Testing site selection for seeding trials using hatchery reared juvenile *Haliotis mariae* Wood, 1828 along the western Dhofar coast, Arabian Sea, Sultanate of Oman.

*Schalk de Waal, Salem Khoom, Salim Al-Ghassani, Ali Al-Mashikhi, Virgie Sol TamandoTitular

Fisheries Research Centre-Salalah, Ministry of Agriculture and Fisheries Wealth, P.O. Box 33, Salalah, P.C. 217, Sultanate of Oman

*Corresponding author: email: sdewaal@gmail.com

Telephone: 968 98985725

Fax no: 968 23219275

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Abstract

In order to test site selection and seeding methodology hatchery reared juvenile *Haliotis mariae* with an average shell-length 30-52 mm were seeded along the Dhofar coast during the winter months of the NE monsoon. 18 sites (10 juveniles per site) were sampled after 30, 60 and 90 days. Approximately 70% of the total area seeded comprised habitat that has the potential to shelter and protect juveniles (boulders <50 cm Ø). In total 93% of the juveniles
recovered utilized this type of habitat. 86% of the juveniles moved <1m over the experimental period. Growth rates ranged from 1.39 to 3.57 mm month\(^{-2}\). A significant negative relationship was found between time and recovery rates (p = 0.04). Site selection and seeding methodology was shown to be consistent and reliable, paving the way for larger scale long-term seeding experiments.

**Introduction**

The wild abalone (*Haliotis mariae*, Wood 1828) fishery along the Dhofar coast forms an integral and important part of Omani fishing culture. Fishermen from communities between Ras Mirbat in the west, through Sadah, Hadbin, Hassik and Ras Sharbithat in the east, utilize this seasonal resource as part of a multi-species fishery (Figure 1, Al-Hafidh, 2006; Sanders, 1982). Like many other commercial abalone species worldwide, this abalone species has drastically declined in abundance over the last decade (Raemaekers et al., 2011, Al-Rashdi and Iwao, 2008, Guzmán del Próo et al., 2004). The Ministry of Agriculture and Fisheries in Oman has implemented strategies aimed at protecting the abalone fishery, one of these was closing the fishery from 2008 until 2010. The recovery from this closure was short-lived and average abalone densities throughout most of the fishery have declined from 2012 to 2013 (unpublished data), and abalone stocks are still considered overexploited (Balkhair et al., 2013). The development of stock enhancement or restocking technology (Bell et al., 2008, 2006; de Waal et al., 2013, Hart et al., 2013a) is an additional management strategy now under consideration by authorities.
Seeding research using hatchery reared juveniles has been undertaken in a number of countries, including Japan, South Africa, Australia, New Zealand and China (Hart et al., 2013a; Prince and Peeters, 2010; Hart et al., 2007; Heasman et al., 2007; James et al., 2007; Roberts et al., 2007; Roodt-Wilding, 2007; Dixon et al., 2006; Hutchette et al., 2005; Guzmán del Próo et al., 2004; Simizu and Uchino, 2004; Gallardo et al., 2003; de Waal, 2002). Oman now has the capability to produce hatchery-reared abalone (Al-Rashdi and Iwao, 2008 Balkhair et al., 2013). Once seeding methodologies have been developed that optimize survival over both the short and long term large scale restocking strategies can be developed for *H. mariae*. Small-scale experiments can produce the required data to develop seeding methodology without doing large-scale extensive mass seeding experiments (Read et al., 2013; Hansen and Gosselin, 2013; de Waal et al., 2013; de Waal, 2005. The goal of this study is to further develop and test the knowledge and methodology established in a prior seeding experiment conducted with translocated wild juveniles described by de Waal et al. (2013).

The availability of seed of a suitable size and suitable diving conditions determined the timing of the experiment. During the summer months (July to September) the SW monsoon winds drive a strong surface ocean current (the Somali Current) across the Arabian Sea inducing ocean and coastal upwelling (Tudhope et al., 1996). This period is also associated with rough seas that make scientific diving very difficult. From the beginning of the SW monsoon (June, July) until late October/November there is an abundance of food available for abalone resulting in significant increases in growth rates in juveniles (de Waal et al., 2013), but the masses of algae make searching for juvenile abalone very difficult. From 3
December until May/June, growth rates decline (de Waal et al., 2013) but there is little macroalgae, making sampling very effective. As a result seeding took place when food availability declines and by the end of the experimental period growth rates were at a relative seasonal minimum. The combination of open and macro-algae free habitat and small seeding densities increase searching efficiency by the divers. While we did not use any statistical manipulation to estimate accuracy (Hart et al., 2007), recovery rates are direct counts of abalone found. Underestimation of survival due to abalone not being found is definitely possible.

Methods

Seed size

In this study, we have investigated the effects of seeding juvenile abalone ranging in SL (shell length) from 30 mm to 52 mm (SL). In seeding experiments in a number of countries, South Africa, New Zealand, Australia and Canada juveniles in this size range have been used (de Waal, 2002; Roberts et al., 2007, Schiel, 1993; Hart et al., 2007; Read et al., 2013).

Selecting suitable seeding sites
Seeding site selection, comprising largely of habitat specifically suited for juveniles, under-boulder habitat, cracks and crevices, has been shown to be vital to the survival of seeded juveniles (Hart et al., 2013a; Hart et al., 2007; Heasman et al., 2007; Roberts et al., 2007; Dixon et al., 2006; Hutchette et al., 2005; de Waal, 2005). In some abalone species both recruits and juveniles are found predominantly under sea urchins (Goodsell et al., 2006; de Waal, 2005; Day and Branch, 2002; 2000). However, studies in Oman have shown that under specific conditions urchins do play a significant role in supporting a large proportion (~38%) of the wild juvenile abalone population in the fishery areas of the Dhofar coast (de Waal et al., 2012). As a result, the presence of urchins is not considered crucial in site selection here.

Seeding sites were selected that comprised habitat similar to that which supported wild juveniles (de Waal et al., 2013). Six experimental seeding sites were selected in each of three areas stretching over a distance of approximately 80 km of coast (Figure 1). Raha, the most westerly, Haat, approximately 40 km north east of Raha, and the most easterly, Hassila just outside Hadbin. In each of these three areas, each seeding sites was separated from the next by a distance of between 10 and 20 m. Each site was marked with a lead weight and a colored piece of rope tagged with a number. All abalone were individually tagged and numbered.

Selection of seeding sites was done visually, based on physical characteristics of habitat supporting wild juveniles (de Waal et al., 2013). An attempt was made to maximize the proportional cover of small boulders in comparison to larger boulders and to minimize exposed area (reef, bedrock or sand offering no shelter to juvenile abalone). Physical and
biological habitat characteristics were quantified for each of the sites. Seeding was done at
the beginning of December when macro-algae abundance was declining rapidly.

**Seeding methodology**

2 to 4 days prior to seeding the juvenile abalone were individually tagged using Superglue
and numbered plastic tape. Shell length (SL) was measured for each individual used in this
series of experiments. One day prior to seeding the loose juveniles were placed in small net
bags, 10 at a time, the bags were kept in tanks at the Mirbat facility. On the day of seeding,
the net bags containing the juvenile abalone were placed in plastic Cooler boxes and
transported to the seeding sites by vehicle. On site the bags with the abalone were
immediately placed in the water, once the divers had transported them to the preselected
stations the abalone were seeded by the divers (de Waal et al., 2013).

All juvenile abalone were seeded by hand, placed directly into cracks and crevices and under
boulders. Normally the juveniles clump together in the net bags in which they are transported
and so a number, two or more, will usually be seeded together (de Waal et al., 2013, Hart et
al., 2007; Schiel, 1993). The abalone are held against the surface of the rock or crack until
they attach securely. Observations are made until the abalone are obviously stable. The
seeding experiments comprised six sites in each of the three areas. Each of the three
experimental areas were seeded on separate days, Hassila on the 4th, Haat on the 5th, and Raha
on December 6, 2012. Seeding took less than 1 hour on each day. 10 abalone, average size
40.22 mm SL (SD 4.1), were seeded in each of the six sites. All 10 abalone were released within a couple of centimeters from each other so that survival could be compared on the smallest microhabitat scale possible within the context of these experiments. The same two divers (authors) did all site selection, seeding and sampling. Sampling was destructive and exhaustive; with the same searching methods employed throughout.

Description of each site.

Each site comprised a circle 6 m in diameter (Ø). Sites were described in the following basic substratum categories (estimates were made by the same person throughout the series of experiments):

- % area exposed, sand, reef or big boulders surface that cannot provide shelter for juvenile abalone.
- % area comprising boulders with a diameter (Ø) greater (> ) than 50 cm.
- % area comprising boulders with a diameter (Ø) between (-) 30 and 50 cm.
- % area comprising boulders with a diameter (Ø) less (<) than 30 cm.
- % area covered by crustose coralline algae.
- Number of urchins.
- Number of wild juvenile abalone.
- Depth.
Statistical analyses were conducted using StatistiXL Software. Non-parametric analyses were used because data sets were limited in size.

Variability in habitat categories (listed above) was tested between the three areas using Kruskal-Wallis Tests.

**Sampling regime**

Within the context that physical, environmental and ecological characteristics are not constant between sites, site selection, seeding and sampling was standardized as far as possible in all three areas (de Waal et al., 2013). In each area, the two sites sampled at the end of the specific sampling period were replicates of one treatment. Sampling was conducted in each area on separate days, in the same order that seeding took place. In total six sites were sampled after each experimental period. In each area, two sites were sampled after a period of 30 days, two after 60 days and the last two after 90 days. (In Raha 7 sites were seeded. After the first 30 days one site was found to be completely covered by sand. Only one juvenile was found buried under the sand. This site was therefore discarded as an outlier and the additional site was sampled after 90 days. Raha therefore has three sites sampled after the 90-day period. This is reflected in the analyses). This study yielded data from 18 sites sampled over a period of 90 days.
Recovery rates and the effect of sampling period and area.

After each sampling period recovery rates from each of the sites were recorded as minimum number surviving. A Spearman Rank Correlation (1 tailed negative correlation) analysis was conducted to test for a relationship between time and recovery for all the sites sampled over the 90 day experimental period Mann-Whitney tests were applied to data from each time to test variability between areas.

Relationships between juvenile abalone recovery rates, habitat categories, urchin and wild juvenile numbers per site, and habitat utilization by recovered juveniles.

Spearman Rank Correlation Tests were conducted to test for relationships between recovery rates and the different site attributes for each of the 18 sites. The number of recovered juveniles utilizing each habitat category, including urchins, for shelter was recorded for each site, the data was then pooled. Mann Whitney tests were then conducted to test for significant variability in utilization by juvenile abalone between individual habitat categories. A Kruskal-Wallis Test was conducted to test for variability in habitat utilization between areas.

Dispersal and Growth
Dispersal from the actual point of release was measured for all abalone recovered in a circle of diameter (Ø) 6 m. Frequencies of dispersal were calculated within 1m distance classes from the point of release. Because the data sets were limited in size dispersal frequencies in distance categories for all 18 sites were pooled. Mann-Whitney Tests were conducted to test for differences between individual distance categories. A Spearman Rank Correlation was conducted to test for a relationship between time and distance moved for all sites pooled.

Firstly growth rates from each individual abalone sampled where grouped by sample period and then by area. Variability between specific areas were compared using Mann-Whitney Tests for each of the sample periods, 30, 60, and 90 days. Secondly, growth rates from all sites in each area were pooled and variability between areas was tested using a Mann-Whitney Tests.

Results

General relative characteristics of each experimental area

Although the seeding sites were selected visually with respect to physical characteristics such as the prevalence of small boulders and less exposed area, be it bedrock or sand, detail results show that this was not always the case (Table 1). The Raha sites were generally deeper than both Hassila and Haat, depth differences tested significant (p = 0.01 Table 1). Raha also had the most urchins, the other two sites had between 35 and 45 % less. Hassila
had the least wild juveniles, almost 50% less than Haat and 25% of those found at Raha, the
deeper area. The proportional cover of crustose coralline algae on the rock and boulder
surfaces was similar in Raha and Haat, and approximately 40% lower at Hassila, one of the
two shallower areas. Both Hassila and Haat comprised less exposed habitat, 10-20%, while
Raha comprised 53%. Hassila had almost double the amount of boulders >50 cm Ø (46.7%)
than the other two sites, Raha had the smallest proportion of boulders 30-50 cm Ø, and Haat
the highest (Table 1). Raha had the least amount of the smallest boulders, 6.6%, Hassila 15%
and Haat the most, 35.4%. The differences in exposed habitat tested significant between areas
(p = 0.01).

Keeping in mind the complexity in shape of natural boulders and the degree to which that
affects estimates of true boulder diameter the proportional cover of small boulders varied
between sites. Haat had the most available under-boulder (the inverse of exposed) habitat
(89%), Hassila slightly less (79%), and Raha the least (47%) (Table 1).

Recovery rates

Recovery rates between areas varied throughout the sampling period (Table 1). By the end of
the 90 day experiment the average recovery rates for all three areas was approximately equal
at 60%. The recovery rates varied between sites and times with no consistent pattern (Table
1). However when average recovery rates are pooled from all sites sampled over each
sampling period and plotted against time a downward trend is clearly visible decreasing from
72 % (±8.6 SE), to 65 % (±12 SE) and then to a minimum of 45.7% (±12 SE) over 30, 60, and 90 days respectively. A Spearman Rank Correlation 1-tailed test for negative correlation did show a significant negative relationship between time and recovery rates (p = 0.04). The Mann Whitney tests applied on recovery rates between areas for each time period tested insignificant.

Recovery rates and habitat utilization

Mann-Whitney Tests showed the differences to be significant between the utilization of urchins and all categories of boulders (p = 0.04, 0.04, and 0.001 for the largest to the smallest boulders respectively). Tests between the utilization of the different boulder classes were not significant. Because only four abalone were recovered from exposed habitat analyses testing the utilization of this type of habitat is considered redundant. The habitat most frequently utilized by seeded juveniles was small boulders (<30 cm Ø) and then the larger boulders (>50 cm Ø). Urchins were very rarely utilized (Table 2, Figure 2). A Kruskal-Wallis Test revealed that the pattern of habitat utilization did not vary significantly between areas.

Dispersal and recovery

More than 85% of all seeded juveniles recovered were found within 1m from the point of release. Differences tested significant between the 1st and both the 2nd and 3rd m distance categories (Table 3, p = <0.001 for both). A Spearman Rank Correlation for all the data pooled tested not significant for any relationship between distance moved and time.
The sites with the highest recovery rates showed the least dispersal (Table 3). In all three areas lower recovery rates were associated with evidence of dispersal. At the sites with the lowest recovery rates, 35 and 40%, seed were recovered in both the 2nd and 3rd m interval from the seeding point. This was also found for one of the 60% recovery sites. Without ongoing (24 hr.) monitoring, which was not done in this study, detailed dispersal patterns or evidence of dispersal is difficult to interpret.

Growth rates

Seeded occurred during December, winter, when water temperatures average around 25°C. The 18 sites sampled in this series of experiments ranged in depth from less than 1 meter to approximately 5.5 m. The highest average growth rate was measured at Hassila 3.2 (SD 1.3) mm, next at Haat 2.7 (SD 1.4) mm, and the lowest at Raha 2.1 (SD 1.1) mm. The shallowest area was Haat, with an average depth of 0.92 m, and the deepest Raha, at 3.2 m (Table 1). Average growth rates appeared to vary between sites, with the shallower sites generally showing higher growth rates than the deeper ones. When the average growth rates for each period were pooled within each area and compared using the Mann-Whitney Test the difference in growth tested significant in each case between one of the two areas with shallower sites and the area with the deeper sites, Raha. Over the 30 day period the difference tested significant between Raha and Hassila ($p = 0.11$), over the 60 day period it was between Haat and Raha ($p = 0.027$), and over the 90 day period there was a significant difference.
between the two shallower areas Hassila and Haat ($p = 0.017$) and Hassila and Raha ($p = 0.006$). As in the previous analysis, Hassila yielded the highest average growth rate compared to Haat, the area with shallowest average site depth, and Raha, the area with deepest average site depths.

Discussion

Recovery rates

The primary goal behind this study was to test the strength of site selection and seeding methodology developed in an earlier experiment using wild juveniles (de Waal et al., 2013). Short-term recovery rates have been used as the primary indicator of success. In contrast to the experimental design followed by Hart et al. (2013), which allowed for long term monitoring of the same sites, our method of destructive sampling (which optimizes finding juveniles) did not allow this. Their study showed that over an extended period both juveniles and adults can move both in and out of an experimental area, affecting recovery and therefore expected potential survival rates over time. In our study the relationship between time and recovery was considered weak and therefore not a good indicator of success either way. Similar overall recovery rates did however indicate that the quality of site selection was reasonably consistent throughout. While we do not know what happened to the juveniles we did not recover (Prince and Peeters, 2010), we do know that those that have survived and grown over the 30 to 90 day periods survived through the period that food was severely limited, reflected in low growth rates (de Waal et al., 2013). It is possible that seeding in
times that food is abundant will affect survival beneficially. The recovery rates found in this
study are comparable to those found in studies conducted on other abalone species in similar
size classes and over similar time scales (de Waal et al., 2013; Hart et al., 2007; James et al.,
2007; Roberts et al., 2007; Goodsell et al., 2006; Hutchette et al., 2005). What this research
has also shown clearly is that regardless of seeding methodology and the selection of sites
with similar characteristics, recovery rates are variable between sites. Comparisons between
sites, geographic areas, and species should be done with caution (de Waal et al., 2013).

Habitat selection, depth, urchins and growth

Interpreting results on a site specific scale is important because abalone will be seeded
according to the criteria developed and evaluated through this series of experiments. All three
geographic areas have yielded both good and bad recovery rates, overall however, the results
show that with appropriate habitat selection seeding could be successful in any of the areas.
These areas reflect the abalone fishery area along the western Dhofar coast, in other words
there is abundant similar habitat available throughout the fishery. Those factors measured in
these experiments are only part of the process required to evaluate the potential viability of
seeding juvenile *H. mariae*, either wild or hatchery bred. The costs of producing different
size classes of juveniles and the potential impact on wild fisheries have not been addressed
here (Hart et al., 2013a,b; Roberts et al., 2007).
The most important fact that drives short term survival is the fact that juvenile abalone are photosensitive and they attempt to move into shade as soon as possible (de Waal et al., 2013; Prince and Peeters, 2010; de Waal, 2005; 2002). If that shade is provided by habitat that can protect the abalone from predation it is an added benefit. Approximately 70% of the total area seeded comprised habitat that has the potential to shelter and protect juveniles (boulders <50 cm Ø). This type of habitat typically comprises layers of small boulders, the more physically complex the site the more habitat there is for juvenile abalone (Heasman et al., 2007; Dixon et al., 2006; Hutchette et al., 2005). In total 93% of the juveniles recovered utilized this habitat. The pattern of specific habitat selection made by recovered juveniles did not vary significantly between areas (Figure 2). The measure of quality of the most favored habitat could include availability of food, specific predator species, and unmeasured small scale (the scale at which an individual abalone lives) micro-habitat effects. Those sites with an abundance of smaller boulders appear to be more effective for survival. This could reflect the availability of surface area on which microalgae settles and grows, and therefore grazing can take place.

Within the restricted depth range of this study no significant effect on survival by depth was evident. In this study urchins played an insignificant role in the survival of seeded *H. Mariae* juveniles. The relationship between seeded juveniles and urchins is also not that significant with either *Haliotis midae* in South Africa (de Waal, 2005), or with *Haliotis rubra* in Australia (Goodsell et al., 2006). The growth rates measured in the sea are comparable to those for the same species reared in the Mirbat hatchery where juveniles have been shown to grow up to 4.1 mm per month (Al-Rashdi and Iawo, 2008). These growth rates are seasonal
and monitoring of tagged wild juveniles in 2012 showed a marked increase beginning in May/June (de Waal et al., 2013). Growth rates are important because of the potential relationship between seed size and survival reported in a number of experiments internationally (Hart et al., 2007; Heasman et al., 2007; Schiel, 1993). In this study Hassila, not the shallowest site, yielded the highest average growth. It is the most easterly site and factors such as water temperature and available nutrients may have caused this. These factors are not measured in our study.

Dispersal

Evidence of dispersal could indicate that low recovery rates may not be because of mortality but because of dispersal (de Waal et al., 2013; Prince and Peeters, 2010; de Waal et al., 2003). In the majority of the sites used here, dispersal was limited. As a result where no dispersal was evident low recovery rates were assumed to indicate low survival. Juvenile abalone need to move as they grow, increased growth and the transition between juvenile and sub-adult phase may require movement to new habitat as they mature (Hart et al., 2013a). If this dispersal occurs during a short-term experiment recovery rates will be low but not a reflection of potential survival. The relationship between increased growth rates and dispersal needs much further investigation.
Conclusions

This study has shown that the criteria used for site selection and the seeding methodology used is successful. There may be some benefit gained from seeding when food is more abundant, just prior to and after the SW Monsoon. This, amongst other factors such as decreased seeding size need to be investigated in the next phase of research. In the context of larger scale, long term seeding projects research must take place to investigate the relationship between seeding densities, potential survival and adult stocking densities related to habitat capacity.

Acknowledgements

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References


Table 1. The general habitat characteristics for each experimental area. *p* values are for variability in physical characteristics between sites using the Kruskal-Wallis Test (* denotes significance at 95% confidence limits).

Table 2. *p* values from Mann Whitney tests show variability in the utilization between specific habitat categories by juvenile abalone. (* denotes significance at 95% confidence limits). Bottom row shows average % utilization of habitat categories by juvenile abalone.

Table 3. Percentage frequency dispersal in 1-m distance categories for all abalone recovered. Mann-Whitney tests showed the significant variance to be between the first distance category and the two other categories, not between the second two (in both cases *p*<= 0.001* at 95% confidence limits).
Table 1. The general habitat characteristics for each experimental area. *p values are for variability in physical characteristics between sites using the Kruskal-Wallis Test (* denotes significance at 95% confidence limits).

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<th>Sampling period (days)</th>
<th>% Recovered</th>
<th>Depth (m)</th>
<th>Area exposed</th>
<th>Boulders &gt;50cm Ø</th>
<th>Boulders 30-50cm Ø</th>
<th>Boulders &lt;30cm Ø</th>
<th>% Area CCA</th>
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<td>20</td>
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<td>23</td>
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<td>30</td>
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<td>40</td>
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<td>Ave.</td>
<td>58.33</td>
<td>3.22</td>
<td>53.33</td>
<td>26.67</td>
<td>13.33</td>
<td>6.67</td>
<td>47.50</td>
<td>81.17</td>
<td>16.33</td>
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<tr>
<td>SD</td>
<td>26.39</td>
<td>1.30</td>
<td>23.38</td>
<td>21.60</td>
<td>8.16</td>
<td>5.16</td>
<td>20.43</td>
<td>68.52</td>
<td>11.45</td>
</tr>
</tbody>
</table>

*p 0.01* 0.01* 0.12 0.08 0.05 0.14 0.54 0.05
Table 2. *p* values from Mann Whitney tests show variability in the utilization between specific habitat categories by juvenile abalone. (* denotes significance at 95% confidence limits). Bottom row shows average % utilization of habitat categories by juvenile abalone.

<table>
<thead>
<tr>
<th>Categories</th>
<th>&gt; 50 cm Ø</th>
<th>30-50 cm Ø</th>
<th>&lt; 30 cm Ø</th>
<th>Urchins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposed area</td>
<td>0.04*</td>
<td>0.034*</td>
<td>0.001*</td>
<td>1</td>
</tr>
<tr>
<td>&gt; 50 cm Ø</td>
<td>0.99</td>
<td>0.192</td>
<td>0.04*</td>
<td></td>
</tr>
<tr>
<td>30-50 cm Ø</td>
<td>0.252</td>
<td>0.001*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 30 cm Ø</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

% utilization by juvenile abalone

<table>
<thead>
<tr>
<th>Exposed area</th>
<th>&gt; 50 cm Ø</th>
<th>30-50 cm Ø</th>
<th>&lt; 30 cm Ø</th>
<th>Urchins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposed area</td>
<td>3.74</td>
<td>28.97</td>
<td>24.3</td>
<td>40.19</td>
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</table>
Table 3. Percentage frequency dispersal in 1-m distance categories for all abalone recovered. Mann-Whitney tests showed the significant variance to be between the first distance category and the two other categories, not between the second two (in both cases $p<0.001^*$ at 95% confidence limits).

<table>
<thead>
<tr>
<th>Period (days)</th>
<th>Distance categories (m)</th>
<th>0-0.9</th>
<th>1.1-1.9</th>
<th>2.1-2.9</th>
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</thead>
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<tr>
<td>Hassila</td>
<td>30 days</td>
<td>100</td>
<td>0</td>
<td>0</td>
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<tr>
<td></td>
<td>60 days</td>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>90 days</td>
<td>71.43</td>
<td>14.29</td>
<td>14.29</td>
</tr>
<tr>
<td>Haat</td>
<td>30 days</td>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>60 days</td>
<td>77.78</td>
<td>22.22</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>90 days</td>
<td>75.00</td>
<td>16.67</td>
<td>8.33</td>
</tr>
<tr>
<td>Raha</td>
<td>30 days</td>
<td>60.00</td>
<td>20.00</td>
<td>20.00</td>
</tr>
<tr>
<td></td>
<td>60 days</td>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>90 days</td>
<td>92.31</td>
<td>7.69</td>
<td>0</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td>86.28</td>
<td>8.99</td>
<td>4.74</td>
</tr>
</tbody>
</table>
Figure 1. Experimental seeding areas along the Dhofar coast of Oman (Map supplied by Mikhail V. Chesalin).

Figure 2. Proportional utilization of each habitat category by juvenile abalone in each area (Mean ± S. E.).

Figure 3. Mean monthly growth rates (± S. E.) for each site over the three sample periods in each of the three geographic areas. Inset in each figure gives the time period in days (left hand column), and depth for each site in meters (right hand column).
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