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Pitcairn Marine Research Outline Plan

A report prepared for The Pew Charitable Trusts, the National Geographic Society, and the Pitcairn Island Council for submission to the UK Foreign and Commonwealth Office

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Overview

Scientific knowledge of the Pitcairn Islands is based on a series of expeditions from 1825 to 2012. These have been of varying duration and intensity of effort, but the majority have focused on collection trips and inventories of a range of species (plants and animals) from the four islands. In relation to marine species found in the Pitcairn Islands, these expeditions have produced extremely valuable information, although this is inevitably skewed depending on the research effort on the different islands and the focus of previous expeditions (summarised in Irving and Dawson, 2012). There has, however, been no on-going scientific monitoring carried out in Pitcairn's waters, so we have no knowledge of whether or how Pitcairn's marine biodiversity has changed over this period.

In 2012, the National Geographic Pristine Seas Expedition to all four islands undertook the first rigorous, quantitative measures of species diversity of algae, corals, and fishes, as well as coral cover, fish abundance, and biomass (at 10- and 20-metre depths). This important study provides a quantitative baseline that can be used as the basis for measuring changes in the marine environment over time. This is particularly important should a marine reserve be established, because it provides a "pre-reserve" baseline against which future management can be judged. (Maps of the 96 monitoring sites are included in Appendix A.)

The combination of isolation, endemism, near-pristine status, and variations among the four islands—along with the relatively limited amount of research and the 2012 baseline data—provides an extraordinary opportunity to develop a more cohesive research plan linked to the establishment of a marine reserve.

Current Research

The current research projects underway (or planned for the near future) for the Pitcairn Islands are:

1. **Institute for Pacific Coral Reefs/Centre for Island Research and Observatory of the Environment reef monitoring programme.** The fish and scleractinian coral populations and hydrological parameters of two sites around Pitcairn are being monitored as part of a 16-year study (started in 2009) of 20 islands in the four French Polynesian archipelagos.
2. **Royal Society for the Protection of Birds Henderson Island restoration programme.** This project is focused on terrestrial habitats and seabirds. However, there are opportunities for joint visits and to build upon previous assessments of bird stomach contents to determine changes in diet over time.
3. **National Geographic Pristine Seas Expedition.** This expedition visited all four islands and conducted 384 individual dives, counted and measured 40,210 fishes, 5,000 sea urchins, 6,300 coral colonies, and 14,500 algae. Importantly, it established the first quantitative baseline which can be used for on-going monitoring and the first investigation of deep-sea areas. Analysis of the data has been completed and will shortly be submitted to a peer-review journal.
4. **Darwin Initiative (led by Professor Terry Dawson, University of Dundee).** This work will be carried out primarily around Pitcairn, and the project will focus on standardised monitoring of key habitats and species having commercial or conservation value; implementing sustainable fisheries management for the inshore fisheries and an overall management plan for the marine reserve; and increasing engagement in Pitcairn's marine biodiversity for tourists and the UK public.

Proposed Research Priorities

Table 1 outlines proposed research priorities in the first three years, starting in 2013. Should a marine reserve be established as proposed, it is planned that a research and monitoring programme be created. This could be led by the Zoological Society of London but with input from others, particularly Blue Ventures. This is obviously resource-dependent and will require proactive grant writing to secure funds for these projects. The timetable for some projects works to those set by the Darwin Initiative. Further details of the context of these projects are provided in the Outline Scientific Plan section on the following pages.

Table 1:

Three-year research plan to inform management of the Pitcairn marine reserve

Project	Year 1 (2013)	Year 2 (2014)	Year 3 (2015)	Project Partners
Monitoring status and trends				
1. Inshore reefs less than 25-m depth around all four islands	Repeat monitoring of sites established by National Geographic (or appropriate subset)	Repeat monitoring of these sites	Repeat monitoring of these sites	<ul style="list-style-type: none"> • Darwin project team • Blue Ventures scientific tourists
	Monitor coral cover at monitoring sites and measure changes over time (building on previous surveys)	Repeat monitoring of these sites	Repeat monitoring of these sites	<ul style="list-style-type: none"> • Darwin project team • Blue Ventures scientific tourists • Institute for Pacific Coral Reefs/Centre for Island Research and Observatory of the Environment
			Assess coral diseases in the region	<ul style="list-style-type: none"> • Zoological Society of London/Big Ocean Network
	Monitor species diversity, abundance, and biomass of reef fish at monitoring sites.	Repeat monitoring of these sites	Repeat monitoring of these sites	<ul style="list-style-type: none"> • Darwin project team • Blue Ventures scientific tourists • Institute for Pacific Coral Reefs/Centre for Island Research and Observatory of the Environment
			Conduct detailed assessments of priority species, e.g., those that are globally endangered and/or endemic	<ul style="list-style-type: none"> • Darwin project team • Blue Ventures scientific tourists
2. Fisheries	Establish baselines, introduce fisheries management guidelines	Logbooks and surveys of focal species	Logbooks and surveys of focal species	<ul style="list-style-type: none"> • Darwin project team • Pitcairn Islanders
3. Offshore 25-80-m depth			Baited remote underwater video baseline surveys of fish species and relative abundance between 30 and 80 m	<ul style="list-style-type: none"> • Zoological Society of London/University of Western Australia/National Geographic expeditions
4. Open ocean greater than 80-m depth		<p>Marine Instant Wild deployment at trial sites for biodiversity, environmental parameters, surveillance</p> <p>Repeat Dropcam deployments from National Geographic surveys</p>	<p>SISSTAs baseline surveys of fish species and relative abundance associated with sea mounts</p> <p>Marine Instant Wild network deployment</p>	<ul style="list-style-type: none"> • Zoological Society of London/ University of Western Australia

Project	Year 1 (2013)	Year 2 (2014)	Year 3 (2015)	Project Partners
Focal species				
1. Cetaceans	Initial surveys of cetaceans around Pitcairn Island	Implement local observer/citizen science programme throughout Pitcairn Islands	Maintain local observer/citizen science programme	<ul style="list-style-type: none"> • Darwin project team • Pitcairn Islanders • Supply vessel, cruise ships, visiting yachts • Blue Ventures scientific tourists
2.. Turtles		Survey nesting population of turtles on Henderson and check for signs of nesting on Oeno	Repeat surveys	<ul style="list-style-type: none"> • Blue Ventures scientific tourists (with turtle scientist)
3. Sharks		Establish standardised visual census of reef sharks around Pitcairn	Repeat surveys	<ul style="list-style-type: none"> • Blue Ventures scientific tourists • National Geographic expeditions
		Initial surveys of whale sharks around Pitcairn Island	Implement local observer/citizen science programme throughout Pitcairn Islands	<ul style="list-style-type: none"> • Pitcairn Islanders • Supply vessel, cruise ships, visiting yachts • Blue Ventures scientific tourists
			Obtain baseline data on pelagic shark populations at monitoring sites and monitor changes over time (SISSTAs, Marine Instant Wild)	<ul style="list-style-type: none"> • Zoological Society of London/University of Western Australia
Environmental Monitoring				
1. Sea temperature	Install temperature loggers at monitoring sites			<ul style="list-style-type: none"> • Darwin project team • Blue Ventures scientific tourists
2. Basic oceanographic data profiles	Hydrological parameters at two sites	Hydrological parameters at two sites	Establish transects around four islands and localised measurements at monitoring sites (seamounts, lagoons) around conductivity, temperature, depth and fluorimetry	<ul style="list-style-type: none"> • Institute for Pacific Coral Reefs/Centre for Island Research and Observatory of the Environment • Zoological Society of London/ University of Western Australia
3. Marine litter			Repeat marine litter survey conducted in 1995	<ul style="list-style-type: none"> • National Geographic or similar expedition?
4. Reporting			Issue first annual research and monitoring report	<ul style="list-style-type: none"> • Zoological Society of London

Costs

Table 1 describes the priority projects for management purposes with a three-year plan, which would be intended to continue as an on-going monitoring programme. It would be achievable with a minimum of one three-week expedition a year, with an estimated cost of around £100,000.¹ This is realistically fundable through a Darwin grant or other fundraising sources.

Outline Scientific Plan

There is, in addition to the above, enormous scope for research in Pitcairn. This section gives further details of an outline scientific plan and examples of research projects that would inform management.

Establishing baselines

With the current proposals for a marine reserve in Pitcairn, it is important to prioritise research that will inform management. This can range from establishing baselines for key species and habitats to determining threshold values for key environmental parameters that are linked to management actions. Baseline data have been established to 20 m for species, abundance, cover and biomass of reef fish, but in other cases are extremely limited due to the previous focus of research expeditions on inventories. In order to prioritise research that will inform management, some basic approaches should be adopted:

- 1. Identify routine monitoring sites.** As the four islands are unique, a monitoring plan is required for each. Due to the logistics involved in reaching Henderson, Oeno and Ducie, it is inevitable that more effort will focus around Pitcairn. However, effort should be taken to conduct regular assessments on each island, and monitoring sites should be established on each, based on previous data (Appendix A shows the monitoring sites used by National Geographic that will form the basis for establishing focal monitoring sites).
- 2. Establish monitoring methods.** Wherever possible, standardised methods should be used to ensure that the data are directly comparable with other global datasets (e.g., underwater visual and photoquadrat surveys, baited remote underwater video) and relevant regional and UK Overseas Territories surveys (the Chagos Islands, Big Ocean Network).
- 3. Feed into international databases and studies.** There are many international databases which will ensure that information collected from Pitcairn forms part of global biodiversity assessments and determinants of population trends. These include the International Union for Conservation of Nature Red List, C-Reefs, TOPP, Living Planet Index, Big Ocean Network, Genbank, Spawning Aggregations Database, International Whale Shark Photo-identification database. In addition, samples collected from Pitcairn could potentially provide important data points for broader studies so all research expeditions conducted in the Pitcairn Islands should aim to collect material and samples for such studies.
- 4. Identify focal species.** Although there is always some research interest or question that applies to every species, priority for study should be given to species that are globally threatened, under exploitation (or potential for fisheries development), or endemic.

¹ Ship = £40,000, equipment = £10,000, airfare and salaries for 10 persons for three weeks = £45,000.

Scientific research in Pitcairn should aim to feed into the main themes of the Big Ocean Network, identified as being most relevant and shared amongst large-scale marine protected areas:

- Biological and ecological characterisation, including studies on the abundance and distribution of organisms, habitats, and ecosystems.
- Connectivity, including biological, physical, and anthropogenic connectivity.
- Monitoring of temporal trends, including patterns caused by both anthropogenic sources and natural variability.

Biodiversity monitoring

While some data exist on the major groups of marine life in the Pitcairn Islands (corals, molluscs, echinoderms, fishes, turtles, and cetaceans), population estimates are not available and there are no data on trends over time. Birds are not considered here as they are covered by the Royal Society for the Protection of Birds conservation programme.

Threatened species

Cetaceans

Twenty-two species of cetaceans have been recorded in the Pitcairn Islands, including four endangered whale species (blue, humpback, sei, and fin). As part of the Darwin Initiative proposal, Robert Irving hopes to obtain acoustic data from humpback whales to assess population size, diversity, and duration of visits.

Possible research projects

- Determine species, population size, and seasonality of visits of whales through surveys at locations throughout the Pitcairn Islands (e.g., direct observations, acoustics, drones).
- Establish information on distribution and abundance of all cetaceous species in the Pitcairn Islands through the introduction of volunteer recording using a simple field guide and data collection system. This could use local observers (Pitcairn islanders), visiting/transiting yachts, and supply and cruise ships.

Turtles

Marine turtles are globally threatened and two species have been observed in Pitcairn (hawksbill and green), but they have been poorly studied. Greens have been reported to nest on Henderson (10 laying females in 1991), but they have been little studied. These turtles require regular monitoring and satellite tagging in order to determine movements.

Possible research projects

- Determine the nesting population of turtles in Henderson and check for signs of nesting on Oeno through regular surveys of potential nesting beaches.
- Establish the relatedness of turtles in the Pitcairn Islands to the global population through collection of tissue samples for genetic analyses to feed into global analyses/databases.
- Assess migration routes, feeding, and nesting locations through satellite tagging of adult turtles.

Endemic species

More than 14 endemic marine species have been found around the Pitcairn Islands, and more will likely be found during further surveys.

Possible research projects

- Establish the distribution and population status of endemic species around the Pitcairn Islands to determine the Red List status of each species and develop a species action plan.
- Establish a routine monitoring programme for endemic species as part of the overall monitoring programme.

Reef species and habitats

Corals

Corals around the Pitcairn Islands have been recognised as being unusual and having affinity with those around the Galapagos Islands and Easter Island. The four Pitcairn islands have considerable variability in their coral reefs; therefore, routine monitoring programmes would be required at all four. There has been evidence of mass coral mortality before 1971, but, similar to other sites such as Chagos with low anthropogenic pressure, there is evidence of high resilience.

The Pacific region has suffered from severe coral bleaching as a result of elevated sea surface temperatures, so monitoring these in Pitcairn is important in a regional context. Methods should look to complement those used at the two Pitcairn sites as part of the Institute for Pacific Coral Reefs/Centre for Island Research and Observatory of the Environment study. The Big Ocean Network has prioritised comparative studies of coral diseases across very large marine protected areas. No research has been done on this topic in Pitcairn, though it is an important indicator of reef health and resilience.

Possible research projects

- Record coral cover at monitoring sites and changes over time (building on previous surveys).
- Assess coral species, diversity and recruitment (through juvenile coral monitoring).
- Assess coral diseases in the region.

Reef fish and invertebrates

These are considered the best studied taxa in Pitcairn, primarily in terms of documenting species at a number of sites but with some survey data on abundance (for example, National Geographic data indicate that abundance at Henderson is five times higher than at Pitcairn, with Oeno and Ducie in between).

Possible research projects

- Monitor species diversity, abundance, and biomass of reef fish at monitoring sites.
- Conduct detailed assessments of focal species (e.g., those that are globally threatened and/or endemic).
- Analyse genetic connectedness of focal species regionally (building on studies done in 1980 and 1984).
- Assess connectivity of species regionally (e.g., with marine protected areas in the Cook Islands, French Polynesia, Easter Island) to test whether marine protected areas are working as a network.
- Assess movement and behaviour of key species using remote telemetry.

Sharks

Nine species of sharks and one ray have been recorded around the Pitcairn Islands, including reef sharks and oceanic species. Oceanic species include greater hammerhead, oceanic whitetip and whale sharks, though specifics are limited. The National Geographic expedition reported some concerning observations of an absence of reef sharks at some sites, which needs further investigation.

Possible research projects

- Establish information on distribution and abundance of whale sharks in the Pitcairn Islands through the introduction of recording using a standard photo documentation and data collection system that feeds into global databases. This could use local observers (Pitcairn islanders), visiting/transiting yachts, and supply and cruise ships.
- Obtain baseline data on reef shark populations at monitoring sites and record changes over time.
- Obtain baseline data on pelagic shark populations at monitoring sites and record changes over time.
- Assess movement and behaviour of key species using remote telemetry.

Fisheries monitoring and management

The Darwin Initiative project plans to focus on the species currently being fished in Pitcairn (spiny and slipper lobsters, coral trout and other groupers, tuna spp.). Baseline data will be collected through initial surveys, then a fisheries monitoring system will be implemented to be recorded by the islanders.

Groupers are particularly vulnerable to fishing because of their high commercial value, especially for the live reef fish trade and because many species breed in spawning aggregations. Some of the large groupers found in Pitcairn, such as the humphead wrasse (*Cheilinus undulatus*), are known to spawn in aggregations that consist of tens of thousands of fish that may have travelled more than 100 kilometres to an aggregation site on a particular reef at a predictable time.

Possible research projects

- Monitor abundance and biomass of key fisheries species. This should include the species currently targeted by fisheries, but also species that are high-demand/high-value species elsewhere (particularly pelagic species, groupers, and snappers).
- Survey and monitor any known or potential spawning aggregation sites (historical records, local knowledge, biological features).
- Track sea cucumber densities at monitoring sites.
- Develop and implement fishing recording system for islanders and visiting yachts (part of the Darwin project).
- Prioritise (with several agencies and Big Ocean Network) methods of improved detection of illegal fishing.

Open-ocean monitoring

Virtually no studies have been done on open ocean species, other than opportunistic observations from vessels and very limited fisheries data when the tuna fishery was active in Pitcairn.

Possible research projects

- Determine species diversity, relative abundance and biomass using non-destructive monitoring methods (image capture and videography) of pelagic species. Methods should be comparable to those developed in Chagos.
- Assess movement and behaviour of key species using remote telemetry.

Deep-sea monitoring

Bathymetric maps and submersible diving surveys have identified more than 90 seamounts, plus abyssal plains and troughs, in the Pitcairn Islands. Data have been obtained from the seafloor using remote methods such as satellite altimetry and multi-beam bathymetry, as well as some ROV surveys. The National Geographic survey conducted 17 Dropcam deployments from 78 to 1,585 m deep.

Possible research projects

- Generate detailed mapping and species inventories from seamounts in Pitcairn.
- Investigate the effects of islands, atolls, and seamounts on mid-water animals.
- Investigate the presence of hydrothermal vents (there is some mention in papers that these are suspected to be present, and because it is on a volcanic ridge, that seems possible) and, if found, develop maps and examine their biodiversity.

Environmental monitoring

There are limited data on oceanographic parameters in Pitcairn, especially sea surface temperature and indicators of productivity. Mortality from high sea temperatures is known to be the most immediate threat to corals in the Pacific, with mortality from bleaching widely reported.

Possible research projects

- Record sea temperatures at monitoring sites by installing continuously recording temperature loggers at various depths at sites across the four islands, in lagoons, passes, and seaward slopes. This could be achieved as an integral part of our underwater remote monitoring systems.
- Conduct routine transects around the four islands and localised measurements at monitoring sites (seamounts, lagoons) of basic oceanographic data (conductivity, temperature, depth, and fluorimetry).
- Monitor changes in ocean alkalinity by installing a recorder on the supply vessel.
- Repeat the marine litter survey conducted in 1995.

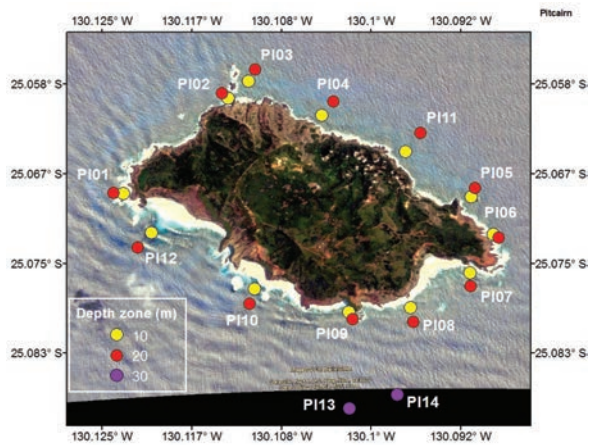
Infrastructure

Building research infrastructure and capacity will increase the income and benefit to the community through home-stays, use of visitor units, etc. If appropriate, training could be provided to build this capacity within the islanders, or it may offer opportunities for additional people to live on Pitcairn to service the research facilities. The following would be required to support a more structured research programme in Pitcairn:

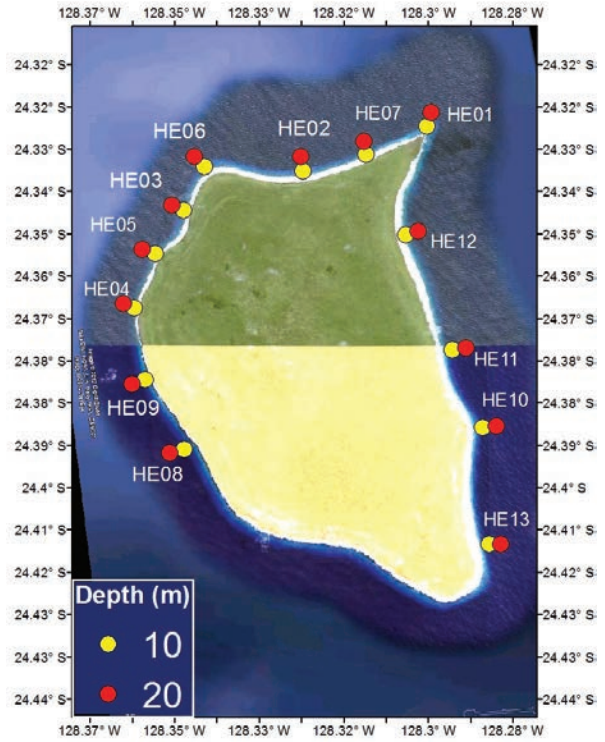
- **Research space:** There is no working research space in Pitcairn, though the Darwin project includes plans for simple bench space within the museum, which will enable processing of samples. However, if research is to expand considerably, a research facility may need to be considered for equipment storage and to support visiting scientists. Given the lack of space at the museum, and that the museum has no obvious connection to scientific work, it would be more appropriate to house such a facility within the nursery, which is currently being refurbished and will house the Natural Resources Department. Plans for this would be discussed with the Natural Resources Department to ensure their suitability. Such facilities usually have a manager who helps co-ordinate logistics for visits, research permits, and approvals, and supports researchers while they are on site.
- **Research vessel:** A suitable vessel is required to access all four islands. Smaller ribs for deploying divers, deploying equipment, and tagging are also required. Currently, the supply ship *Claymore II* is the only reliable means of getting to and from Pitcairn Island itself, but this limits researchers to spending either 10 days or three months on the island, which is not convenient for most research work. Additionally, the *Claymore II* visits only Pitcairn and not the other three islands. The *Claymore II* can be chartered outside of the normal supply service to all four islands for any length of time, however this is very expensive (more than £215,000 for one month). Other commercial vessels have been used, but their availability is not reliable. This lack of a reliable, flexible vessel is a major limiting factor to the ability to conduct scientific expeditions to the Pitcairn Islands.
- **Diving:** Although some islanders routinely scuba dive to fish, there is no recompression chamber or medical support for dive-related injuries or sickness. This would need to be considered in setting the parameters for research diving. Examples exist of best practices to operate in the absence of a chamber in remote locations, which would involve, for example, a trained dive medic on every expedition, setting safe diving limits (e.g., less than 25 m, maximum of two dives per day, no mixed gas diving) and an equipment servicing, maintenance, and renewal programme.
- **Equipment:** To reduce costs of shipping, some basic equipment should be included as part of the research facility, such as basic dive kits (cylinders, compressor, weights), fridge/freezers, microscopes, and scales.

Appendix A

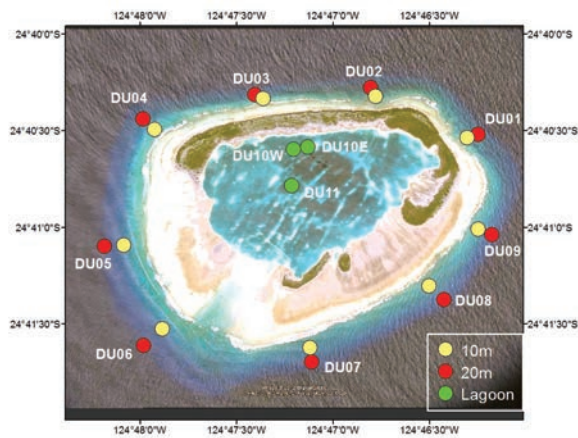
Sampling stations used by Sala et al. (2012) around all four islands in the Pitcairn group.



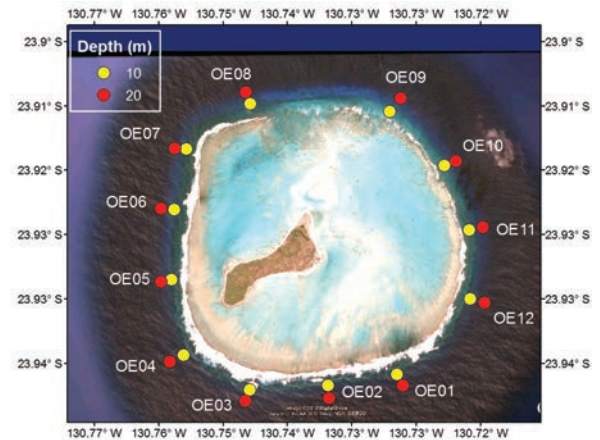
A. Pitcairn Island



B. Henderson Island



C. Ducie Island



D. Oeno Island

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Facebook: [/ProtectPitcairn](https://www.facebook.com/ProtectPitcairn)

Additional Resources: protectpitcairn.org, visitpitcairn.pn, ocean.nationalgeographic.com/ocean/explore/pristine-seas/pitcairn/

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About the National Geographic Society: The National Geographic Society has been inspiring people to care about the planet since 1888. It is one of the largest nonprofit scientific and educational institutions in the world. Its interests include geography, archeology and natural science, and the promotion of environmental and historical conservation.

About the Pitcairn Island Council: The Pitcairn Islands are an Overseas Territory of the United Kingdom in the South Pacific Ocean, inhabited by descendants of the mutineers from the HMAV Bounty. The Island Council is the legislature of the Pitcairn Islands, which, with a population of around just 55 people, is the smallest democracy in the world.