Summary of Seahorse Population and Distribution

Koh Rong Samloem
Preah Sihanouk, Cambodia

Report on seahorse demographics and habitats

Marine Conservation Cambodia
December 2012/End of Year Report 2012

Photo 1 –*H. Spinosissimus* on the Corral, MCC 2009

Report By:

Zachary Calef – Marine Biologist

Paul Ferber - Managing Director and Project Founder, MCC

Neil Garrick-Maidment – The Seahorse Trust

Abstract

This is a follow up report for the seahorse population and habitat surveys undertaken, starting with an initial survey done in June 2011 and continuing in August 20012 through to December 2012.

The aim of the ongoing survey has been to access and monitor the changing conditions of the study site, called the Corral, off the East coast of Koh Rong Somloem.

The December 2012 survey consisted of 28 survey sites and in summary, there were a total of 25 seahorses found comprised of two species, 24 *H. spinosissimus* and 1 *H. kuda* spread over the site.

Due to the ongoing continuous nature of these surveys there is a better understanding of the local seahorse populations, their behavior, depth range, migratory patterns, yearly movements and distribution within the study site.

Through the ongoing continued research it is hoped to establish a database of the conditions of this diverse and ecologically important area over a long period of time so that the data collected can be used to protect this fragile ecosystem.

By establishing relationships between species composition and diversity, depth, preferred holdfasts and holdfast densities, habitat cover, sexual demographics and reproductive activity it is possible to more effectively design and implement an effective conservation strategy as well as monitor its success over time.

All of this will lead to a better understanding for the long term protection of this fragile species and sensitive habitat.

Marine Conservation Cambodia
Koh Rong Samloem Village, Koh Rong Samloem
Mittapheap District, Sihanoukville
CAMBODIA
info@marineconservationcambodia.org

Acknowledgements

Marine Conservation Cambodia (MCC) has been working on conservation and community livelihoods in collaboration with the Royal Government of Cambodia Fisheries Administration (RGC FiA), local authorities and local communities since 2008.

The Marine Monitoring and Marine Research programs around Koh Rong and Koh Rong Samloem are now well underway and are currently undertaking marine surveys around Koh Rong Samloem, this is to monitor the Seahorse populations and the coral reefs, so it is possible to assist the FiA in the creation of Marine Fisheries Management Areas (MFMAs), Cambodia's equivalent to Marine Protected Areas (MPAs).

Close collaboration with the FiA and international institutions such as the FAO Regional Fisheries Livelihoods Programme (RFLP), The Seahorse Trust (UK), Save Our Seahorses (Ireland) has proven that MCC is now a respected and credited leader in conservation and community work in Cambodia.

Special Thanks Too

H.E. Dr. Nao Thuok	Director General of the Fisheries Administration
Mr. Ing Try	Deputy Director of the Fisheries Administration
Mr. Ouk Vibol	Director of Fisheries Conservation Division
Mr. Doung Samth	Chief of Sihanoukville Fisheries Cantonment

Research Team

Paul Ferber	Managing Director and Project Founder, MCC
Zachary Calef	Bsc – Director of Marine Research, MCC
Alexandra Barlow	Project Site Manager/Field Research Coordinator, MCC
Lorna Song	Statistical Analyst, MCC

Research partners / advisors

RGC FiA	Royal Cambodian Government
Kealan Doyle	SOS
Neil Garrick-Maidment	The Seahorse Trust

Table of contents

Introduction

Cambodia has a unique marine environment that has an unusual array of species and a diverse range of habitats. As part of an ongoing, long term survey of the seahorses in southern Cambodia a site was chosen within a specific area off the small island of Koh Rong Samloem Island, due south west of the port of Sihanoukville. The chosen site is known locally as the Corral and the surveys were commenced throughout June/July of 2011 and again in November/December of 2011, which were followed in August/September/October/November of 2012 and finally in December 2012, all of which is the subject of this report.

Population assessments provide a useful tool for measuring the current condition and viability of a specific population allowing for accurate estimates of abundance and structure of organisms within a studied area. Each survey undertaken provides a static picture of the condition and abundance of organisms and bottom composition for our selected area. When done in comparison to later surveys and looking back at previous surveys on the same sites, patterns start to emerge that will be beneficial to understanding the behaviour, migration, and distribution of the seahorses.

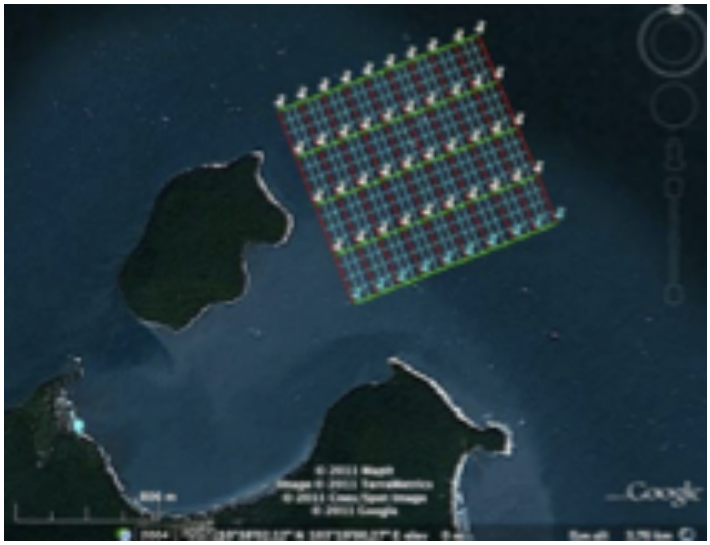
The assessment will therefore allow the seahorse population of the Corral site to be tracked and the effects of disturbance, such as destruction from trawling boats, to be monitored over long periods of time. Other trends, such as shifts in the dynamics of the species composition and age structure can also be observed over time. By comparing the previous set of data from the previous year with the new survey data in this report it is hoped to gain insight into the changing population and distribution demographics, as well as species composition and age structures within our study site.

As more surveys are performed an accurate trend of what is really happening at the study site will begin to emerge. It is vitally important to have a clear understanding of the conditions and number of organisms throughout the study area, so that management protocols can be efficiently implemented and effective conservation and monitoring strategies designed. Furthermore, it is vital to recognize habitat degradation and consequently population decline early on, so that effective measures can be put into place to mitigate and alleviate the pressures causing it.

Study Area

Koh Rong Samloem Island is located 2 hours west of Sihanoukville, a port city on

Cambodia's southern coast. The island's coastline is largely shallow, composed mainly of sand flats, seagrass beds and coral reef habitats. Previous studies have identified 5 geographically separated coastal areas of seahorse habitat, designating one particular area, the Corral site, as a location for targeted seahorse research, due to its large breeding populations and close proximity to Marine Conservation Cambodia (MCC) facilities.



Grid layout of the study area showing its location next to Koh Rong Samleom, this is the site known as the Corral.

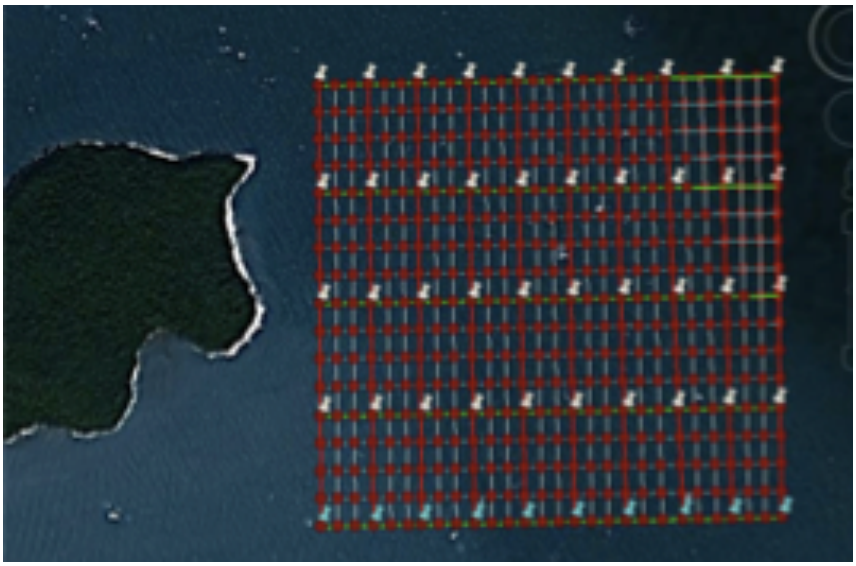
The Corral site is located to the east of Koh Koun, a small island located off the northern coast of Koh Rong Somloem. The area is dominated by sand flats, which slope gradually from the east coast of Koh Koun, with depths ranging between 5-20m. The area supports populations of bivalves, soft corals, hydrozoans and large numbers of pencil urchins (*Prionacidaris spp*), which provide valuable holdfasts for seahorses.

Species diversity of the area has been observed to be unusually high, with 6 species of seahorse identified from photographic evidence taken at the Corral site. These species are *Hippocampus spinosissimus, Hippocampus trimaculatus, Hippocampus kuda, Hippocampus comes, Hippocampus kelloggi, Hippocampus barbouri*. *Hippocampus spinosissimus* and *H. trimaculatus* have been most commonly found in the area, with *H. spinosissimus* heavily dominating the population particularly in 2012.

The habitat was observed to be in excellent condition in 2007, but damage from illegal trawling activity has greatly impacted the habitat since, reducing the biodiversity and productivity of the local ecosystem. Field observations from 2007 suggest that seahorse species diversity was previously higher, and has decreased over a very short period of time to strongly favor *H. spinosissimus*.

Protection of the habitat has been established in the form of a 300m No Take Zone (NTZ) extending from Koh Koun Island, unfortunately protection measures are often ignored or circumvented, however, and frequent monitoring is necessary to prevent trawling activity in the area. Regularly conducted population assessments provide the consistent data necessary to measure the recovery of this area, and to make comparisons to its previously observed productivity of the ecosystem.

Methods



Layout of the structure of the grid pattern for surveying the Corral.

The population assessment was conducted through underwater visual transects that were randomly located within the 1.8 km^2 Corral study area. The starting point of each 500m^2 transect was randomized by a random number generator, which selected numbers that corresponded to specific GPS coordinates within the study area. The direction of transects was also randomized, with a random number generator assigning a value that corresponded to one of eight possible directions (N, NE, E, SE, S, SW, W, NW).

Transects were created by laying two 50m lines parallel, spaced 5m apart, projecting

from the starting point in the randomly assigned direction. Two divers swim from the original side on either side of the first transect line, each surveying the 2.5m areas adjacent to the tape. At the far end of the tape, the divers would swim to the second tape and survey the 2.5m on either side going the opposite direction. The total surveyed area for each transect was 500m_2.

Seahorse species, demographic class, trunk and snout length, and associated habitat were recorded for each seahorse specimen within the transect area. Juveniles were defined as any seahorse with a trunk length under 2cm, and were not distinguished by sex due to difficulties in differentiating small individuals without fully developed sexual and species characteristics. Counts of pencil urchins, soft corals, anemones, seagrass, hydrozoans, sea pens and manmade structures were also recorded.

Estimates of the type of substrate cover were determined by swimming in a 1m circle with the centre point being along the transect line, by analysing the area it was possible to estimate the percentage of substrate area covered by benthic organisms.

Results

Over the 28 surveys done there was a total of 25 seahorses recorded. Of the 25 seahorses 24 were identified as *H. spinosissimus* and 1 was recognized as *H. kuda*. There were no pregnant males observed, however the remaining demographics were all recorded, with 10 females, 6 males, and 9 juveniles identified as can be seen in Figure 1.

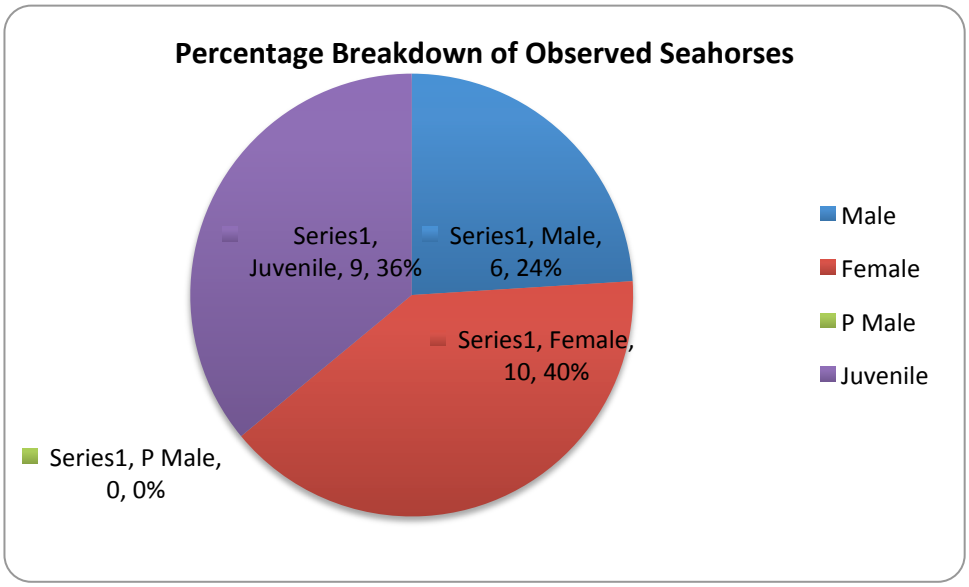


Figure 1: Seahorse sexual distribution – December 2012

Holdfast selection heavily favored pencil urchins with 24 of 25 observed. There was 1 seahorse found attached to a rock, as seen in Figure 2.

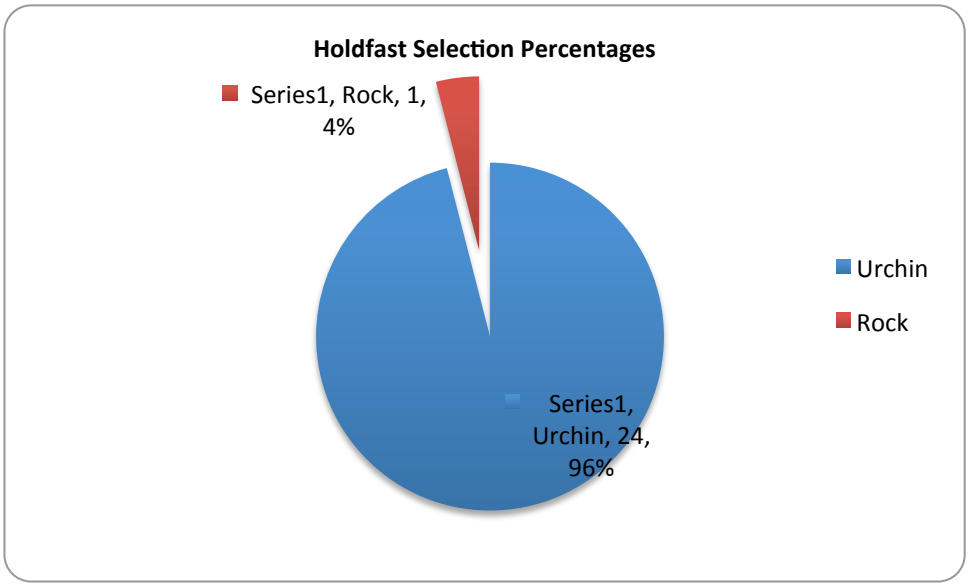


Figure 2: Seahorse holdfast selection – December 2012

The average depths for each demographic can be seen in Figure 3. The overall average for seahorses observed was 12.13m. Males and females were found at average depths of 10.18m and 11.72m respectively. The average depth of juveniles was 13.87, and there were no pregnant males recorded.

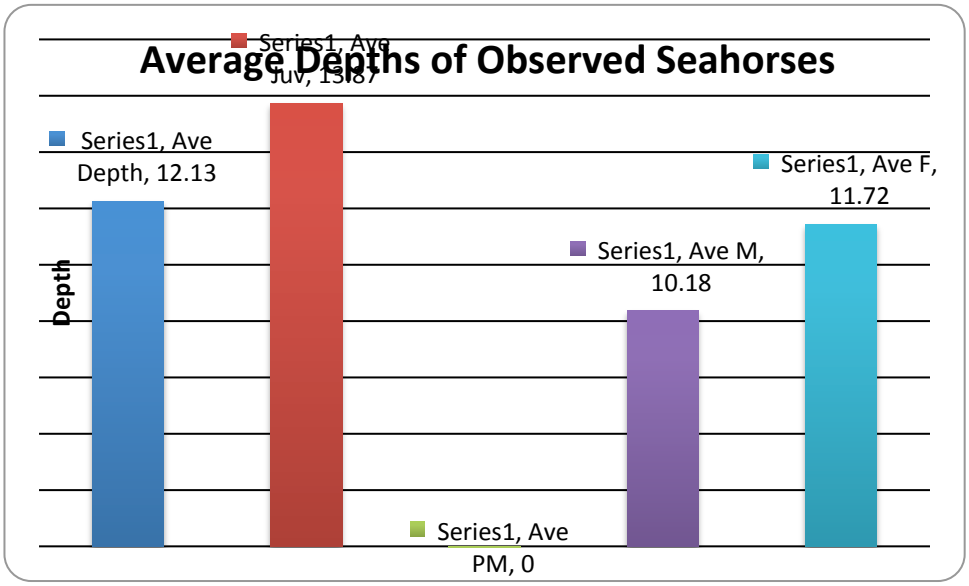


Figure 3: Average seahorse depth December 2012

As with our previous surveys, measurements of the number of pencil urchins corresponding with the extent of the shell cover on the sea floor were taken. These were then correlated to each other using a paired T-test as well as to the number of seahorses found at each survey sight. The results can be seen in Table 1, and all three relationships were found to be significant.

Relationship	P-value
Pencil Urchin vs Seahorses Observed	2.0763E-04
Shell Cover % vs Pencil Urchins	3.7167E-04
Seahorses Observed vs Shell Cover %	1.6286E-04

Table 1: Relationships between urchin densities, shell cover % and seahorses observed in December 2012. P-value determined with a paired T-test

Discussion

This ongoing survey is starting to reap rewards in consistent data and a pattern is now starting to emerge as to the seahorse species, their habitat preference, depth found throughout the year, and sex ratios on the site.

In this discussion we look at all of these aspects and try to understand the implications of all of these factors on the study site at the Corral.

Holdfast and habitat preference

The seahorse holdfast selection was recorded to again be composed primarily of pencil urchins with 1 individual found attached to a rock; this is consistent with what has been found in previous surveys, however the lack of observations of seahorses being found on sea pens and whole shells can only be attributed to the low level of seahorses observed and further long term research is needed to quantify if there is indeed a correlation with these types of holdfast.

The correlation between pencil urchin population density to the percentage cover of broken shell on the seabed (caused by illegal trawling) and seahorses found, were again all found to be significant relationships and it is supposed that the lack of solid complete objects for the seahorses to secure themselves to, shows that the illegal fishing is having a negative effect on the seahorse populations. Traditionally, based on studies and observation of other species, in a prime undamaged seahorse habitat, they would be attached to solid non-motile holdfasts such as seafans, coral, algae and the like. However, at the Corral due to the destructive nature of the trawling, solid holdfasts are in limited supply, so the seahorses have adapted to using other items such as pen urchins. Where these are not available they are either drifting on the seabed or have moved out of the area.

That being said, observational data from as early as 2007 indicates that seahorses have been using pencil urchins since the site was first being visited, prior to when the major trawling occurred. It is possible that the local populations, or at least *H. spinosissimus*, have been using these urchins as holdfasts pre-trawling simply because of there natural abundance in the area, and have only now, because of the trawling damage, become so heavily reliant on them. Future study on holdfast selection, when given options for stable objects, will be able to clarify the distinction.

Another interesting point of notice is that there are routinely extremely strong currents present at our study site. On several occasions it has been observed that the currents will actually take the pencil urchins with them, bouncing them along the seafloor like tumbleweed. This again raises interesting questions on holdfast selection and territoriality. How can the local population be expected to maintain a territory if the currents are far to strong to swim against and their primary holdfast is also no match? Further study on current strength and direction will hopefully provide clarification on the how the local population has adapted to these conditions.

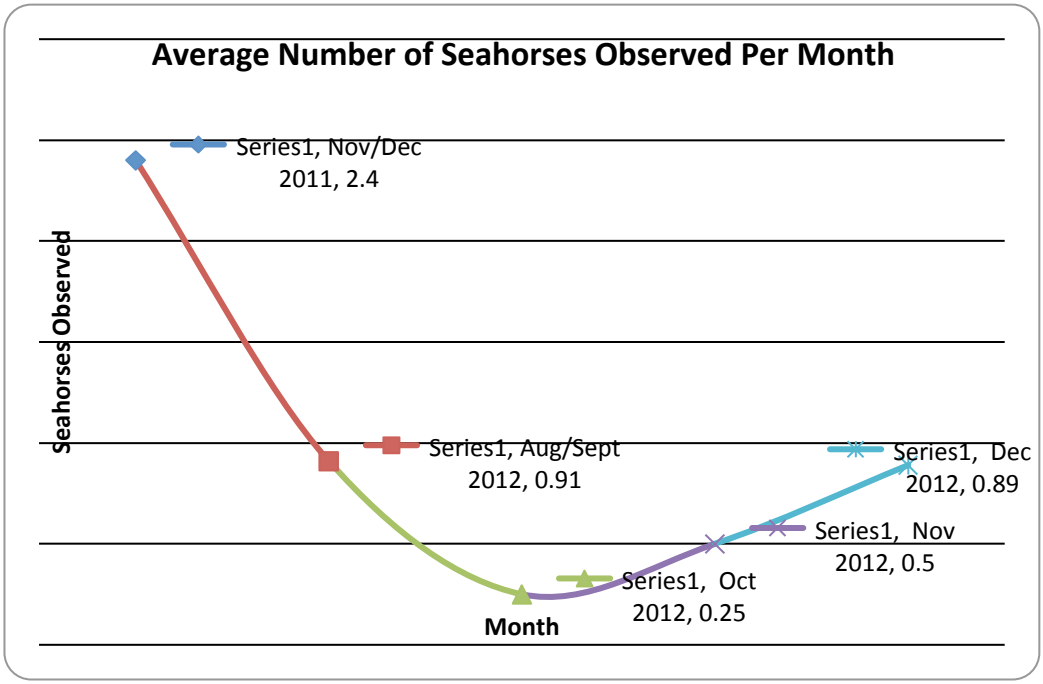
Pre trawling it was recorded that there were 6 species of seahorse in large numbers; only the *Hippocampus spinosissimus* is present in any significant numbers during 2012, leading to the conclusion that they are best adapted to this fragmented habitat. However, in December 2012 the first sighting of a species other than H. *spinosissimu*s was recorded since November 2011, with 1 H. *kuda* positively identified in our study site.

In the long term, as the original habitat is reinstated, it is hoped that the other seahorse species will return to the area.

Seahorse population

During this survey set the number of seahorses increased to 0.89 seahorses per survey with 25 individuals identified over 28 surveys.

During the Aug/Sept 2012 survey there was an average of 0.91 seahorses per survey, in October 2012 there were only 0.25, and in November 2012 we had an average of 0.5 seahorses, recorded per, as shown in Graph 1.



Graph 1: Averaged observed seahorses per survey over time

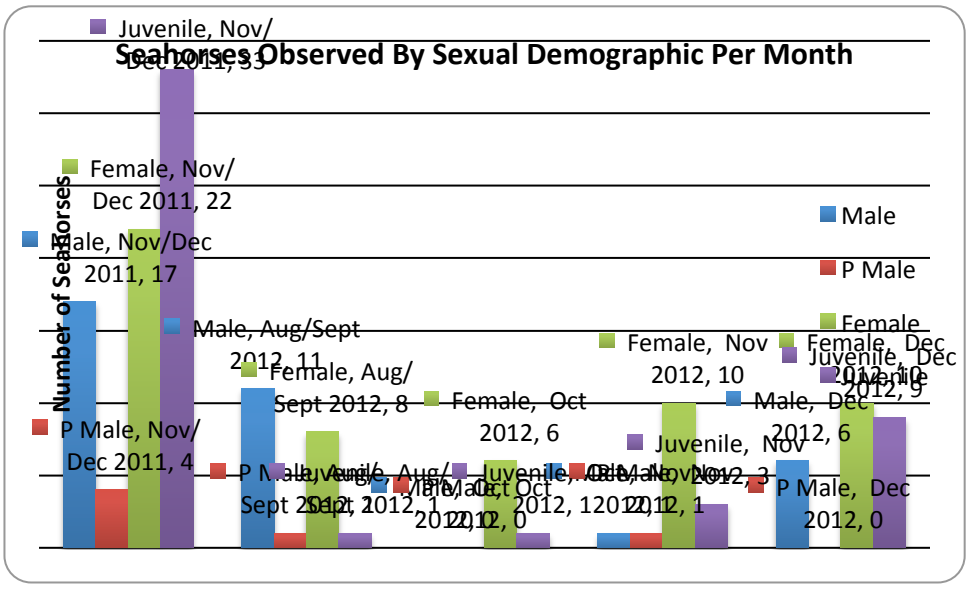
During the Nov/Dec 2011 surveys there was an average of 2.4 seahorses over 32 surveys observed. When compared to November 2012 this is a decline of 79% in seahorses seen per dive in just one year. It is all the more startling when you look at the total number of seahorses found. In Nov/Dec 2011 there were 76 seahorses recorded and just one year later that number is down to 15 when surveying the same site. In December 2012 the average per dive has returned to Aug/Sept 2012 levels. The possible cause for the drop in observed seahorses in Oct. 2012 is addressed in more detail subsequently.

As can be seen in Graph 2 and 3. Every single sexual demographic is lower than it was in Nov. 2012. Males and females observed have taken a noticeable drop in numbers, but that is to be expected in a population that is in decline. The most troublesome figures however, are the ones associated with reproduction. In one year we see the number of pregnant males recorded has been reduced to a quarter of its former value, and where we saw 33 juvenile seahorses in Nov. 2011, in Nov. 2012 we saw a paltry 3. In Dec. 2012 we do see an increase in the juveniles identified at 9, which is considerably more that the rest of 2012 combined at 5. The number of reported pregnant males still remains low, with none being recorded during this most recent data set. In fact, we see an increase since Oct. 2012 in every sexual

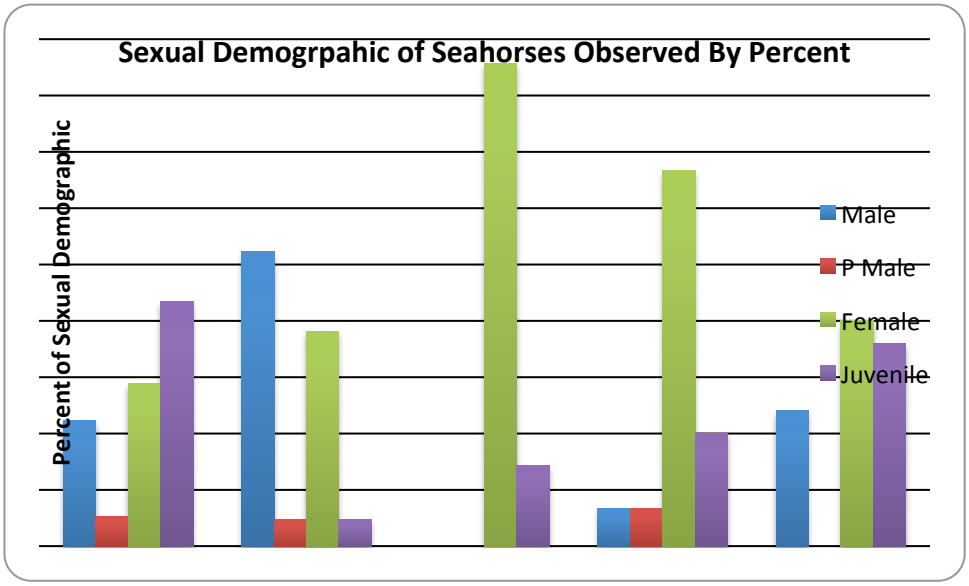
demographic except for pregnant males. The gap between females and juveniles is the greatest in October but the discrepancy has been diminishing over the previous months, so that by December, the percentage of observed juveniles and females are closer and better distributed.

Fewer juveniles mean a smaller population for the next generation of males, pregnant males, and female seahorses. The low juvenile count in Aug/Sept 2012 may speak for the dip in population in October. Conversely, this month's reemerging numbers in juveniles may be a hint at growth in population for the following months

It is possible that the increase in juveniles during December is the result of some form of mating season or breading cycle. Further research will confirm or deny this possibility and give insight into the breading habits and behaviors of the local population, particularly when analysis of water temperature and other seasonal variations such as current flow and direction are considered.



Graph 2: Seahorses observed by sexual demographic



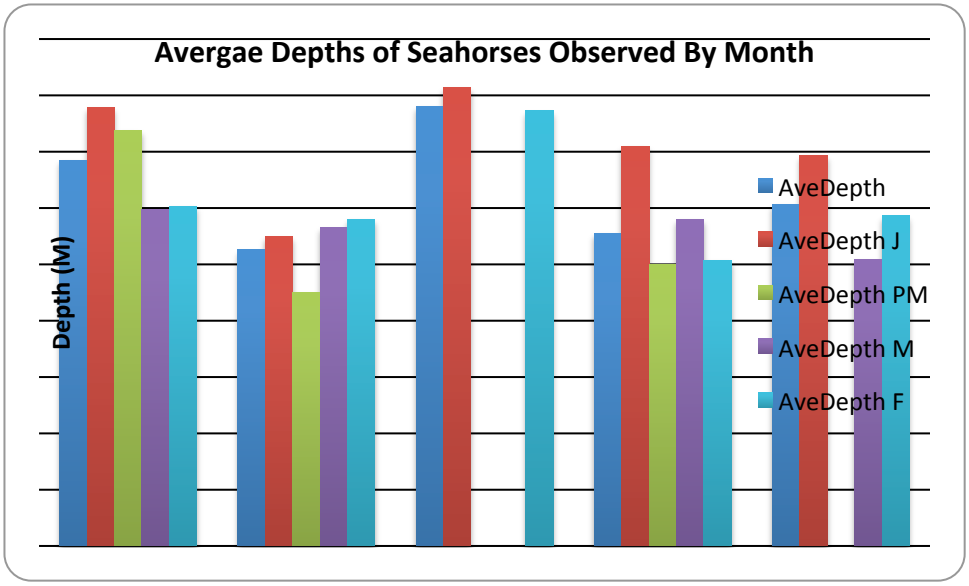
Graph 3: Sexual demographic of seahorses by percent

In the rest of this discussion the attempt is made to make some correlation out of the numbers and data that we have collected during 2012. And indeed there do appear to be patterns emerging that will hopefully aid our future research and conservation efforts. However, interpreting these patterns is hindered by a relatively small data set, and low numbers of seahorses identified. This being said, I fear that if the numbers collected relating directly to reproduction (pregnant males and juveniles) does not increase it may become impossible for the local population to recover without intervention, despite the modest increase seen in December.

One possible reason for the drop in seahorses recorded in October 2012, compared with Aug/Sept, is that the random selected points for that month gave a disproportionate number of deep survey sites, as seen in Table 2. The average depth for the survey points for this period was 19.4m with only 5 surveys done below 15m. November's average survey depth was 11.4m, with a more varied depth distribution. October's average dive depth of 19.4m noticeably deviates from the rest of the other average dive depths and may fall out of the range of the seahorse's preferred depth range, while November and December's 11.4m and 12.1m may fall within it.

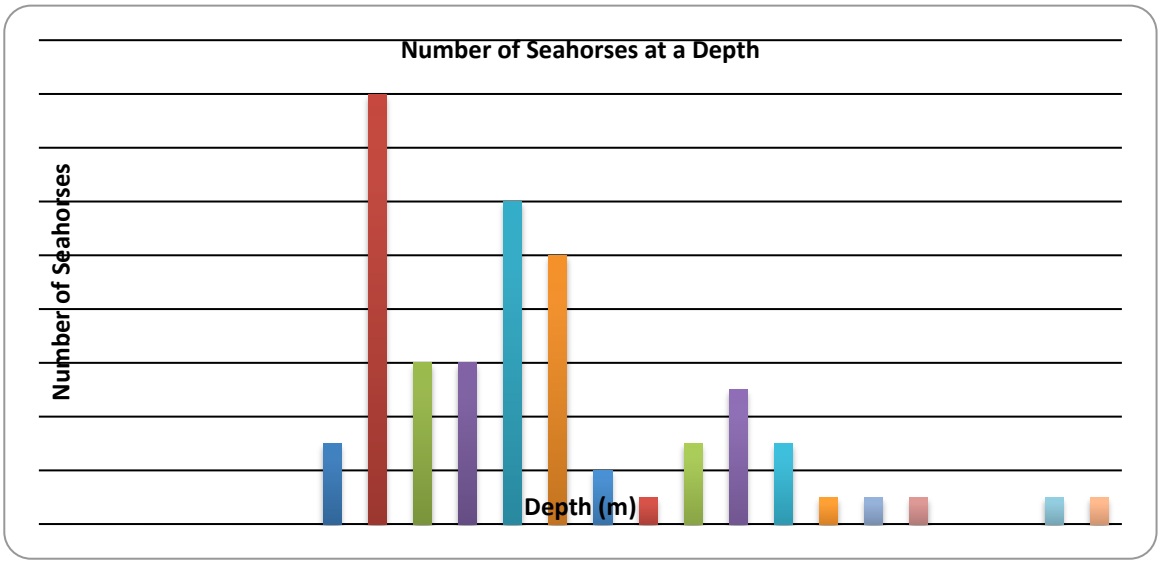
MONTH	AVERAGE DIVE DEPTH
AUG/SEPT 2012	10.396 m
OCT 2012	19.414 m
NOV 2012	11.44 m
DEC 2012	12.121 m

Table 2: Average depth of survey dives by month



Graph 4: Average depth of seahorses observed through December 2012

When examining Graph 4 it would seem that the average seahorse depths of all sexual demographics lies predominantly in the range of 10 to 15 m. However, it is important to note that a few monthly averages are unfortunately represented by single sightings of seahorses rather than a calculated average of two or more. These single sighting at 9 to 11 m as well as the single juvenile found 16.3m in October, could be outliers. If 10 to 15m is indeed a preferred range, it is evident that the average dives in October fall outside of this. August, November, and December rest in the range and would thus have higher counts in seahorses. This favorable range may explain the increase in seahorse counts since October. But it does not account for the significantly greater number of seahorses in August/September. August/September 2012, which has an average dive depth of 10.4 m, is heading towards the lower outskirts on the suggested range of 10 to 15 m.



Graph 5: Number of recorded seahorses per depth from Aug. 2012 through Dec. 2012

As shown in Graph 5, seahorses have been observed at depths of 7 to 24 m. Within this range, there appears to be two groups that the seahorses were found: 7 to 12 m and again at 15 to 17 m. After 18 m, seahorses are solitary if observed at all. This can also be seen in a topographic map form in the Appendix, Map 1.

The first group of seahorses from 7 to 12 m holds the majority – 76% – of seahorse data. It is arguable that this may be a favorable depth for the seahorses. The second group of seahorses from 15 to 17 m holds 15% of the data. Cumulatively, the two groups account for 91% of all seahorses observed.

There is a dip at 13 and 14 m, which separate the two groups of data. Otherwise, the two groups may have been able to form one larger group. Why are there two groups? Are there two favorable depth ranges for seahorses? If so, what is happening in between the two ranges? Could it possibly be an area passed through during some form of migration due to seasonal variations or breeding habits?

In the Aug/Sept report it was hypothesized that pregnant males (PM) migrate to deeper water to give birth due to the high proportion of PM and juveniles found at an average depth of 15m, compared with adult males and females found at an average depth of ~11.5m. In October 2012 1 juvenile was found at 16.3 meters and no PM were recorded. In November 2012, 3 juveniles were recorded with an average depth of 14.2 meters, 1 PM was found at 10

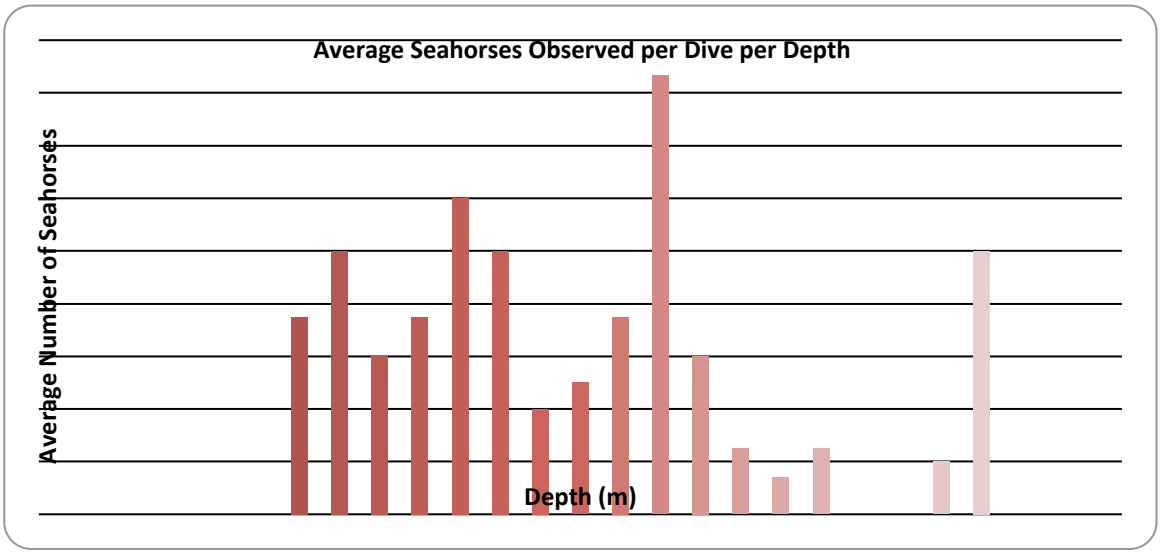
meters, with the average for males at 11.6 and females at 10.15. Again in December the average depth of juveniles was 13.87 while the average depth of males and females was 10.18 and 11.72 respectively. This is again consistent with our previous hypothesis as we are finding the bulk of our juveniles in deeper water. It would appear that Graphs 5 and 6 support this hypothesis also, and the average depths for each demographic in 2012 can be seen in Table 3. The presence of a single pregnant male at 10 meters may indicate that he migrated back to shallower water to mate and has not gone back to the deep to giver birth yet. It must also be noted that while the difference in depth between demographics does not appear to be very large, the topography of our study site is a very gradual sloping bottom. The difference in depth of 3 meters can equate to several hundred meters of distance. With long-term data, it will be possible to further discern the ranges of our local population and validity of any migratory hypotheses.

Females	12.23m
Males	11.02m
Juveniles	13.84m

Table 3: Average depths of sexual demographics for the 2012 data set

Due to the size of the data sample at this time, it may be necessary to consider the number of dives made at depth. If few dives were made at 13 and 14 m, then it only follows that fewer seahorses would be observed. Similarly, observing more seahorses at a specific depth, such as 8 m, could simply be the result of more frequent dives at that depth.

To understand the relationship further, taking the average number of seahorses observed at each depth will eliminate the variables mentioned above and can be seen in Graph 6.



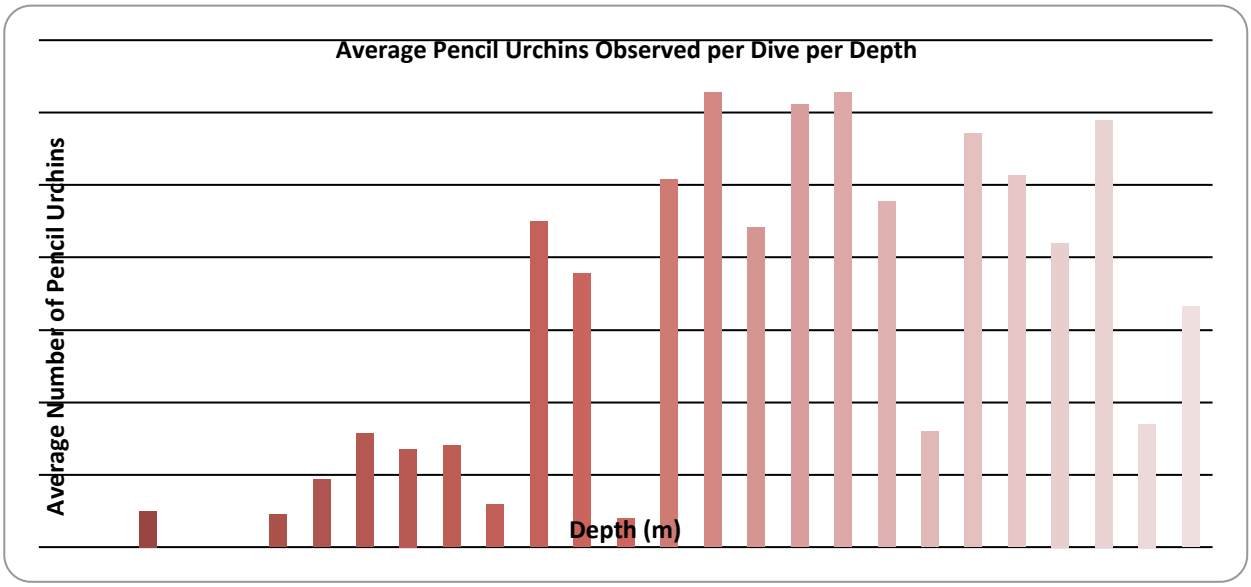
Graph 6: Average seahorse observed per depth per dive Aug. 2012 through Dec 2012

Last year, the survey team made a total of 109 dives ranging from 3 to 27 m. The dive numbers for each depth range from 0 to 16 dive times per depth. 8 m had a total count of 16 dives. 9, 11, and 12 m have 10 dives each. In contrast, 14 m had only 2 dives.

The shape of this graph is smoother and with fewer outlying points. There is still a spike at 16 m, which resulted from a single dive that observed 3 seahorses. Another spike at 24 m is because only one dive was made at the depth and a seahorse was observed, which leads to an uninformative average of 1 seahorse. Future research will clarify whether singular anomalies are simply chance or the beginnings of a trend.

Nevertheless, both graphs indicate 7 to 12m as a favorable range regardless of the number of dives at any specific depth. This leads to the question of why seahorses prefer that depth range. Exploring further variable such as temperature, migratory patterns, and holdfasts is the next step.

Previous reports examined the holdfast and habitat preference of seahorses. This year, 86% of observed seahorses were using pencil urchins as holdfasts. Correlating a positive relationship between depth of pencil urchins and depth of seahorses could explain the seahorse preferable depth.



Graph 7: Average pencil urchins observed per depth per dive Aug. 2012 through Dec. 2012

Similar to Graph 6, there is a group of pencil urchins found from 6 to 11 m, which slightly overlaps with the favorable range for seahorses proposed between 10-15m. Comparatively however, a dominating majority of pencil urchins observed are found at deeper depths beyond the 10-15m range. Consequently, at this time it does not seem possible to positively correlate pencil urchins and seahorses through depth. Though seahorses are partial towards pencil urchins, pencil urchins are not an explanation for the favorable depths of seahorses. This can be seen more clearly in the depth map for pencil urchins and seahorse density found in the Appendix section, Map 2.

In the map, the depth curve at 13 m separates the blue tones on top and the yellow and red tones below it. Generally the deeper waters can be found above the 13 m curve while the shallower waters are found below. The majority of big colonies of urchins, 50 to 300, are sighted above the curve where seahorses are in contrast typically found alone if at all. Below the curve, urchins are in smaller colonies of 0 to 100 whereas seahorses are more frequently in ones to fours.

Though the seahorse and pencil urchin have a significant relationship, it is not yet possible to determine any correlation or causal relationship between the two. This is because, while seahorses suggest the presence of pencil urchins, the opposite is not true.

The most striking observation of the 2012 survey data is the comparison between November 2011 and 2012 where a dramatic drop off in the number of juveniles has been identified. There has been a significant drop in pregnant males as well, but with so few being observed during surveys this drop could be possibly explained through random survey points just missing them, as sightings are fairly rare in general. The drop in juveniles however, cannot be explained away. Since our survey in 2011 when 33 juveniles were observed, in the 4 months surveys have been carried out in 2012 we have had just 14 juveniles recorded. This is a very dramatic drop off that has implications beyond the general decline of the local population. It suggests that the local populations ability to recover and continue to breed though their natural behavior, which is already undetermined and possibly quite untraditional due to the very unique habitat they are in, is being impeded. This has consequences for our continued conservation and research. If the seahorse's natural ability to reproduce has been so degraded that they can no longer sustain a population, then further efforts to protect the area may be futile in regards to seahorse recovery. It may be necessary to implement a captive breeding and reintroduction program to augment the natural population and give them a chance to recover to their previous densities.

Conclusion

This is the early stages of a long term survey project and as such the conclusions should be considered to be in there early hypothesis, as the project progresses, results will generate differing answers to those contained within this report.

Each monthly report will build into yearly reports, which will be collated every 5 years to show a continuous pattern in seahorse species, population assessment, and further data on the condition of the seabed and holdfast preferences.

As can be seen in this report, there is a direct correlation between the condition of the seabed and the number of seahorse species, this has been concluded by looking at the pre trawled data with the post trawling data and looking at the pattern of results post trawling. The majority of pre-trawled data is strictly observational and based around species distribution, diversity, and population densities with little direct data on urchin densities and shell cover before illegal trawling did large-scale damage. However, the impact that trawling

has had on density and distribution of seahorses is undeniable, and it reasonable to assume that the removal of holdfasts and the drastic altering of the habit was a driving force behind seahorse declines.

Another possible reason for the drastic reduction in species diversity is the seahorse focused illegal fishing that occurred in 2008-2009 when species numbers and diversity were radically reduced. Further study is needed to determine if the slow population recovery and diversity, after the area was protected, is a result of low density impacting mating behavior, low survivorship, long gestation, slow growth to sexual maturity, etc. All these factors can be possible reasons for the different rates of recovery by different species.

By comparing the type of complete or incomplete holdfasts on the study site it shows clearly that *Hippocampus spinosissimus* is best suited to adapt to this broken and fragmented habitat and even this hardy species is reducing in numbers.

To reestablish traditional seahorse numbers and diversity of species it is necessary to firstly stop the trawling and secondly allow the habitat to reestablish or take mitigating actions to restore it to its former status.

There is a great deal more to learn on this, such as the correlation of depth and time of year to breeding, and as to whether the seahorse species on this site pair bond as is considered normal for seahorses, or if they indeed have adapted as *Hippocampus spinosissimus* appears to have done to the fragmented habitat.

Only by continuing this survey into the future will these questions reach some form of conclusion.