Abalone Production Model:

Anticipated Stocking Rates and Annual Production

For any form of farming to be viable, it must be cost effective to produce a profit. If this condition cannot be met, there will be no investment of time, labour or capital.

Farming systems are at their most viable when the greatest value of production is created with the least cost. In the simplest way this implies achieving the highest annual production at the least cost. Abalone are generally sold per kilo not per piece (i.e. individual animal) and thus the production is looked at from the point of view of saleable biomass (kilos of abalone) produced. A higher density may lead to a higher biomass produced even though growth rates may be suppressed. This can happen if sufficient food is supplied and there is sufficient flow of water to provide enough Oxygen, but not so much flow that the food is washed away. As abalone is a bottom, (benthic) dwelling animal the stocking density is usually based upon percent of available surface area. It has been found that the best yield will occur when the abalone are stocked at 45% cover.

The farm site has some predominately cleared areas. Using these with minimal additional clearing and keeping reasonable working distances it has been calculated that 60 tonne per year production can be achieved. In order to achieve this production it is necessary to know the expected survival rate at each growth stage, the fertilisation rate of eggs, and the numbers of eggs likely to be produced by female abalone.

All of this information has been determined for Australian abalone by Australian research over the past 20 years.

To begin we intend producing Black Lip Abalone (*Haliotis rubra*), a locally available species. When this species was first cultured the mature adults (broodstock) were collected from the wild in late spring (October) before water temperatures rose. Now research has been undertaken which allows us to breed them at any time of the year. If held at a constant temperature and in good water conditions mature abalone can be expected to spawn approximately every 180 days given the appropriate stimulation.

For further detail on broodstock and hatchery methods please refer to (Heasman, 2007).

It has been found that to minimise genetic inbreeding it is necessary to use a minimum of 12 females and 8 males for breeding (P. J. Smith & A. M. Conroy, 1992). This assumes a 40 to 60 % successful spawning of females and males, respectively, and should produce at least 12 to 18 million eggs (Hone, 1997).

So, after the appropriate amount of time and with the appropriate stimulation 28 females and 20 males should produce approximately 27 million eggs and an excess of sperm.

These are then combined in a fertilisation bucket. From this, fertilisation should be 80 to 85% successful (always assume worst case). Thus from 27 million eggs we can expect 21.6 million fertilised eggs.

The fertilised eggs are transferred into an approx. 150 to 500 litre cylindrical hatchery vessel. After 18 to 20 hours, all viable eggs will have hatched (depending on temperature). Approximately 80% can be expected to be viable giving 17.28 million larvae (initially an unshelled form [Trochophore] and after 48 hours post hatching they change [metamorphose] into a larval shelled form [veliger]).

The larvae should be ready to settle onto juvenile plates (with a covering of small algae) about a week after fertilisation. These plates are housed in vertical racks and sit in tanks (1.5 x5x0.5 m) in the juvenile building. Approximately 50% of the larvae survive this metamorphosis into the surface (benthic) living juvenile leaving 8.64 million juveniles. Of these only 5% of the juveniles survive this stage (Hone, 1997), leaving 432,000 post algae feeding juveniles.

Once the Juveniles have attained a size of at least 1mm and preferably 1.5 mm, (this can take 30 to 70 days) (Heasman, 2007)they can be weaned off the algae diet onto a largely artificial diet. Here they are transferred into the outdoor juvenile tanks. The racks of plates are placed in the outdoor tanks along with abalone shelters called hides, into which the abalone move as they become increasingly sensitive to light. They can be stocked at very low density to encourage maximum shell growth. This is useful as shell growth is linear (constant) and weight is exponential (slow at first then very fast). At about 12 months old, the shell length could be expected to be about 30 mm the weight about 4 grams and a total mass of 1.38 tonnes. 80% (Hone, 1997) of the juveniles should survive from the previous stage leaving about 345.6 thousand still alive. These animals are derived from wild sourced stock and will thus have very variable growth rates. This becomes more pronounced with time. This is even to the extent that by 3 years old there will be an overlap in the various generations size ranges. Due to the variable growth rates, these sizes at ages are averages. To facilitate management the cohorts (same age groups) are kept unmixed with other cohorts in identifiable tanks and raceways. This facilitates record keeping as we track feed rates, survivorship and health.

At approximately 30 to 40 mm shell length (SL), they are transferred to the raceways in the secure growout buildings by moving the hides (with abalone attached) to the raceway.

At about 24 months, the average shell length will be about 60 mm and the weight average 33 grams each. At this point, the survival will be about 90% (Hone, 1997)from the previous stage leaving about 311 thousand individuals.

At about 36 months, the average shell length will be about 90 mm and the weight about 113 grams. Once again the survivorship should be about 90% leaving about 280 thousand abalone with a total weight of 31.6 tonnes.

The abalone growth pattern results (on average) in the abalone weighing 80 grams at 80 mm SL. They are harvested when the majority of abalone under a hide is 80 to 90 mm. They are harvested by transferring the hide with abalone in an aerated shallow tank to the depuration room in the facilities building. They are measured and checked for health record kept and if satisfactory removed by spatula and placed on plastic sheets in crates. These are then placed in the depuration tank until packing in oxygenated plastic bag lined foam boxes for chilled transport to market live.

The standing populations of 120 brood stock will supply enough individuals to allow a twice yearly spawning run of 48 (the excess broodstock are to allow for missed spawning and culling) individuals to produce about 280 thousand individuals, weighing about 31.6 tonne over the six month period due to their variable growth rates. At 2 successful spawning runs per year and with a cohort every 6 months the total biomass on the farm at any one time will be approximately 67.3 tonnes. Production can be expected to be approx. 31.6 tonnes over every six-month period resulting in about 63.3 tonnes per year production of 80 to 90 mm shell length, 80 to 113 gram weight abalone.

See the following Table for additional details.

TABLE OF PRODUCTION, GROWTH RATES AND SURVIVAL

60 tonne of blacklip abalone produced per annum.									
brood stock systems, hatchery, juvinile production to be based on NSW D.P.I manual									
Raceway: 3 Meters long by 500 mm wide by 150 mm deep, cross sectional area 441cm square http://www.1728.com/circsect.htm									
hides: half pipe 150mm dia 1.5 m long 4 supporting feet									
Density: best tank yield 75% -> 100% effective cover M0re & Hone 1995 in Hutchinson & Vandepeer 2005									
Density: best tank yield effective cover 45% cover -> 100% in 9 months Wassnig, Roberts, Krsinich &Day 2010									
Effective surface area Area available in ddaylight (inside of tank + inside of shelters Hindrum et al 1998									
Effective surface area (meters) = 6*0.6 + 5.5 * 0.23 = 3.6 + 1.3 = 4.9 plus ends thus 5 mSquare.									
Effective surface area (centimeters) = 600*60 + 550 * 23 = 36,000 + 12,650 = 48,650 plus ends thus 50,000 cmSquare.									
Flow: 1 liter per minute per kilo of abalone at stocking									
Stock at 50% cover Then destock to 75% when 100% cover or unionised ammonia exceeds 0.1 mg per liter by removeing hides with abs.									
Will require 120 broodstock ratio 2male to 3 female (2 dozen replacements per year)						Mass = .3 * 130 =	40.00	kilos	
	from Ab hatchery manual Hone etal assuming spawning every 6 months (28 female and 20 male) + half again incase of failure.								
age (months)	shell leng	ind mass(g)	total mass (g)	total mass (kg)	total mass (t)	number	%survive		
eggs						27,000,000.00	100.00		
fert						21,600,000.00	80.00		
larvae						17,280,000.00	80.00		
settle						8,640,000.00	50.00		
5 month						432,000.00	5.00		
6	15.00	0.50	194,400.00	194.40	0.19	388,800.00			
12	30.00	4.00	1,382,400.00	1,382.40	1.38	345,600.00	80.00		
18	45.00	14.00	4,596,480.00	4,596.48	4.60	328,320.00			
24	60.00	33.00	10,264,320.00	10,264.32	10.26	311,040.00	90.00		
30	75.00	65.00	19,206,720.00	19,206.72	19.21	295,488.00			
36	90.00	113.00	31,632,768.00	31,632.77	31.63	279,936.00	90.00		
total mass				67,277.09	67.28				

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