GREAT NEWS! CAPE RANGE INSCRIBED on the WORLD HERITAGE LIST

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View south from Charles Knife Road, Cape Range. Photo: Kirsty Dixon

The 'Brief Description' on the UNESCO World Heritage List reads as follows:

> The 604,500 hectare marine and terrestrial property of Ningaloo Coast, on the remote western coast of Australia, includes one of the longest near-shore reefs in the world. On land the site features an extensive karst system and network of underground caves and water courses. Annual gatherings of whale sharks occur at Ningaloo Coast, which is home to numerous marine species, among them a wealth of sea turtles. The terrestrial part of the site features subterranean water bodies with a substantial network of caves, conduits, and groundwater streams. They support a variety of rare species that contribute to the exceptional biodiversity of the marine and terrestrial site.

Of course this does not adequately describe the 'outstanding universal values' of the site. In 1998 Elery Hamilton-Smith, Kevin Kiernan and I stated in our Executive Summary of a report to the Western Australian Department of Environmental Protection (Hamilton-Smith et al 1998):

> *... our review reinforces the argument that the Cape Range peninsula is a highly important site with a range of unique values. We would not usually use the term "unique" at all and do not do so lightly. We suggest that the archaeological, geomorphic and subterranean faunal attributes and setting of the peninsula amongst the fringing coral reefs render this area as well worthy of international (and national) recognition through nomination, and ultimately listing, Cape Range peninsula as a site of World Heritage significance. We point to the area as one of particular interest and importance for scientific research which is really only in its infancy in this area.*

Others say:

> *Cape Range is one of the great geological set-pieces of the State...* (Carter, 1987, p108)
>
> *...it ranks more and more as a world class subterranean fauna.* (Main, 1993, p 243)
>
> *...the area ranks as unique and scientifically as world class.* (Main, 1993, p246)

To back up some of these statements I have provided some background information below.

Climate

Cape Range has also had a most interesting climatic history having originally been a rainforest during the Miocene (Humphreys, 1993, Wyrwoll et al. 1993). The environment is now decidedly an arid to semi-arid tropical environment except in the odd years when cyclones exert their influence. Some rainfall also arrives with the passing of minor fronts. Evaporation exceeds rainfall by a factor of ten to fifteen. The current dry climatic conditions would appear to have operated for over 170,000 years after even more arid conditions pertained before that time.

View south from Charles Knife Road, Cape Range. Photo: Kirsty Dixon

Geology

The carbonate geology of Cape Range is based on the middle Miocene (24-25 million years BP) Cape Range Group that is made up of three limestone units deposited in differing marine environments. Most of the karst phenomena is found within the Tulki Limestone. There are also much younger Pleistocene to Holocene age limestone units hosting karst features. The fringing Ningaloo Reef is a current carbonate deposition site.

Structurally, the limestones are tectonically complex in an asymmetric anticline. The number and age range of karst-hosting carbonate units and the structurally unusual, for Australia, tectonically altered Tertiary limestones give the site its geological significance from a karst viewpoint.

Clints, grikes and karren above Charles Knife Road, Cape Range. Photo: Kirsty Dixon

Geomorphology

The asymmetric anticline has produced steeper slopes on the eastern flank dissected by a few deep gorges. The western flank has a denser, but not deeply incised drainage pattern. Significant alluvial fans occur on both sides of the peninsula but are larger to the east. There is only one permanent surface watercourse – Yardie Creek.

Uplift of the Cape Range peninsula has produced a series of wave-cut marine terraces of probable pre-Pliocene age. Some of these terraces are overlain by ancient dune fields.

The relatively great relief, enhanced in the past by lower sea levels, provides the opportunity for significant karst development. However this must be balanced against the aridity of the present climate. Hamilton-Smith et al (1998) discuss this issue at length and describe a variety of karst forms including caves, gorges, dolines, springs and karren. All of these point to a long period of landscape development probably initiated in more favourable climatic regimes than those pertaining today. Nearly 850 karst features, mainly caves, have been identified at Cape Range, largely through the sterling efforts of Darren Brooks.

The close proximity of the fringing Ningaloo Reef has a close geomorphic and hydrologic relationship with the terrestrial and subterranean parts of Cape Range Peninsula.

Hydrology

The hydrology is complex with periodic fluvial systems and with vadose and phreatic elements. The details of the karst drainage systems are unknown. Cape Range is underlain by a Ghyben-Herzberg groundwater system with a freshwater lens floating on saltwater. This has considerable implications for cave development and their cave-dependant fauna. Tidal influences in the caves and phreatic zone are a very rare phenomenon in an Australian context.

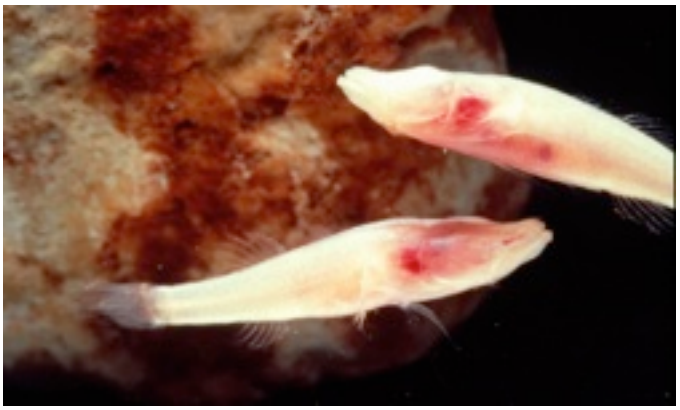
The ongoing extraction of groundwater to supply the town of Exmouth, tourist and defence facilities has implications for the Ghyben-Herberg system and raises concerns for the highly significant subterranean aquatic fauna. The immense Gorgon gas development on nearby Barrow Island will have further impact on water supply as a substantial influx of residents is expected in Exmouth. The issue of water supply versus the underground environment was internationally recognized when the Karst Waters Institute placed Cape Range on its 2000/2001 list of the top ten Endangered Karst Ecosystems worldwide (karstwatersinstitute.org). This was as a result of a joint nomination by ACKMA and the Australian Speleological Federation Inc.

Owl roost (6C4), Cape Range. Photo: Kirsty Dixon

Biology (abridged from Humphreys 2008)

The World Heritage significance is enhanced by the inclusion of many higher order taxa found nowhere else in Australia or even the southern hemisphere and by the close affinity of some of the aquatic taxa with other subterranean species on either side of the North Atlantic. This imparts an international flavour to the world heritage significance of the fauna as the three sites Bundera Cenote at Cape Range, the Blue Holes in the Bahamas and a marine lava cave in the Canary Islands hold the key to the history of the disjunct cave faunas in the area of the former Tethys Sea (Humphreys 1994)

The biological diversity at the surface is not particularly attributable to the karst, but to the geomorphological diversity and the overlap of three bioclimatic regions (southern, tropical and arid). The biological significance of the region largely attributable to karst lies in the subterranean fauna. The more humid caves contain a rich subterranean fauna largely comprising a relictual rainforest fauna with both tropical and temperate elements. This fauna, along with the anchialine and freshwater fauna, continues below a deep covering of Pliocene and Pleistocene dunes at the southern and northern end of the range. The fauna is regionally diverse both within the range and distinct from that of the coastal plain, the latter having some taxa in common with Barrow Island.



Stygobiont fish - Blind Cave Gudgeon Milyerina veritas.
Photo: Douglas Elford, Western Australian Museum

Beneath the lower slopes and the coastal plain, the anchialine and freshwater fringes of the range support a diverse stygobiontic community, rarely accessible, that of the eastern shore having at least one taxon indistinguishable electrophoretically from one on Barrow Island. The caves contain Australasia's only known obligate vertebrate cave fauna, the Blind Cave Eel (*Ophisternon candidum*) and the Blind Gudgeon (*Milyeringa veritas*). The diversity of anchialine fauna reaches its peak in Bundera Sinkhole, because of the deeper access it provides (33 m). In addition it is the only known site in the southern hemisphere for several higher taxa (class, order levels).

It is important to consider the karst in its entirety (including its relationship with the Ningaloo Reef), because it is the juxtaposition of diverse terrestrial, freshwater and anchialine habitats on Cape Range that contributes to the unusual concentration of subterranean animals, and the higher taxonomic composition make it possibly the phylogenetically most biodiverse site globally. A significant amount of this diversity lies outside current and projected conservation estate, including the WHA boundaries.

The subterranean fauna provides evidence of local and global geological processes and of climate change. The composition of the fauna indicates that the area was previously covered by rainforest (both temperate and tropical) and thus provides evidence for the retreat of rainforest as the climate became more arid. Remipede-type anchialine fauna provides strong evidence of former connection with Tethys Sea. Evidence for the isolation of taxa formerly of marine origin resulting from the uplift of the anticline (Melitidae). The biotic characteristics of Cape Range subterranean fauna are largely relictual from past climates (rainforest cover) and geographical position (on shores of Tethys), rather than related to the specific karst type. The surface flora is diverse because it is an overlap zone of northern, southern and arid zone floras, and topography supports microclimatic relicts (e.g. *Livistonia alfredii*), rather than the fact that it is karst.

Yardie Creek Gorge, Cape Range. Photo: Department of Environment and Conservation

Stygobiont fish - Blind Cave Gudgeon Lasionectes exleyi. *Photo: Douglas Elford, Western Australian Museum*

Scenic values

Although the underground scenery is not particularly spectacular there is some use of the caves for adventure tourism. Webb and Brooks (1995) reviewed the caves in regard to their tourism potential. They recommended several would be suitable for adventure, ecotourism and advanced SRT training. They also made recommendations about training and management. Owl Roost Cave does receive some adventure tourism.

However, the surface scenery is spectacular and relatively heavily used given the remote location. Ningaloo Reef, which must be regarded as part of the karst system, is a very significant attraction with its whale sharks, corals and a huge diversity of other marine life.

Human factors

Although Morse (1993) and Hamilton-Smith et al (1998) have commented on the significance of the area to Aboriginal people there is undoubtedly more to be learnt about the archaeology and anthropology of the area. Both the west and east coasts would have been resource-rich areas although the lack of freshwater may have limited the use in some areas. Springs and other karst features may have provided water points.

The area is a popular tourist destination for its landscape, significant fringing reef and coastal waters. There are a number of defence facilities in the area. Tourism, urbanisation and other developments have and will continue to compromise the karst and its dependent biota (Hamilton-Smith et al 1998, Spate et al 1998). Hopefully World Heritage status will lead to enhanced planning and management of the reef and karst.

Research and reporting

Although bedrock geology, gross geomorphology, groundwater hydrology and biospeleogical aspects have all received considerable research inputs and the caves are relatively well documented there is much that remains unknown about the karst biology, geomorphology and hydrology. The area offers many opportunities for studies of long-term climate change on geomorphic processes and for terrestrial and subterranean biology.

Comparable sites

There are no similar Tertiary orogenic karst sites in Australia although many of the world's caves are found in such systems. Hamilton-Smith et al (1998) state:

> *What is significant about the lithological systems at Cape Range as far as karst geoheritage is concerned? Relatively few Australian karsts are formed in limestones of comparable age to the Cape Range Group. Most of the karsts in the eastern states have formed in much older, crystalline limestones. The only other significant karsts formed in Miocene limestones apart from Cape Range are the Nullarbor karst and some karsts in the Murray Valley of South Australia - there are a few very much more minor examples only, such as those in the Wynyard and Redpa areas in Tasmania. Oligocene limestones also host karsts in SE South Australia and along the Glenelg River, Victoria.* (page 11)

and they go on to say:

> *There may be no comparable karst setting elsewhere in the world.* (page 15)

Concluding remarks

The listing of the Ningaloo Coast brings the number of Australian World Heritage properties to 19 – about half have karst or pseudokarst attributes. (I may be stretching this a bit by including the Mount Hypipamee crater in the Wet Tropics of Queensland World Heritage property!) However, the Ningaloo Coast nomination and subsequent inscription relied very heavily, and properly, on the geomorphic and subterranean fauna values.

The nomination was for an area of 708,350 hectares. Lobbying by local community led IUCN to recommend to the World Heritage meeting in July this year that the area be reduced by about 15% to 604,500 hectares as can be seen on the accompanying map. The 15% included some leased grazing lands as well some unallocated Crown lands. It may be possible to include these lands in the future – a much easier process than the nomination procedure!

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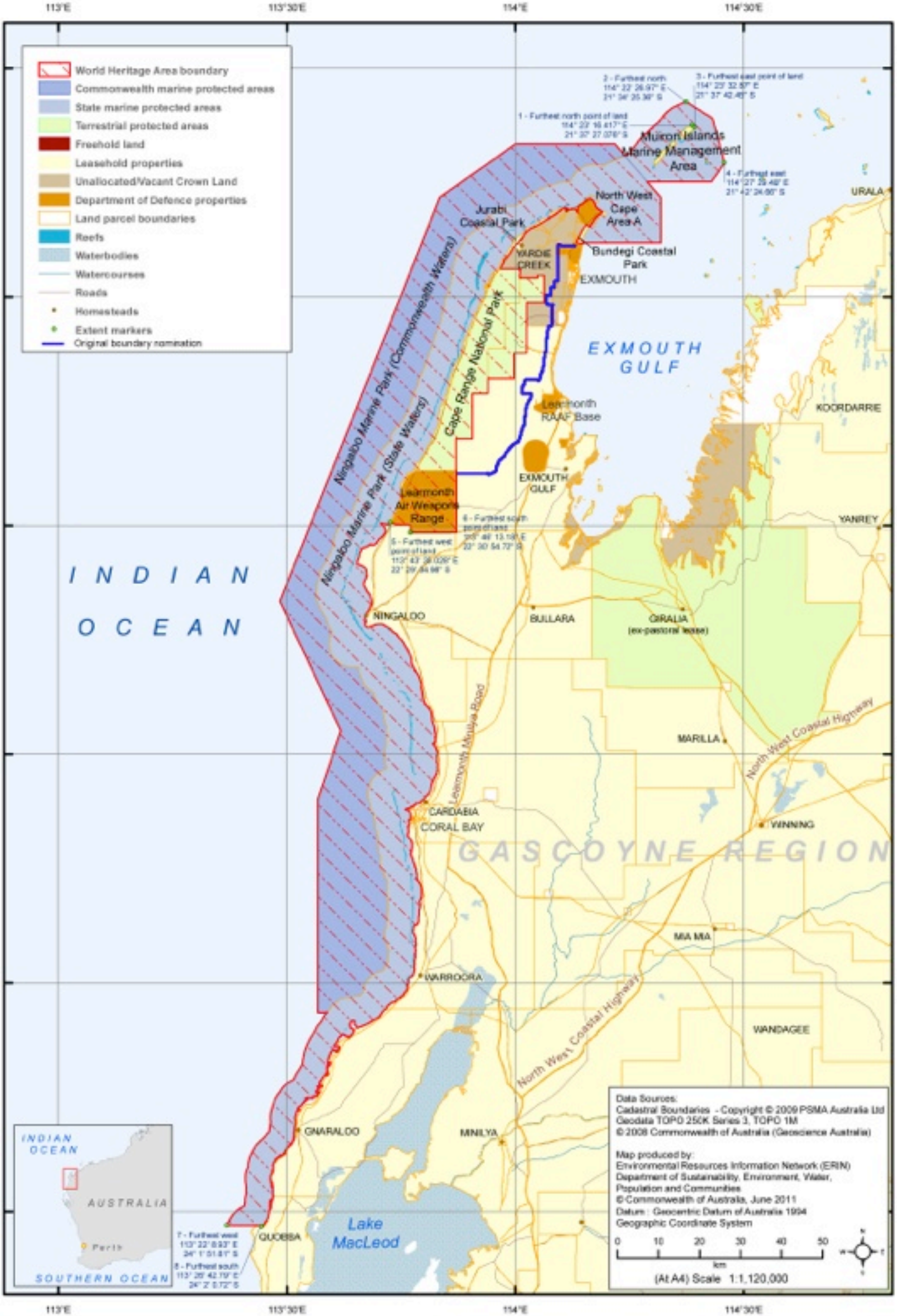
World Heritage Area boundary
Commonwealth marine protected areas
State marine protected areas
Terrestrial protected areas
Freehold land
Leasehold properties
Unallocated/Vacant Crown Land
Department of Defence properties
Land parcel boundaries
Reefs
Waterbodies
Watercourses
Roads
Homesteads
Extent markers
Original boundary nomination
113°E
113°30'E
114°E
114°30'E
21°30'S
22°S
22°30'S
23°S
23°30'S
24°S
2 - Furthest north
114° 22' 26.97" E
21° 34' 25.39" S
3 - Furthest east point of land
114° 23' 32.57" E
21° 37' 42.46" S
1 - Furthest north point of land
114° 23' 16.417" E
21° 37' 27.078" S
4 - Furthest east
114° 27' 29.48" E
21° 42' 24.80" S
Muiron Islands Marine Management Area
North West Cape Area A
Jurabi Coastal Park
Bundegi Coastal Park
WARDIE CREEK
EXMOUTH
URALA
EXMOUTH GULF
Cape Range National Park
Ningaloo Marine Park (Commonwealth Waters)
Ningaloo Marine Park (State Waters)
Learmonth RAAF Base
KOORDARRIE
EXMOUTH GULF
Learmonth Air Weapons Range
6 - Furthest south point of land
22° 30' 54.72" S
5 - Furthest west point of land
22° 29' 44.98" S
YANREY
INDIAN OCEAN
NINGALOO
BULLARA
GIRALIA
(ex-pastoral lease)
Learmonth Minilya Road
North West Coastal Highway
MARILLA
CARDABIA
CORAL BAY
WINNING
GASCOYNE REGION
MIA MIA
WARROORA
WANDAGEE
GNARALOO
MINILYA
Lake MacLeod
QUOBBA
7 - Furthest west
113° 22' 0.93" E
24° 1' 51.81" S
8 - Furthest south
113° 28' 42.79" E
24° 2' 5.72" S
INDIAN OCEAN
AUSTRALIA
Perth
SOUTHERN OCEAN
Data Sources:
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Map produced by:
Environmental Resources Information Network (ERIN)
Department of Sustainability, Environment, Water, Population and Communities
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Datum : Geocentric Datum of Australia 1994
Geographic Coordinate System
0 10 20 30 40 50
km
(At A4) Scale 1:1,120,000