AN ANNOTATED BIBLIOGRAPHY OF MARINE RESEARCH AT CHRISTMAS ISLAND AND COCOS (KEELING) ISLANDS

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This compilation of published research within or directly related to marine environments and organisms at Christmas Island and Cocos (Keeling) Islands, was produced at the direct request and under contract to Commonwealth of Australia as represented by the Department of Regional Australia, Local Government, Arts and Sport (IOT Administration). Key contributors to this work are Morgan Pratchett, Deborah Pratchett and Darren Coker (ARC Centre of Excellence for Coral Reef Studies, James Cook University), Jean-Paul Hobbs (Oceans Institute, University of Western Australia), and Steve Newman (WA Fisheries).

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Background

Australia’s Indian Ocean Territory (IOT), comprising Christmas Island and the Cocos (Keeling) Islands, is an important biodiversity hotspot representing a unique area of overlap between the major biogeographical provinces of the Indian Ocean and Pacific Ocean. Moreover, there are many important and iconic species (e.g., the Red Crab, *Gecarcoidea natalis*) that are endemic to the IOT. Despite the significant biodiversity and unique marine environments of the IOT there is a widely held concern that limited research on marine ecosystems and organisms has undermined local conservation efforts. The purpose of this annotated bibliography was to compile a comprehensive list of primary research papers (e.g., peer-reviewed journal articles) and other published reports based on research conducted at Christmas Island and/or the Cocos (Keeling) Islands, or are directly relevant to marine ecosystems and organisms in this region. These papers were organised under broad headings to further highlight areas (mostly, taxonomically) of critical future research.

Summary of findings

At least 506 publications, including 337 peer-reviewed journal articles, have arisen based on research conducted at Christmas Island and the Cocos (Keeling) Islands, or are directly relevant to marine ecosystems and organisms at these islands (Table 1). Much of the biological research of marine organisms (22.5% of publications) that has been undertaken at Christmas Island focuses on land crabs (e.g., *Gecarcoidea natalis*), which are an extremely important and iconic component of the island’s fauna. Moreover, there are many more publications on the terrestrial biology and ecology of land crabs which has not been included within this annotated bibliography. Similarly, much of this research (96 publications: 25.1%) relates to sea birds. Approximately 200 publications are directly focussed on marine ecosystems or exclusively marine organisms (e.g., corals and fishes) at Christmas Island and the Cocos (Keeling) Islands is 200, most of which relate to teleost fishes (58 publications: 29.0%). This level of output is a small fraction of the research that has been undertaken at other similarly isolated Australian coral reef systems (e.g., Lord Howe Island). For example, there are only 16 papers about reef-building (Scleractinia) corals at Christmas and Cocos (Keeling) Islands, and these are mostly limited to published species lists. In contrast, there have been 413 publications based on coral research at Lord Howe Island, describing
temporal changes in species composition, explored the local reproductive biology and settlement of dominant taxa, and also quantified growth, mortality and population dynamics.

**Table 1.** Distribution of marine research across major taxonomic groups and topics.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Journal Articles</th>
<th>All publications</th>
<th>Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>MARINE GEOLOGY</td>
<td>50</td>
<td>66</td>
<td>1900-2008</td>
</tr>
<tr>
<td>NATURAL HISTORY</td>
<td>38</td>
<td>57</td>
<td>1832-2011</td>
</tr>
<tr>
<td>MARINE VEGETATION</td>
<td>2</td>
<td>2</td>
<td>1984-1988</td>
</tr>
<tr>
<td>CORALS &amp; Sponges</td>
<td>16</td>
<td>21</td>
<td>1887-2011</td>
</tr>
<tr>
<td>IMPACTS &amp; MANAGEMENT</td>
<td>8</td>
<td>36</td>
<td>1831-2011</td>
</tr>
<tr>
<td>FISHERIES</td>
<td>1</td>
<td>16</td>
<td>1949-2010</td>
</tr>
<tr>
<td>TELEOST FISHES</td>
<td>49</td>
<td>61</td>
<td>1954-2013</td>
</tr>
<tr>
<td>CHONDRICHTHYAN FISHES</td>
<td>3</td>
<td>5</td>
<td>2004-2013</td>
</tr>
<tr>
<td>ECHINODERMS</td>
<td>5</td>
<td>6</td>
<td>1947-2011</td>
</tr>
<tr>
<td>MARINE MAMMALS</td>
<td>6</td>
<td>8</td>
<td>1887-2007</td>
</tr>
<tr>
<td>TURTLES</td>
<td>2</td>
<td>13</td>
<td>1887-2010</td>
</tr>
<tr>
<td>SEA BIRDS</td>
<td>55</td>
<td>96</td>
<td>1841-2009</td>
</tr>
<tr>
<td>MARINE MOLLUSCS</td>
<td>15</td>
<td>18</td>
<td>1887-2000</td>
</tr>
<tr>
<td>LAND CRABS</td>
<td>67</td>
<td>86</td>
<td>1900-2012</td>
</tr>
<tr>
<td>OTHER CRUSTACEA</td>
<td>21</td>
<td>22</td>
<td>1887-2012</td>
</tr>
<tr>
<td>PLANKTON</td>
<td>2</td>
<td>3</td>
<td>1911-2010</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>340</td>
<td>518</td>
<td>1831-2013</td>
</tr>
</tbody>
</table>
Despite the limited marine research that has been conducted at Christmas Island and the Cocos (Keeling) Islands, what is reassuring is the recent increase in the rate of publications (Figure 1). Most notably, the number of journal articles has increased from <20 per decade up until the 1960s, to >60 in the 1990s and 2000s. Further, the projected number of journal articles (based on the number of papers published up until mid-2013 is expected to be at least 100. Recent increases in research publications (from 2000-2013) are attributable to increased research on teleost fishes, chondrichtyan fishes (sharks) and also impacts to and management of the unique marine biodiversity at Christmas Island and the Cocos (Keeling) Islands; 41% of publications since 2010 related to teleost fishes, and particularly biographic studies of community composition and genetic structure.

**Figure 1.** Chronology of published research conducted at Christmas Island and the Cocos (Keeling) Islands that is directly relevant to marine ecosystems and organisms. Total publications for the 2010s are projected based on the number of publications up until mid-2013.


NATURAL HISTORY AND BIODIVERSITY

MARINE VEGETATION

CORALS & SPONGES


IMPACTS AND MANAGEMENT


FISHERIES

1. AFMA (2002). Fishing for sea cucumber (Bêche-de-mer) off the Cocos (Keeling) Islands. Draft exploratory management report. Australian Fisheries Management Authority.

2. AFMA (2002). Fishing using non-trawl methods to take demersal fish off the Cocos (Keeling) Islands. Exploratory management report. Australian Fisheries Management Authority.


TELEOST FISHES


CHONDRICHTHYAN FISHES


ECHINODERMS


MARINE MAMMALS


TURTLES


SEA BIRDS


MARINE MOLLUSCS

LAND CRABS
53. James, D.J. (2007). Population structure and road mortality in Red Crabs (Gecarcoidea natalis) and Robber Crabs (Birgus Latro) on Christmas Island Parks Australia North Christmas Island Biodiversity Monitoring Programme: Report to Department of Finance & Administration and Department of the Environment & Water Resources, Canberra.

OTHER CRUSTACEA

PLANKTON