

Report to AATAMS

Coral Sea nautilus tracking project

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11th February 2009

Project summary

The Coral Sea nautilus project has been underway since 1998. Andy Dunstan is the chief investigator and the project has been supported by Undersea Explorer through vessel and scientist access to remote sites and ongoing data collection by Undersea Explorer staff. The research aims to expand the knowledge of nautilus ecology and life history with emphasis on future conservation and management options. The acoustic tracking component of the project allows for individuals within the discrete population of nautilus at Osprey Reef to be monitored over 3 to 14 month periods to interpret their three dimensional movement patterns. This provides essential data to calculate population numbers, population density, mortality rates and home range of nautilus which may then be extrapolated to other population locales. The tracking has also discovered new patterns of vertical migration and behaviour previously unknown in this species. Journal articles are currently in preparation and will form the basis for the PhD study currently being undertaken by Andy Dunstan

Nautilus habitat is restricted to deep (150 -400m) coral reef areas within the Indo-Pacific area. The k-selected life history of nautilus with slow growth rates, late maturity and low fecundity make them a poor and vulnerable fishery target. There is strong demand for nautilus shells as curio items and nautilus fisheries in many of the areas they currently inhabit. Many of these fisheries such as in the Tanon Straits and Brookes Point in the Philippines have been overfished and the nautilus populations have crashed.

One of the main goals of the work is to provide the missing biological and ecological data needed for the descriptive application process for CITES listing of nautilus. Population statistics and movement patterns are key to this data. Work is underway with WWF and Conservation International to formalize this submission and look to having nautilus listed on Appendix , which would still provide for the collection for important public aquarium and educational exhibits.

Existing data has been analysed and shows consistent data for growth rates in recaptured animals which corresponds with the limited data from captive studies and one previous wild study, while providing a much more comprehensive dataset. These data support the k-selected life history described for nautilus. Population estimates are currently being analysed but also provide the most extensive and only opportunity to assess nautilus population size to date. Osprey Reef is home to a geographically isolated and genetically isolated *Nautilus pompilius* population (collaborative work with Dr Billy Sinclair, UCQ), making it an ideal study site. Capture rates compare with those reported from other locations (Saunders et al, 1979) and provide the opportunity to extrapolate the properties of nautilus population, growth and mortality to provide a general picture of nautilus population biology. This in turn allows sustainable fishery calculations and practical assessment of vulnerability of nautilus stocks which is vital to the CITES assessment process. Combining the mark recapture data of Dr Bruce Saunders from Palau will allow the testing of this broader nautilus population model.

The tracking of nautilus is a key element to defining the population size and distribution through recapture rate probabilities by more accurately identifying movement distances and rates and therefore the sampling area.

Project aims

To:

- track the movements of nautilus at Osprey Reef
- Examine diel migration patterns
- Determine horizontal movement to augment population estimate work already being conducted by long term mark/recapture program
- Establish a base tracking program to pre-empt a proposed expedition using manned submersibles to track nautilus real-time and observe natural behaviour at depth (Deep Ocean Australia project).

Level of achievement

20 Vemco V16p and V16TP transmitters were attached to nautilus and tracked using the VR2W receivers during a 16 month period. The data gained provide valuable information on nautilus movements to further the previously scanty knowledge of this species. The aims provided for the project in the application proposal have been met and the project will now continue to gain further valuable data from this initial study.

Methods

A barrel shaped trap (90x77cm) constructed from wire mesh (7.5x9cm mesh size) baited with chicken and set to 300m depth is used to trap nautilus. Traps are deployed at dusk and retrieved at dawn for a full night's sampling. A dedicated, dark refrigerated tank is used to contain the animals during the tagging process at temperatures between 16-19° celsius.

V16P-1H and V16TP-1H transmitters were attached to nautilus and tracked using four VR2W receivers placed along the Osprey Reef wall at interval distances of one to four nautical miles from the single capture and release site in the Osprey Entrance channel.

Transmitters were calibrated for signal reception by the VR2W receivers through GPS readings providing distance from the subjects. Transmitters were then attached externally to the shell of mature nautilus individuals using buoyant 'saddles' to counteract the in-water weight of the transmitter. Initially two saddles were constructed with timber and fiberglass and attached using fast drying epoxy glue. This was not successful. Subsequent use of a casting mould filled with a mixture of glass microballoons and epoxy resin in equal volume proportions, transmitter placed into the top side of the mixture, shaped hydrodynamically and assessed for neutral buoyancy with a flotation test proved successful. These saddles were attached with 2 part epoxy underwater putty adhesive during a short process where the animals were out of water for a maximum of 5 minutes.

All nautilus individuals were engraved with a unique tag number, measured for diameter and aperture width and maturity and gender were recorded. Animals were again checked for neutral buoyancy and digital images were taken of all individuals prior to release.

VR2W receivers were initialised and placed at four locations including the release site and sites 1 nautical mile south, and 1 and 4 nautical miles north. Attachment of receivers was by stainless chain around strong coral outcrops which projected away from the reef wall at 15-30m depth. The chain had swaged wire attachment and then further chain and snap shackle attachments for the receiver before a polystyrene float located 10m below the surface.

Upon release the transmitters were checked for activation and a VR100 receiver unit was used to monitor descent and initial movement and release behaviour. The tagged nautilus were dived down to 30 metres and checked for neutral

buoyancy and natural swimming behaviour and orientation before release. Following release the animals were tracked using the VR100 receiver for 24 to 48 hours before relying on the remote tracking of the VR2W receivers.

VRW receivers were downloaded when access to Osprey Reef allowed and replaced during a 16 month period from September 2008 to January 2009.

See attached **AATAMS information – AD final.xls** excel spreadsheet for details of receiver deployment sites, downloading information and transmitter identification and deployment details.

Results

TheV16P and V16TP tags were successfully recorded by the VR2W receivers at greater than 500 metres horizontal distance and to a maximum depth of 470.6 metres vertically.

Sites for receiver deployment were chosen to provide a grid around the main trapping and release site for nautilus at Osprey entrance channel.

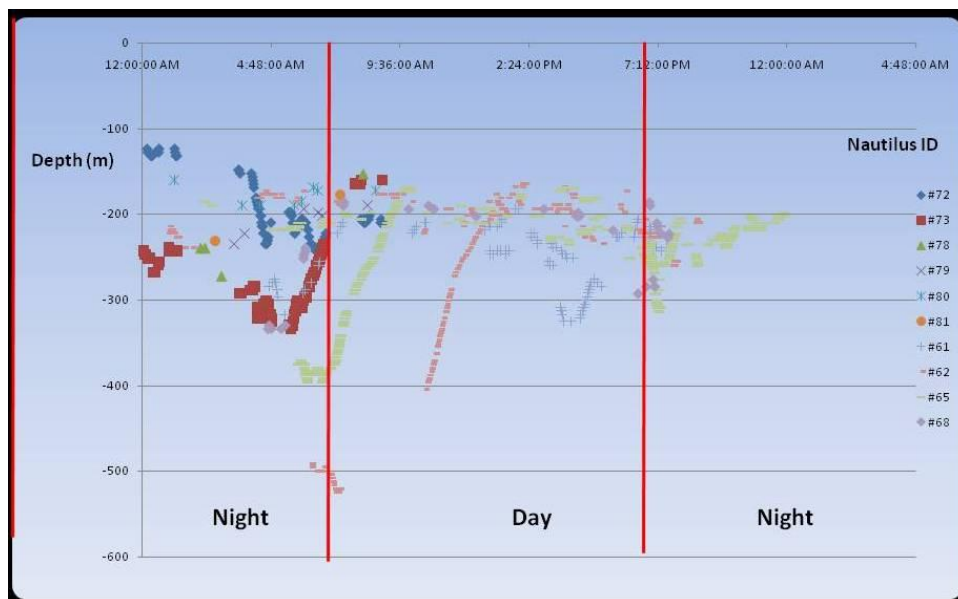
Table 1. Receiver deployment sites

Site	Latitude (degrees/minutes/decimal)	Longitude (degrees/minutes/decimal)	Max depth of transmitter signal received (metres)
Entrance wall	13.53.44	146.33.27	470.6
Nth Entrance	13.52.82	146.33.46	227.3
Raging Horn	13.53.48	146.33.18	433.5
Admiralty	13.53.24	146.33.34	251.8
Coral Castles	13.50.94	146.33.84	450.0

The detection results provide a good 3 dimensional tracking of nautilus movements during the initial three month tracking period of the first transmitter attachments and also a later two month period of further transmitter deployments to nautilus. This has resulted in some important new data on vertical migration of these animals.

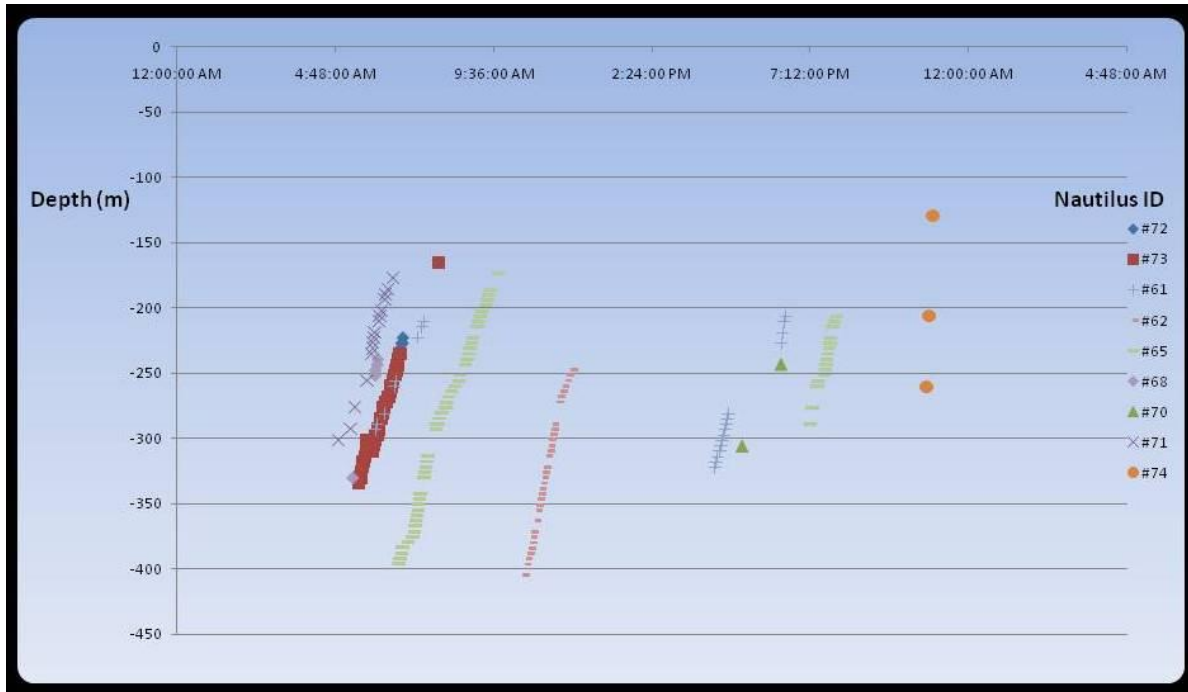
Vertical movement data are currently being analysed for publication but some initial results are shown below.

Figure 1. Nautilus vertical movement patterns.



This demonstrates a consistent pattern of high night activity to between depths of 130m to 540m followed by a daytime return to 160-210m and low activity. This is in marked contrast to previous assumptions of nautilus migrating to the shallows (250m or less) to actively feed at night and then descending to depths of 400m plus to rest through the day (Ward et al 1984, Zann, 1984 and O’Dor et al, 1993). Some of this data derives from the records of the VR100 receiver data.

Figure 2. Nautilus ascent rates



Nautilus ascent rates can also be calculated from the data and are maximum rates are shown to be consistent at around 2 metres / minute.

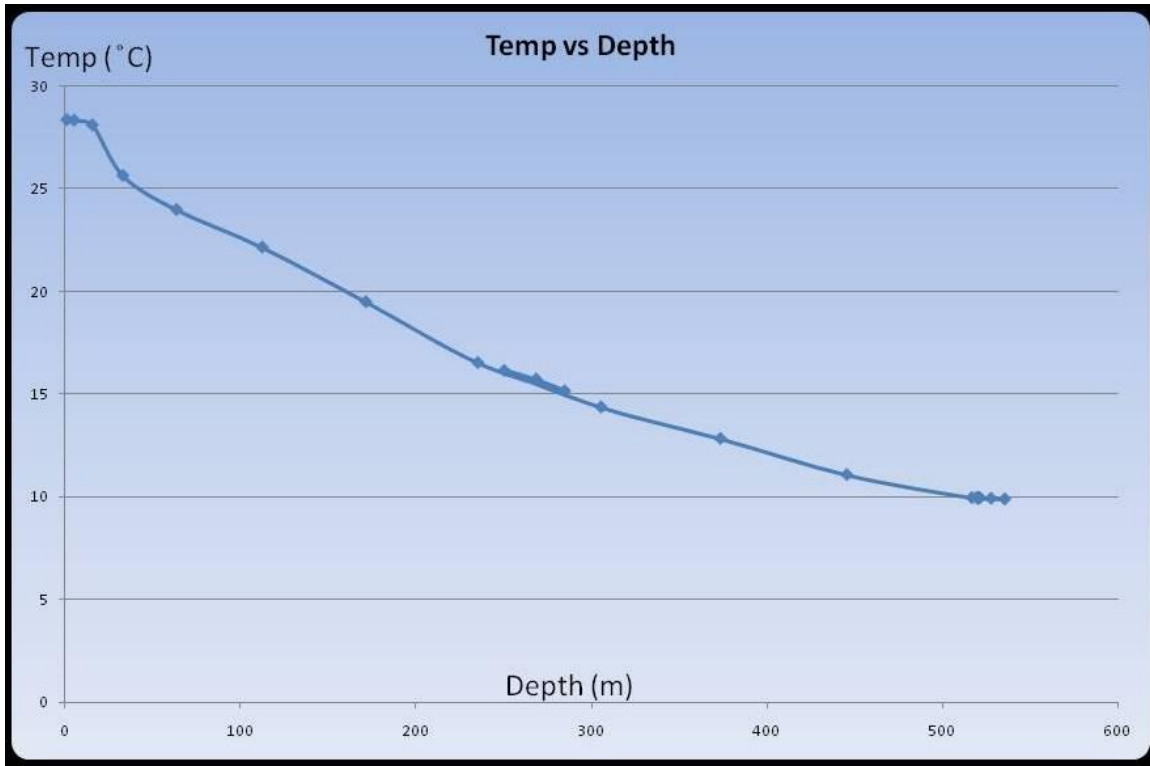
Horizontal movement was recorded to occur in both north and south directions with individuals dispersing after release.

Figure 3. Receiver sites at Osprey Reef (including False Entrance and North Horn where VR100 tracking was undertaken)



Continued observation particularly through VR100 records show movements of up to 6 nautical miles in a 24 hour period from the release site at Entrance to North Horn. During this same period other individuals moved in the opposite direction to False Entrance and all individuals were spread within this tracking area. Data from the VR2W receivers showed a range of horizontal movements which are currently being analysed. 10 nautilus were tagged with transmitters in January 2009 with battery life of 4 ½ months (5 units) and 14 months (5 units). Future data from the array of 40 VR2W receivers still deployed around Osprey Reef will provide significant detailed information on more widespread and longer term movement patterns.

Figure 4. Temperature /Depth profiles for Osprey Reef (Dec 2009)



The use of V16TP-1H transmitters also allowed temperature/depth profiles to be measured. These will continue to be obtained through the VR2W receivers in conjunction with the nautilus vertical movement data.

Sixty-six of the whitetip , grey reef and silvertip sharks, potato cod and manta rays tagged by Richard Fitzpatrick’s group with the following ID codes were also recorded on the VR2W receivers:

18, 19, 2966, 4014, 4024, 4095, 7624, 7640, 7679, 7849, 7854, 7864, 7865, 7866, 7870, 7873, 7876, 7877, 7878, 7880, 7881, 7882, 7884, 7888, 7891, 7892, 7894, 7895, 7896, 7898, 7900, 7901, 7903, 7904, 7906, 7907, 7908, 7909, 7916, 7917, 7918, 7919, 7920, 7932, 7935, 7938, 8094, 8104, 8116, 8120, 8131, 8138, 8143, 8144, 8148, 8156, 8175, 11694, 11704, 11705, 11716, 11720, 11728, 11731, 11738, 11747, 11760, 11775.

Receiver download records

Receivers were downloaded as outlined in the attached **AATAMS information – AD final.xls** excel spreadsheet and these results correlate with the receiver log files attached to this report. Where site information differs in the actual log this has been adjusted in this table to reflect true receiver positioning for the dates shown. These records are attached in the email as .vrl files.

Discussion

Nautilus have long be thought to migrate to the shallows (250m or less) to actively feed at night and then descend to depths of 400m plus to rest through the day (Ward et al 1984, Zann, 1984 and O'Dor et al, 1993). This latest data challenges this theory and provides evidence for a daytime depth of inactivity at around 200m with active night movements from 130m to over 500m depths.

Nautilus vertical swimming speeds of 2m/min have been shown in previous studies and these are supported by this study for a nautilus species which is 50% smaller in diameter than other species studied (Ward et al 1984, O'Dor et al, 1990).

The horizontal movement data equate closely with speeds of horizontal movement previously demonstrated (Saunders et al, 1979) but in the longer term study will provide much more conclusive data over longer time periods to assess home range and prolonged movement patterns.

Outputs

The nautilus movement patterns results will be submitted in a paper to Nature within the next few months. A further paper on population and density estimates of nautilus at Osprey Reef will follow later in 2009. Both papers will form a major component of Andy Dunstan's PhD thesis on the ecology of nautilus expected to be completed in late 2010-2011. The results will also be presented at the Cephalopod International Advisory Council conference in Spain in September 2009.

Acknowledgements

AATAMS for the provision of 4 VR2W receivers

Undersea Explorer for provision of berth space, trapping equipment and logistical support during four field trips to Osprey Reef

Andy Dunstan for provision of VR100 receiver, two V16P transmitters and dedicated digital camera use.

University of Washington and Prof. Peter Ward for provision of eight V16P transmitters

University of Qld, Deep Ocean Australia group for provision of six V16P and four V16TP transmitters

Prof. Justin Marshall and Prof. Peter Ward for professional advice and support.

Chris Talbot and Eva McClure for field assistance

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