

<b>Institution: University of Warwick</b>
<b>Unit of Assessment: A5: Biological Sciences</b>
<b>Title of case study: Declaration of the world's largest marine protected area: marine conservation benefitting the ecosystems and people of the Indian ocean</b>
<p><b>1. Summary of the impact</b></p> <p>Since 1994, Professor Charles Sheppard at the University of Warwick, both individually and in collaboration with others, has published key results and observational studies into the coral reefs and islands of the Chagos Archipelago, central Indian Ocean. This is a British Overseas Territory - the British Indian Ocean Territory (BIOT), the UK's most biodiverse marine environment, comprising five atolls including the largest in the world and ten submerged atolls and banks covering 60,000 sqkm. These studies showed the marine environment there was the least impacted in the Indian Ocean, and the largest undamaged tract of coral reefs remaining in the world. It also has the worlds highest reef fish biomass, highest densities of the huge but endangered coconut crabs, and is the most unpolluted marine environment recorded in the world. Results in 250 papers to date from over 100 collaborators including several from Warwick (PhD students to Professors), provided the scientific basis for the UK Government's declaration in 2010 of the largest strictly no-take Marine Protected Area (MPA) in the world. The MPA exceeds 650,000 sqkm. The intention is to conserve this huge and globally important area in its present condition, for the benefit of the Indian Ocean countries, and to act as a scientific reference site, or baseline, for tropical studies world-wide. This declaration is a major step forward for marine conservation and food security in a region that has undergone massive decline, both in its ecological condition and ability to supply protein for inhabitants of many of the world's poorest countries.</p>
<p><b>2. Underpinning research</b></p> <p>Coral reefs are the most biodiverse and productive marine systems in the world, providing food and coastal protection to millions. However, the gradual destruction of coral reefs by global warming and pollution affects more than the vulnerable coral reef itself<sup>1</sup>. In areas where communities depend on disappearing reefs to survive, human mortality is increasing as a result of marine habitat disturbance, food shortages caused by overfishing and pollution, and climate change. The multitude of threats affecting some reefs from these causes has proved insurmountable, such that one third of reefs are now dead, with another third undergoing stresses and decline. Global warming has accelerated the decline in reefs over the last 20 years.</p> <p>Prof. Sheppard at UoW has carried out research in Chagos since 1975, and has co-ordinated marine and island science there since 1995, focussing on the underpinning research and its application to conservation. His initial research explored the unique aspects of the uninhabited Chagos, an area that has avoided anthropogenic stressors (reviewed in Ref. 2) which showed its exceptionally biodiverse, undamaged and productive character. He has researched and published extensively on the coral ecology, recovery, biogeography and resource provisions of this huge network of reefs, as well as on its potential ability to survive climate change<sup>3-5</sup>.</p> <p>Research since 2010, conducted and/or coordinated by Sheppard, and summarised in two books<sup>6</sup>, showed that: (i) there is a uniquely high degree of biological richness in this 650,000 sqkm area, especially in its reefs and shallow waters; (ii) there are high levels of larval connectivity between Chagos and the western Indian Ocean, thus suggesting the likelihood of Chagos being a key stepping stone in east-west ocean connectivity; and (iii) rapid and complete ecosystem recovery can occur only where there are no local anthropogenic impacts (as is the case in Chagos), confirming the value of no-take areas and strongly supporting the concept of very large no-take MPAs<sup>4</sup>. His research has also shown that, where an area is vulnerable to climate change, marked recovery can occur when extractive exploitation of the area is prohibited<sup>5</sup>, to longer-term benefit. As a result, the Chagos reef system now serves as a global reference point for tropical marine research, and provides a large location that has been little, if ever, affected by anthropogenic disturbance (providing one of few global reference sites) so that changes to tropical marine ecosystems can be measured from a true baseline rather than from one already and unwittingly impacted.</p> <p>Based on various biological measures, including productivity and resilience, the condition of the Chagos reef system is the best of any reef worldwide<sup>3,5</sup>. However, continued research will be</p>

## Impact case study (REF3b)

needed to ensure that it remains protected. In addition, several future expeditions, already funded via Defra's Darwin Fund (of which Sheppard is a PI) will study how climate change is affecting the ecology of this important ecosystem.

**University of Warwick staff:**

**Professor Charles Sheppard**, Professor of Life Sciences (July 1993 – present); Professor Andrew Price (1992-2011); Professor Jacquie McGlade (1990-2000); PhD students: Alistair Joliffe (1998); Rebecca Klaus (2000); Al Harris (2010).

**3. References to the research****Peer-reviewed publications**

1. Ateweberhan, M. *et al.* (2011) Episodic heterogeneous decline and recovery of coral cover in the Indian Ocean. *Coral Reefs* 30, 739–752. DOI: [10.1007/s00338-011-0775-x](https://doi.org/10.1007/s00338-011-0775-x)
2. Sheppard, C.R.C. *et al.* (2012) Reefs and islands of the Chagos Archipelago, Indian Ocean: why it is the world's largest no-take marine protected area. *Aquatic Conservation: Marine and Freshwater Research* 22, 232–261. DOI: [10.1002/aqc.1248](https://doi.org/10.1002/aqc.1248)
3. Sheppard, C.R.C. *et al.* (2008) Archipelago-wide coral recovery patterns since 1998 in the Chagos Archipelago, central Indian Ocean. *Marine Ecology Progress Series* 362, 109–117. DOI: [10.3354/meps07436](https://doi.org/10.3354/meps07436)
4. Graham NJ *et al.* (2008) Climate warming, marine protected areas and the ocean-scale integrity of coral reef ecosystems. *PLoS ONE* 3, e3039. DOI: [10.1371/journal.pone.0003039](https://doi.org/10.1371/journal.pone.0003039) [Ref2]
5. Harris, A. and Sheppard, C.R.C. (2008) Status and recovery of the coral reefs of the Chagos Archipelago, British Indian Ocean Territory. In *Indian Ocean Coral Reefs* (Obura, D. *et al.*, eds), pp. 61–69, CORDIO, Kalmar University (<http://tinyurl.com/purdfwm>)
6. Sheppard, C.R.C., ed. (2013) *Coral Reefs of the UK Overseas Territories*, Springer. ISBN 978 94 007 5965 7 (Book, available on request). Also 'Ecology of the Chagos Archipelago (1999) Linnean Society Special Publication. ([bit.ly/19VkXlg](http://bit.ly/19VkXlg)).

**Peer-reviewed grants and awards**

The funding approach has always been to increase funds. Core funds obtained by Sheppard (listed below), provided full expedition support and, by inviting leading scientists, an approximately 8-to-10-fold increase was 'levered' for each scientific expedition. Thus, Sheppard's grants of approximately £50k invariably resulted in a total spend of £300–500k for each expedition.

- PI: Sheppard: Contribution towards Chagos Scientific and Environmental Survey, Chagos Conservation Trust (2004 – 2006); 12 grants of £5k each from participating institutions
- PI: Sheppard: Marine conservation work in Diego Garcia atoll; DfID and FCO Overseas Territories Environment Programme; Amount awarded £35k.
- PI: Sheppard: Environmental Monitoring for Improved Conservation Management, 2004–2006; DfID and FCO Overseas Territories Environment Programme; Grant reference BIO002; Amount awarded £67.4k.
- PI: Sheppard: Improved conservation management of BIOT using Revised Zone Boundaries, 2007; DfID and FCO Overseas Territories Environment Programme; Grant Reference BIO403; Amount Awarded £103k.
- PI: Sheppard: Strengthening the world's largest Marine Protected Area: Chagos, 2012–2015; DEFRA Darwin fund; Grant reference 19027; Amount awarded £287,788, UoW component approximately £60k.

**4. Details of the impact****Impacts on public policy and services**

Early publications, mainly by Sheppard and dating from as early as the 1980s, showed the ecological scope and value of Chagos, namely its high biodiversity and productivity, its ability to differentiate between local impacts and those from marine climate change, its potential role in serving the Indian Ocean's resource needs, and its fundamental role as a research reference site. It would also greatly assist the UK in meeting its international obligations for marine protection. As a result of this research, over 100 scientists from many marine disciplines have applied to use Chagos for their research, all of whom subsequently became enthusiastic supporters of the idea of creating an important ecological legacy in Chagos. The involvement of most of the 100+ scientists was arranged and coordinated by Sheppard at UoW. Institutions from ten countries that research coral reefs have also been involved. When the evidence was substantial for the need for long-term

**Impact case study (REF3b)**

conservation, Sheppard, together with the Pew Environment Foundation, formed the Chagos Environmental Network in 2008, which comprises a loose amalgam of the Blue Marine Foundation, Chagos Conservation Trust, Coral Cay Conservation, Linnean Society of London, Marine Conservation Society, Pew Marine Foundation, Royal Society, Royal Botanic Gardens Kew, Royal Society for the Protection of Birds, Zoological Society of London, and Professor Charles Sheppard as the only individual. The aim of this Network was to promote to the UK Government the plan to establish this area as an MPA. It achieved its goal in 2010. In addition, the Pew Marine Foundation subsequently provided funds for an office in London for two years from 2008 to 2010, to organise a campaign to persuade the UK Government to declare the Chagos an MPA.

The main objectives of the underpinning research described above were not only to research the productivity and biodiversity of this unimpacted tropical marine area, but also to obtain the governmental protection that the area required. Thus, in 2010, the top 250 marine scientists in the world, including Sheppard, published an open letter calling for substantial protection of large areas of ocean habitats, noting that huge areas of ocean and oceanic productivity had already been destroyed or degraded, some permanently, resulting in substantial human mortality in the poorest countries estimated in the millions of people. As Science Advisor to the Commissioner of the BIOT, Sheppard provided the scientific basis for the UK Government to declare in 2010 the area a strictly no-take MPA; at over 650,000 sqkm, the largest in the world.

The Chagos region is now the largest among six members of the Big Ocean Network, a global initiative aimed at conserving the oceans. In separate statements of support of Sheppard's work, the Foreign Commonwealth Office (BIOT)<sup>a</sup>, Linnean Society of London<sup>b</sup> and Pew Environment Foundation<sup>c</sup>, acknowledged that, "scientific studies organised and led by Professor Sheppard" were "fundamental to achieving this MPA status" of Chagos, "as these studies demonstrated that Chagos has the cleanest sea waters ever tested, the most climate change-resilient coral reefs, the highest known fish biomass anywhere, and is a key part of the Indian Ocean's genetic 'highway', vital for many species". BIOT emphasised the role of Sheppard in providing policy advice, and the Linnean Society highlighted the important impact of Sheppard's work, first in "establishing the UK as being an important leader in marine conservation" and, secondly, of impacting upon "the broader issues of marine management and understanding in the Indian Ocean, including in those many countries whose natural resources are in increasingly impoverished condition". The Pew Environment Foundation stated that, "in short, Sheppard's work has led to increased science, the establishment of a world-beating marine reserve, and work to restore the islands to their original state". This work and its importance has been published by Sheppard for the Houses of Parliament, explaining the benefits of this research and project for both Britain and the Indian ocean, including for food security in the latter<sup>d</sup>.

**Impacts on the environment**

The protected Chagos archipelago is now the biggest reef conservation area and MPA in the world (almost as big as France). It is an area whose richness and unaltered state serves as a reference site for the rest of the world, enabling damaged-area managers in other countries to understand what they should be aiming at to achieve enhancements in their own degraded ecosystems, in terms of trying to modify local activities, and prioritising their work – especially in resource-poor countries. The beneficial impact of this is to help enable marine habitats to recover their diversity and productivity to levels not otherwise seen for many decades.

**Impacts on practitioners and services**

As a result of his research on Chagos, Sheppard works for a range of United Nations, governmental and aid agencies in tropical marine and coastal development issues, advising governments on marine and coastal management.

From UoW, Sheppard also coordinated the research of over 100 scientists from developed countries, with a few (as many as possible) from developing countries also, helping to provide developing countries with the know-how to manage their own reef systems. This has resulted in over 200 scientific publications that are now used to assist countries with damaged marine systems to establish ways of mitigating ecological impacts, such as determining the relative impacts of overfishing and pollution. In particular, work by Sheppard<sup>2</sup> showed directly how the UK could effectively aid conservation measures, including increasing food security, and aid countries to mitigate environmental damage.

**Impact case study (REF3b)****Impacts on society, culture and creativity**

The World Resources Institute, an independent non-governmental organisation that carries out policy research and analysis on global environmental and resource issues and development goals, focusing on the intersection between the environment and socio-economic development, uses Sheppard's research on their website. 'Chagos Archipelago: A Case Study in Rapid Reef Recovery'<sup>e</sup> states that: "Today, the number of reefs around the world without direct human impacts is extremely small, so Chagos represents the rare case where scientists can examine effects of global climate change in the absence of human influence. The recovery of corals in Chagos – in comparison to other sites in the region under greater human pressures – therefore highlights the importance of local management efforts to reduce these pressures".

Sheppard is a scientific advisor to the European Outdoor Conservation Association (EOCA), a 'not-for profit' Association, stretching from Norway to India and from the UK across to the Czech Republic, that aims to prove that the European outdoor industry is committed to 'putting something back' into the environment, and that if everyone involved works together a real difference can be made. Sheppard provides advice to EOCA on which projects they should fund and support for the conservation of wild places and ecosystems for future generations.

Sheppard is a Trustee and Advisor to Blue Ventures, an award-winning social enterprise that works with local communities to conserve threatened marine and coastal environments, both protecting biodiversity and alleviating poverty.

**5. Sources to corroborate the impact**

- a. Supporting Statement, British Indian Ocean Territory (BIOT) Administration, Foreign Commonwealth Office, London. (Identifier 1).
- b. Supporting Statement, Executive Secretary, Linnean Society of London, and Chair of Chagos Environmental Network, London. (Identifier 2).
- c. Supporting Statement, UK Director, Global Ocean Legacy, Pew Environment Foundation, Pew Trusts, London. (Identifier 3).
- d. A full-text article written by Sheppard in *Science in Parliament* (<http://tinyurl.com/prbs2ta>)
- e. World Research Institute, website article using Sheppard's research: Chagos Archipelago: A Case Study in Rapid Reef Recovery (<http://tinyurl.com/odayoj9>)