

Nautilus pompilius fishing and population decline in the Philippines; a comparison with an unexploited Australian *Nautilus* population

Dunstan A¹, Alanis O², Ward P³ and Marshall J⁴

1. School of Biomedical Sciences, University of Queensland, Brisbane, Qld 4072, Australia. 2. C.Castro Road, Brgy. San Pedro, Puerto Princesa City 5300, Palawan, Philippines, 3. University of Washington, Seattle WA 98195-5320, USA, 4. School of Biomedical Sciences, University of Queensland, Brisbane, Qld 4072, Australia



Introduction

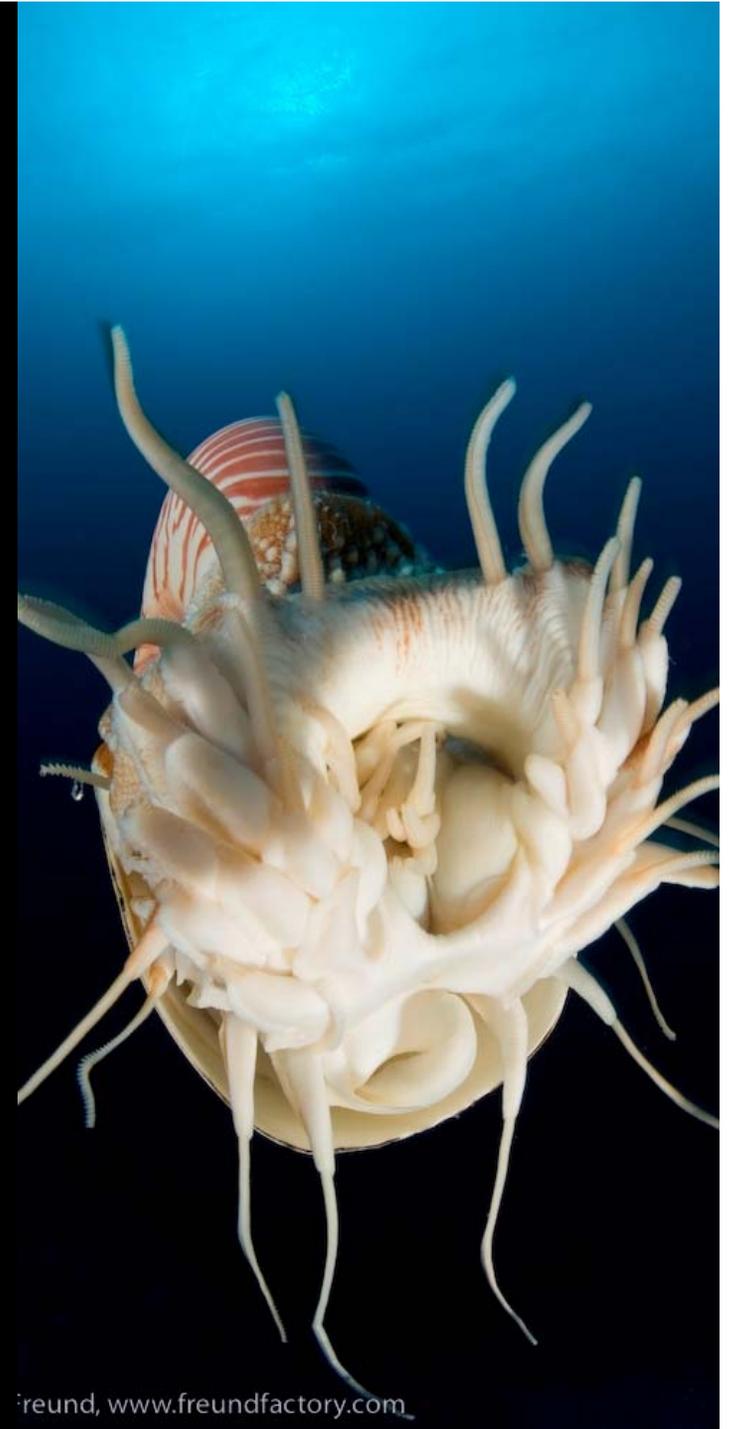
Demand from the ornamental shell trade and restrictive habitat preferences threaten *Nautilus*' populations.

Philippines *Nautilus* fishery is unsustainable and culturally unimportant.

Serious declines in catch rates of 80% over 10 - 20 years.

Unexploited Osprey Reef population shows stable low population density, maturation around 15 years, lifespan of 20+ years, low reproduction potential and high mobility of individuals.

Strong evidence exists for *Nautilus* to be assessed as 'ENDANGERED' in the IUCN Redlist and provides impetus for CITES listing.



Aims:

To investigate the *Nautilus* fisheries of the Philippines:

- Catch per unit effort changes over time
- Cultural and economic importance

To determine for an unexploited population of *Nautilus pompilius* at Osprey Reef:

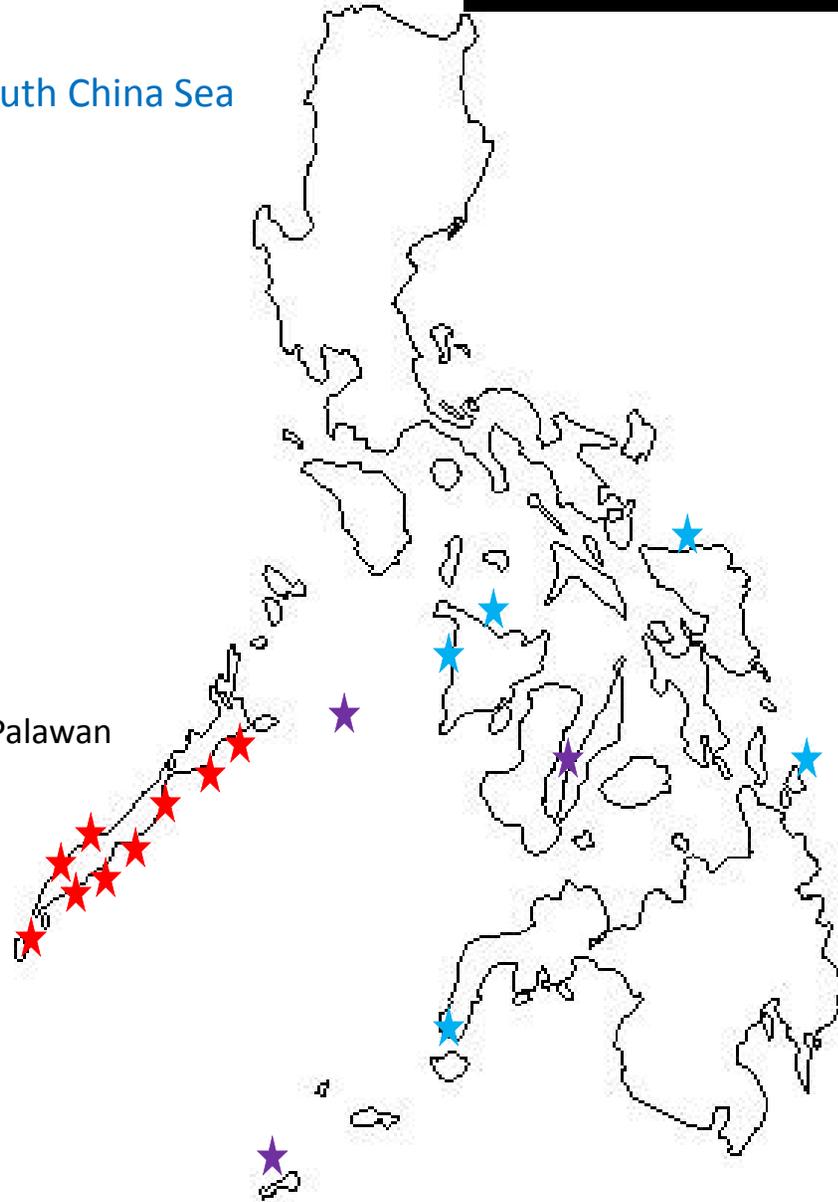
- Population size, density and stability
- Growth rate, maturation times and lifespan
- Movement patterns and home range



Philippines *Nautilus* fisheries

South China Sea

Palawan



★ *Nautilus* fishery study sites

★ *Nautilus* fishing locations

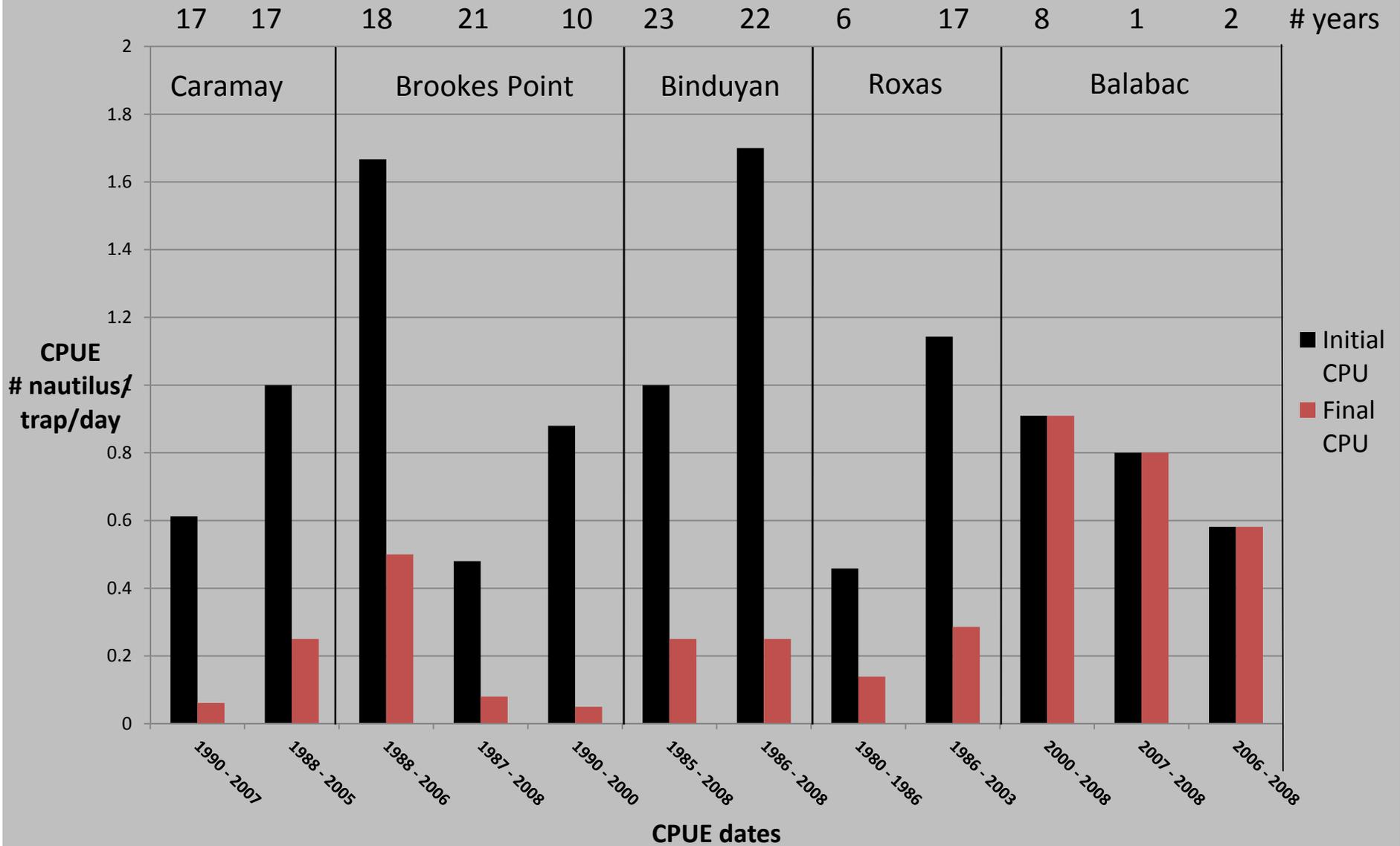
★ 'Crashed' *Nautilus* fisheries

Results

Decline in CPU of 80% from a mean of 0.99 to 0.21 *Nautilus*/trap/day at four of five sites



Catch per unit effort – changes over time



Key findings

- Decrease in CPU of around 80% in one generation time period
- No cultural history or significance of Nautilus fishing



- Nautilus fishers in Palawan were trained by traders from distant depleted areas
- Demand always exceeds supply for *Nautilus* shells
- Export to Taiwan, China, USA, Europe, Australia, Hong Kong and Russia



Osprey Reef



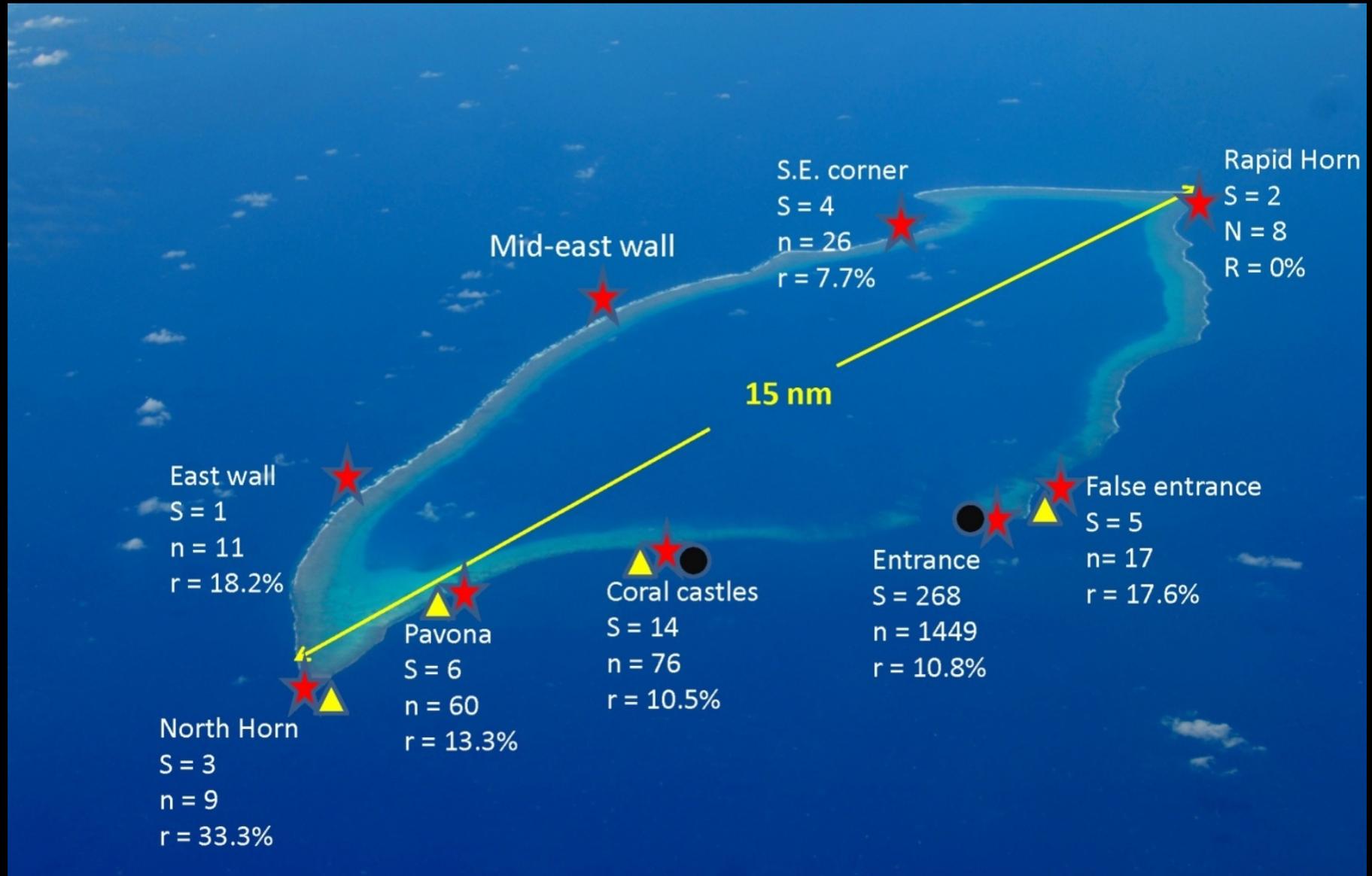
Osprey Reef
Shark Reef

Osprey Reef study site and sampling locations

Trapping ★

ROV ▲

BRUVS ●



Samples	Captures	Recaptures	Growth estimates
354	2460	247	37

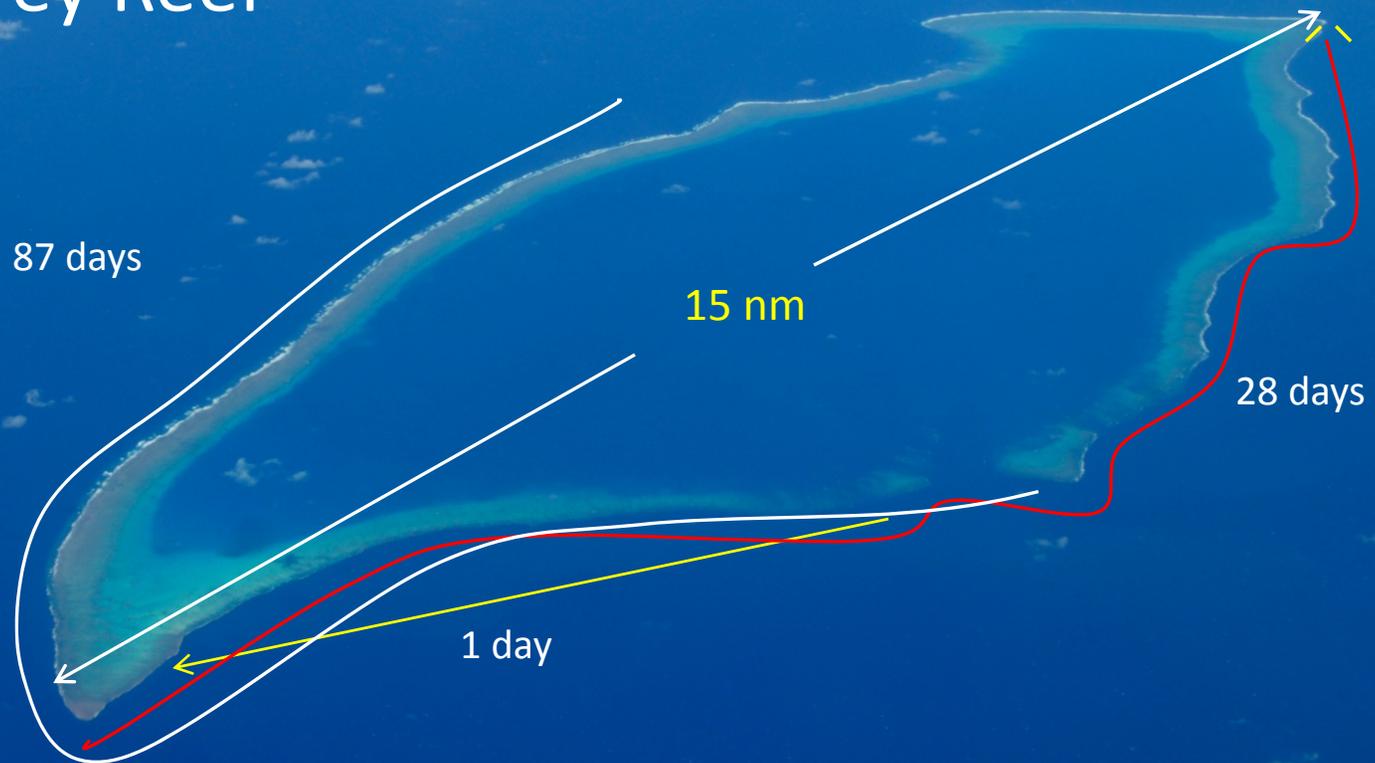


Species	# ind.	Mean mature diameter (mm)			# septa	% males	% mature
		M + F	Male	Female			
<i>N.pompilius</i>	2460	130.7	131.9	118.9	27	89.5	58

Nautilus home range

Movement recorded by ultrasonic tracking and perimeter trapping show individual *Nautilus* to travel the entire perimeter of Osprey Reef.

Osprey Reef





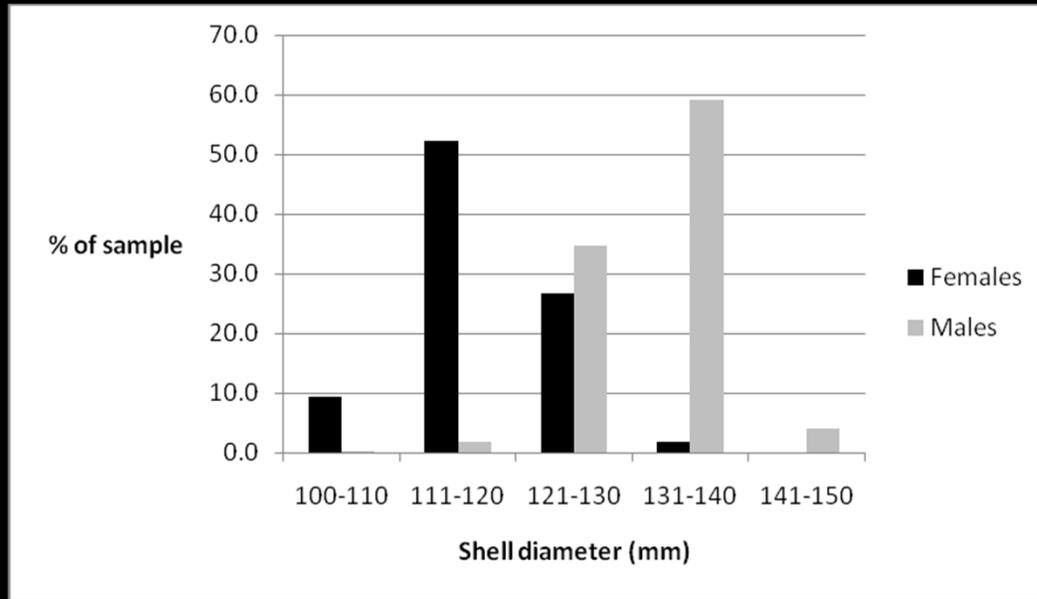
SHORT TERM FAST MOVEMENTS

Nautilus ID	Sex	Shell diameter	Distance	Time (hrs)	Speed (km/hr)
78	M	129	2.169	1:50	1.18
81	M	132	2.703	3:14	0.84

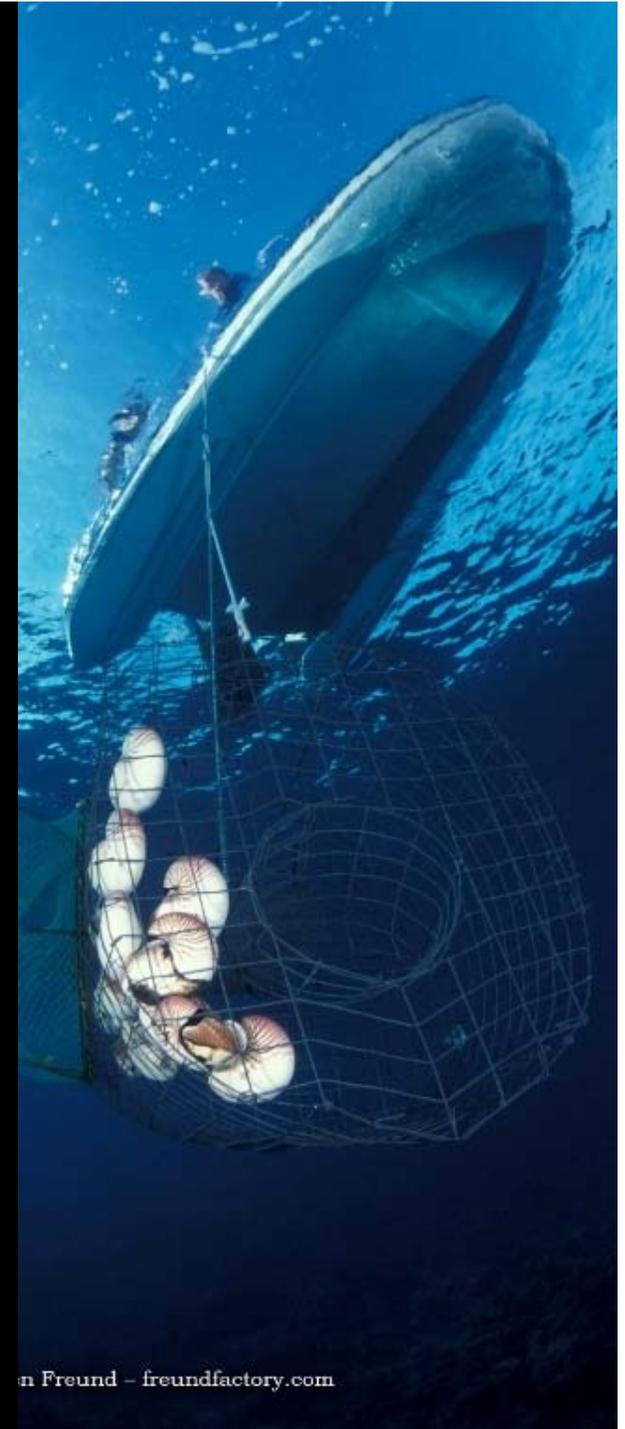
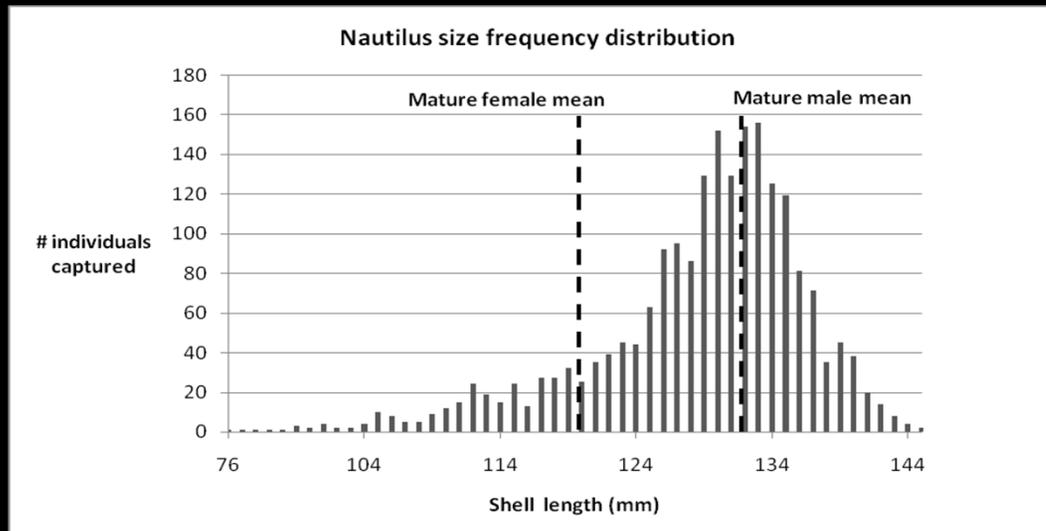
LONG DISTANCE MOVEMENTS

Nautilus ID	Sex	Shell diameter	Distance	Time (days)	Speed (km/day)
78	M	129	29.3	52.3	0.56
79	M	131	10.06	7.95	1.27
81	M	132	10.06	9.1	1.11
81	M	132	24.19	28.8	0.84

Population size and sex distribution

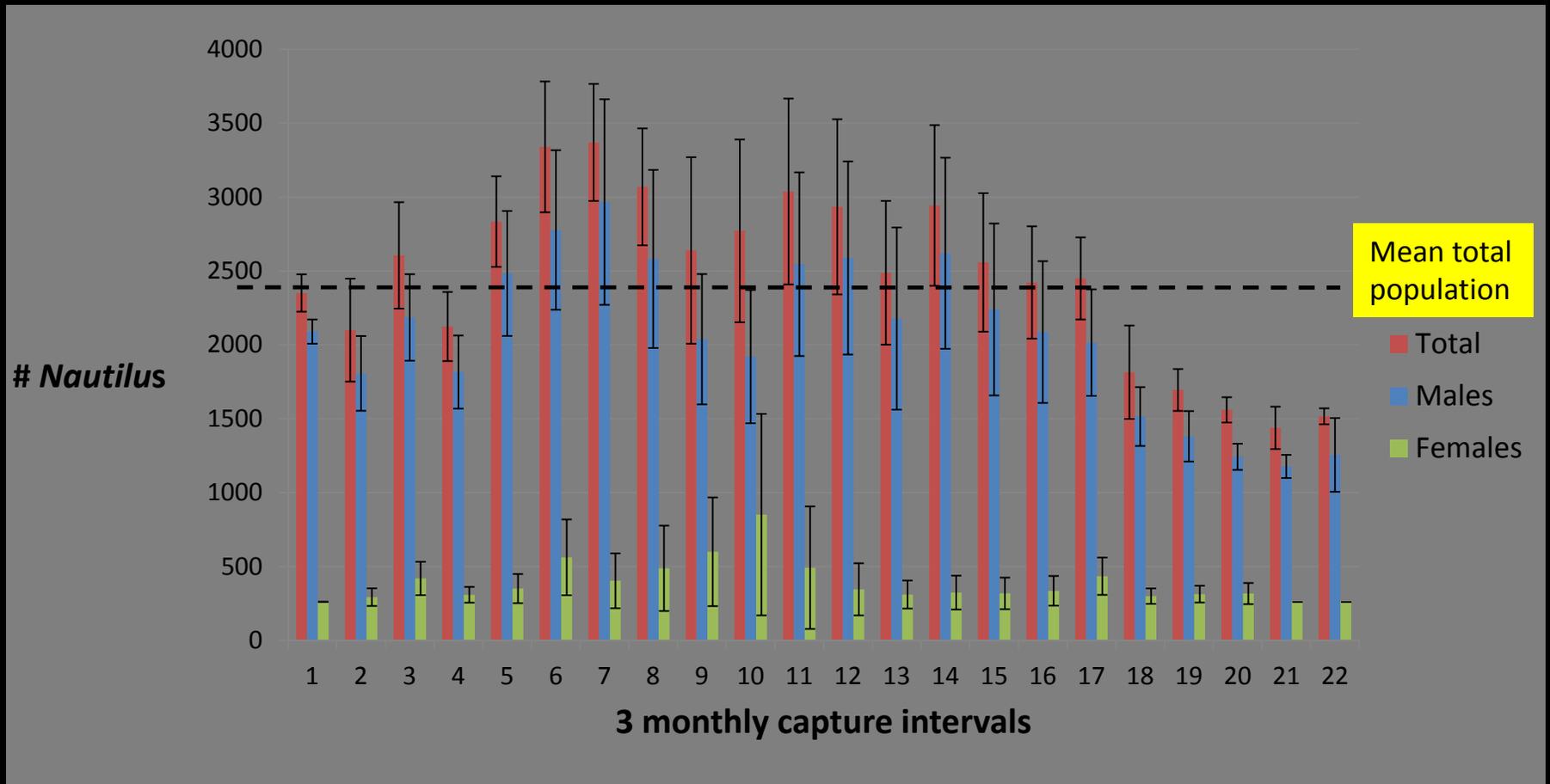


Mature shell length: male = 131.9mm female = 118.9mm



Osprey Reef *N. pompilius* population estimation

Capture / mark / recapture

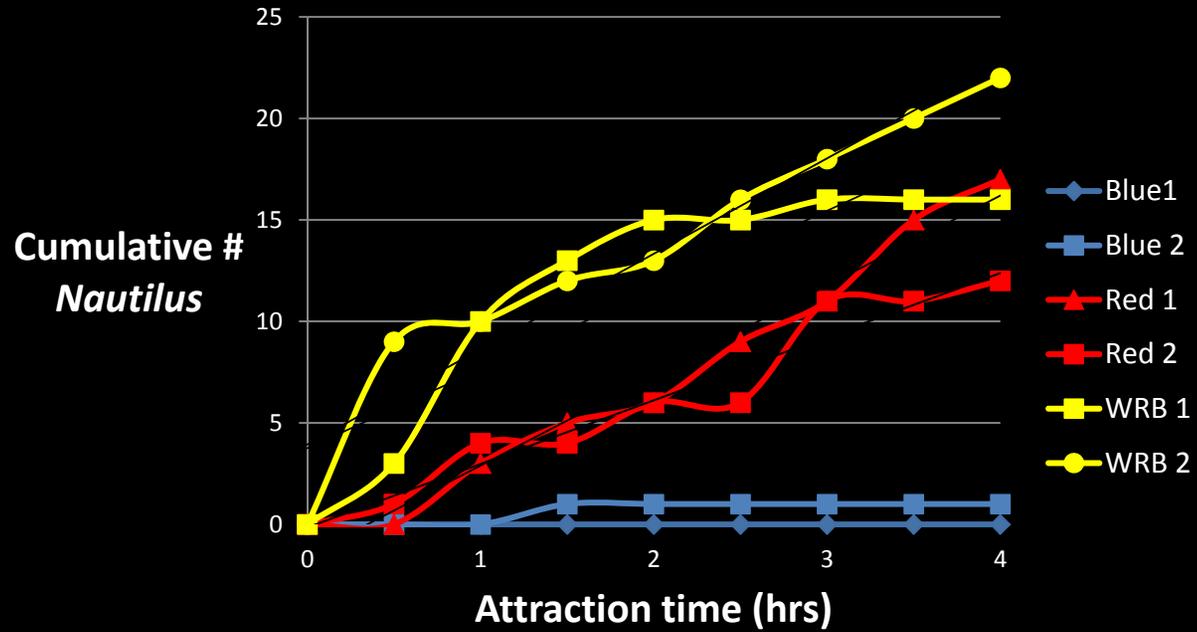


Mean = 2457 (SD = 580.1)

Females = 389 (SD = 141.0)

Density = 42.4 ind./km²

BRUVS *Nautilus* attraction



4.03 *Nautilus* / hr divided by max speed 0.6km/hr = 6.7 *Nautilus* / km.

ROV Nautilus sightings at Osprey Reef (daytime only)

Location	# nautilus	Horizontal survey distance	# Nautilus /km
Coral Castles	13	1.195	10.9
North Horn	10	0.790	12.7
Pavona	15	1.451	10.3
False Entrance	10	0.806	12.4
Total	48	4.242	11.3



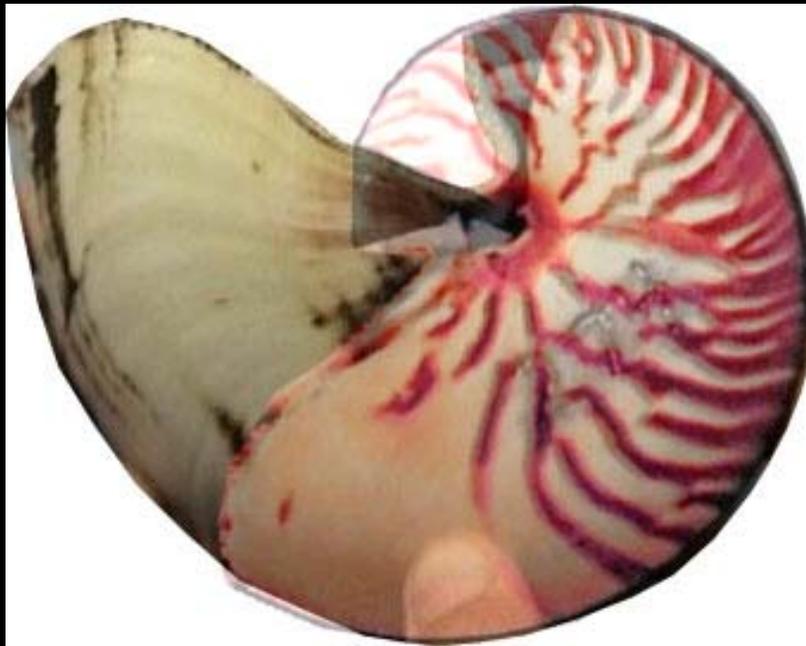
Depth (m)	0-300	300-400	400-500	500-600	600-700	700+	Total
# Nautilus	0	0	7	23	17	1	48
# juveniles	0	0	1	3	1	0	5
Search time (hrs)	4.25	3.83	7.92	7.4	4.57	1.08	29.05

Summary of population estimation results

Method	Population estimate	Comments
Capture/mark/recapture	2457	Mature/sub-mature only for estimate but indication of immature and juvenile ratios
BRUVS attraction	469	Underestimating due to max speed, bait attraction lag period, feeding stimulus level
ROV recording	785	Only sampling daytime active <i>Nautilus</i>

Wild growth rates for *N. pompilius*

2.5 years



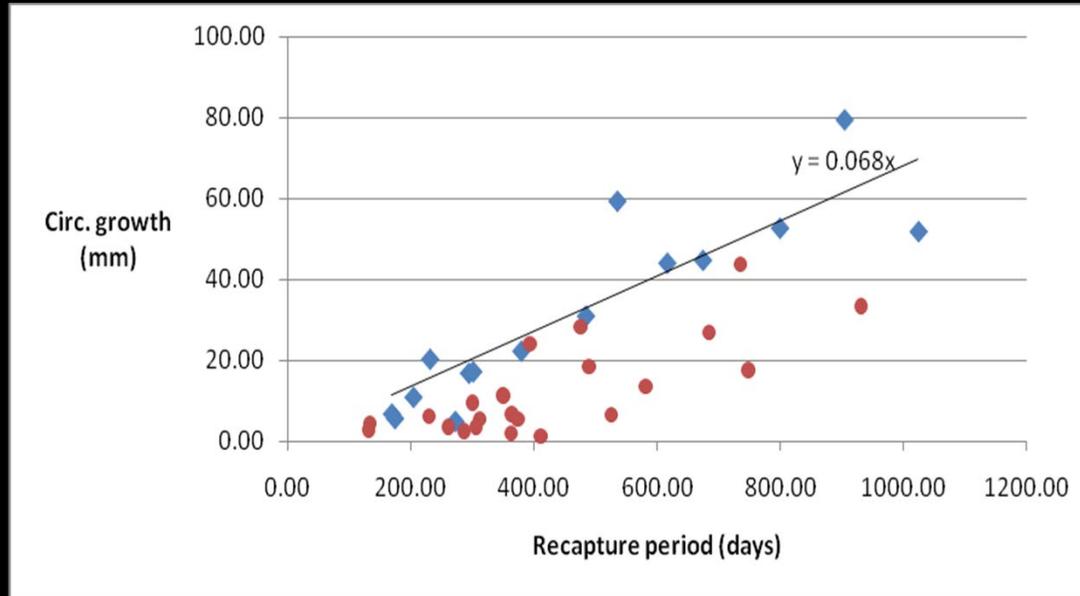
0.061mm / day



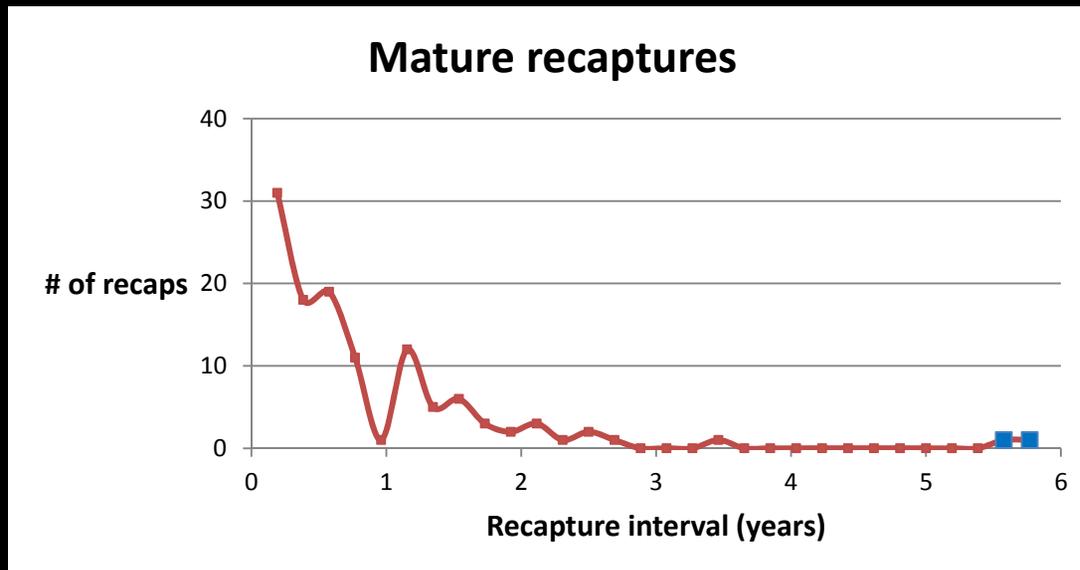
231 days



Apertural growth rate – 0.61mm / day



Longevity after maturity – 5.8 years+



Discussion

Unexploited populations of *Nautilus* show stable numbers at Osprey Reef and also demonstrate consistent initial catch rates in the Philippines prior to fishing.

Nautilus pompilius are mature at 15 years and live to 20+ years; an IUCN calculated generation time of 17.5+ years.

Density of *Nautilus* may be relatively low, around 40 individuals / km²

80% decline over approximately one generation of fishing effort in Philippines

For inclusion as 'endangered' in the IUCN Redlist a species must show 'a population size reduction of 80%, projected or suspected to be met within the next 10 years or three generations' (IUCN Redlist 2001).

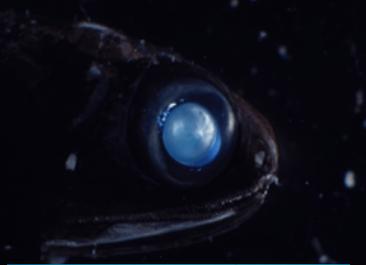


Nautilus – the big picture

- Populations of *Nautilus* have been shown to be genetically different when separated geographically by deep (>800m) ocean barriers to connectivity (*Wray et al 1995*).
- This precludes recolonisation of depleted sub-populations and supports a strong argument for protection of all nautilus stocks to maintain genetic diversity.
- Close similarities in the biology and ecology of all *Nautilus* and *Allonautilus* species argues for the inclusion of all in any management decisions.



Future research plans: use of manned submersibles, BRUVS and Landers



- Fill in the 'knowledge gaps' for CITES proposal
- Manned submersibles to ground-truth BRUVs, Landers and trapping records
- Estimate population size, density and age distribution at various locations using BRUVS
- Describe and compare habitat differences with population density
- Incorporate social science aspects – effects of stopping *Nautilus* fishing

Acknowledgements



This work was funded by

- The Australian Research Council Linkage Grant – Deep Australia, University of Queensland
- University of Washington
- Undersea Explorer
- Australian Integrated Marine Observing System

The author would also like to thank

- Jurgen Freund for photo conservation collaboration
- Field assistance from Chris Talbot, Eva Mclure and the Undersea Explorer biologists and crew