in Philippines and Madagascar!)

Further information…



Sandfish farming: a handbook for communities and extension workers (*In press)*