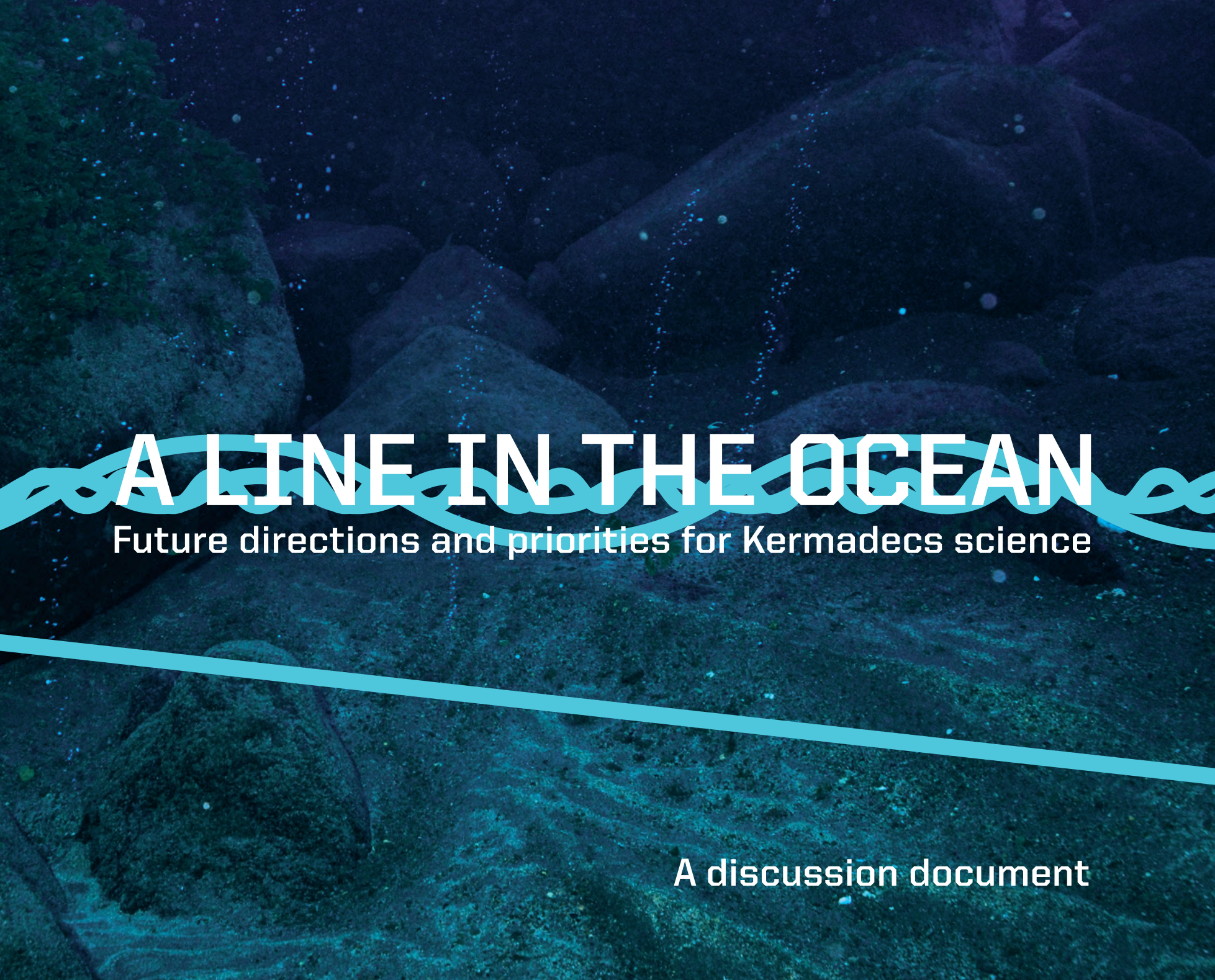


A LINE IN THE OCEAN

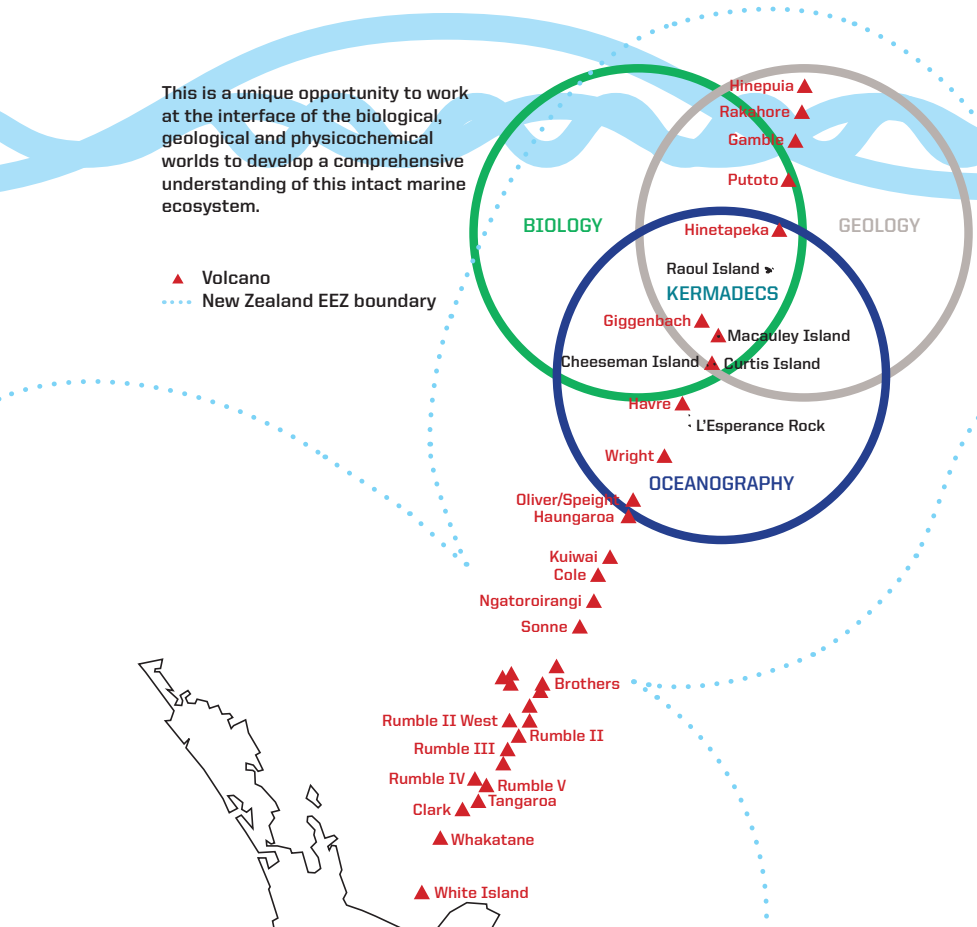
Future directions and priorities for Kermadecs science

A discussion document

A MARINE LABORATORY FOR THE WORLD

The aim of this document is to stimulate interest in scientific research in the Kermadecs marine environment. It is also intended to inform discussion and debate – among the wider scientific community, science investors, decision makers and the general public – about the future of science in this remarkable natural laboratory. It presents some immediate directions and priorities for a more integrated approach to scientific research in the Kermadecs and is a first step towards a strategic approach to Kermadecs science. Research themes and questions in this document have been drafted by the Pew Environment Group, in consultation with scientists conducting research on key aspects of the Kermadec marine environment.

This is a unique opportunity to work at the interface of the biological, geological and physicochemical worlds to develop a comprehensive understanding of this intact marine ecosystem.



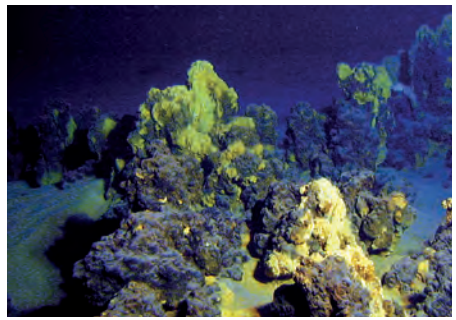
VALUE OF THE KERMADEC REGION FOR SCIENTIFIC RESEARCH

— The Kermadec ecosystems include an extraordinarily wide range of habitats in a relatively small area, covering subtropical to temperate latitudes, and including volcanic islands, shallow reefs, continental slopes, abyssal plains, seamounts, and extreme environments like hydrothermal vents and a deep sea trench.

— The waters and seafloor of the Kermadec region are largely undisturbed by fishing, mining and pollution, and can provide a baseline environment for observation of global trends like climate change, ocean acidification and other human-induced change.

— The Kermadec marine environment is largely unexplored; it contains many unique species and geological formations and has ongoing potential for the discovery of new species and novel natural products.

— As an unfished, unmined, largely undisturbed marine ecosystem, the Kermadec region is a natural laboratory, providing a unique opportunity for scientists from around the world to observe how natural marine ecosystems function.



Iron and silica-rich chimneys on the summit of Giggenbach Volcano are evidence of warm springs that were active at this site in the past
photograph by NOAA/GNS/NIWA
2005 Ring of Fire Expedition

— The marine systems of the Kermadecs are distinctive for being home to many endemic species, having an abundance of apex predators, and playing a role as a migration route for far-ranging species such as large fish, whales, seabirds and turtles.

This combination of features makes the region an incredibly valuable resource for scientists as a reference site for research to help understand the structure and function of a wide range of habitats and marine ecosystems. The quality of science possible in this region is very high and globally important.

THE KERMADECS

There are few marine areas on earth as complex and intact as the Kermadec region of New Zealand. The diverse range of undisturbed habitats and species make this one of the worlds most remarkable places. What makes this place especially valuable to science is that, as well as containing healthy ecosystems, it is – so far – largely unexplored and may yet hold many secrets vital to earth's life-supporting processes.

The remote Kermadec Islands lie in the heart of one of the world's great ocean wilderness areas. The 620,000-square-kilometre Kermadec region, located between New Zealand's North Island and Tonga, straddles tropical and temperate climates and is home to whales and turtles, sharks, seabirds, fish and deep-sea marine life, with new species being discovered every year. The region includes volcanic islands, cold methane seeps, hydrothermal vents and the second deepest ocean trench on earth, making it a hotspot for some of the most geologically active and biologically unusual features on the planet. In 2010, the National Geographic Society and the international Census of Marine Life declared the Kermadecs one of the 'last pristine sites left in the ocean'.

SCIENCE IN THE KERMADECS

The Kermadec Islands became part of New Zealand in 1886 and a permanent field base – initially run by the meteorological service but now by the Department of Conservation (DOC) – was established on Raoul Island in 1937. While the islands have never been permanently inhabited, introduced species, especially rodents, have changed the islands' flora and decimated seabird populations.

The islands are now a nature reserve, and DOC staff and volunteers are working to eliminate exotic flora and fauna and restore the local biota. In the waters around the islands, sightings of migrating whales are increasing after decades of whaling drove many species to near extinction.

Despite the devastating human impact on the seabird and whale populations, the marine environment is largely intact, and is as pure and undisturbed as it is possible to find anywhere in the world. The 12 nautical miles around each island is a marine reserve, while the waters from 12 to 200 nautical miles are a benthic protected zone where no trawling or dredging is allowed.

Scientific interest in the Kermadec region has grown in recent decades. Scientists from New Zealand museums, universities and Crown Research Institutes, along with international researchers, have discovered numerous hydrothermal vents and seamounts, along with species new to science that live in the shallow waters around the Kermadec Islands as well as deep in the sea around the underwater volcanoes. This research suggests there are many new species to discover, geological formations to investigate and complex ecological interactions to untangle, but research to date has been opportunistic, limited not only by logistics and cost but also by the lack of a strategic approach.

Scientist studying the bird fauna on Raoul Island
photograph by Karen Baird

'the fauna is effectively so poorly known we have no basis at this time for knowing how much we do not know'

Andrew Stewart and Malcolm Clark, DEEP*, p.70

THEME 1

AN UNEXPLORED ENVIRONMENT

Improved understanding of the nearshore and pelagic features of large-scale complex marine ecosystems

- What species, including resident and migratory marine species and seabirds, are found in the Kermadec region?
- Are the marine populations of the Kermadecs self-supporting or do they rely on replenishment from elsewhere?
- What is the tectonic setting of the Kermadec and Colville Ridges and how does this relate to the location of mineral deposits and active hydrothermal systems? Do the region's hydrothermal systems have a geophysical signature?
- What are the significant features of the Kermadecs' oceanography, including primary productivity, bathymetry, chemistry, currents, etc?
- What is the volcanic architecture of the Kermadec arc and what are the processes of metallogenesis there?

THEME 2

A LARGE-SCALE INTERCONNECTED ECOSYSTEM

Improved understanding of how the terrestrial and marine environments relate to physical and biological processes

- What are the trophic interactions within the marine ecosystem?
- How are the Kermadecs marine flora and fauna connected to marine flora and fauna in other areas of New Zealand and the South Pacific Islands?
- How are the Kermadecs seabirds connected to seabirds in New Zealand and other parts of the Pacific Ocean?
- What are the key environmental drivers of the distributions and densities of species and communities between the different marine habitats (both pelagic and benthic)?
- How are benthic communities connected? Do seamounts of the Kermadec Arc and Ridge act as 'stepping stones' for large scale dispersal of benthic species?
- How does the ecosystem as a whole function and what are the key relationships between the geology, biology and oceanography, and the terrestrial and marine ecosystems?
- To what extent have the terrestrial volcanoes impacted on the marine environment over time, and how has this affected the nearshore ecosystems?

THEME 3

A BASELINE FOR OBSERVING CHANGE

Medium- and long-term global, regional and local trends across a healthy, complex ecosystem are identified and tracked

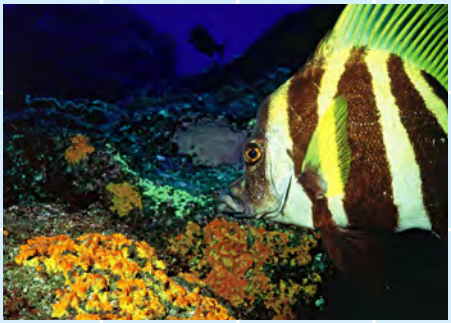
- How and why are key aspects of physical oceanography (e.g. temperature, acidity, pollutants, nutrients, salinity, currents) changing over time?
- How and why are numbers and distributions of species, including ecological indicator species, changing over time?
- How and why are numbers and habits of migratory species changing over time?
- How is restoration of the island ecosystem (seabirds and native vegetation) affecting the marine ecosystem?
- To what extent has the Kermadecs marine environment been influenced by historical human activity and how is human activity affecting it now and possibly into the future?

THEME 4

A NATURAL LABORATORY

The impacts of resource extraction on adjacent or similar ecosystems, and the potential for recovery, are determined by modelling the impact of discrete activities on an intact complex ecosystem

- What is the value of undisturbed Kermadec ecosystems – and the risk of degradation of these ecosystems to science, economics, culture and ecosystem services?
- What are the potential impacts of resource exploitation, such as fishing and seabed mining, on biological communities and their associated ecosystems?
- To what degree do marine reserves protect and sustain benthic communities and apex predators (like tuna and marlin) for continuation of the species and commercial catch in other locations?



A striped boarfish at Raoul Island
photograph by Roger Grace

FIRST KEY GOAL: ESTABLISH A VOLCANO-TO-TRENCH TRANSECT

Long-term monitoring station locations along the transect, covering a diverse range of habitats from the islands down to the extreme depths of the Kermadec Trench, will be set up to gather data key to all research themes and questions. This transect will, potentially, be supported by a Raoul Island laboratory to allow for analysis and processing of samples.

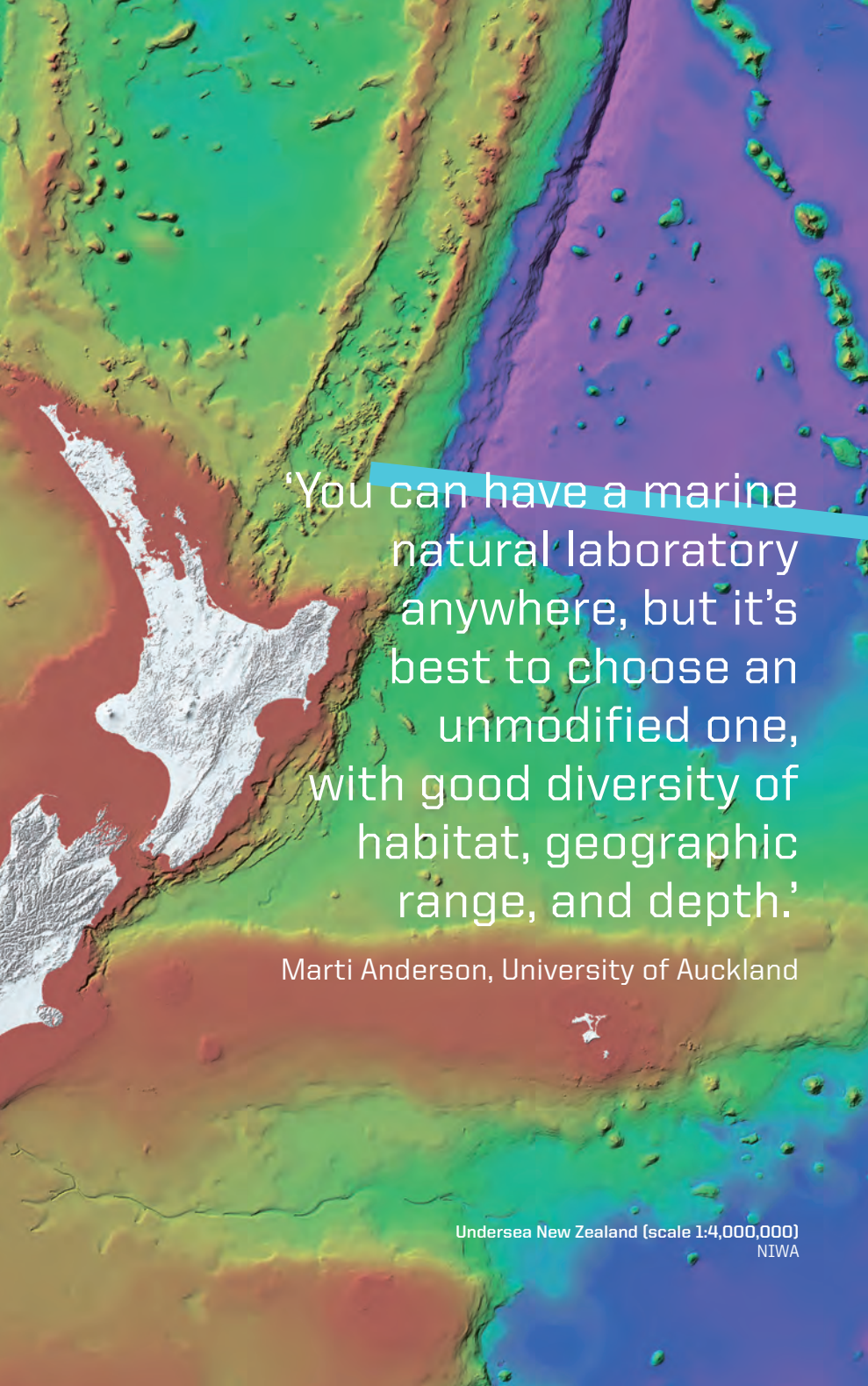
A COLLABORATIVE INTERNATIONAL APPROACH

Research that takes place in the Kermadecs marine environment will be globally significant, reflected in international contributions to science funding, equipment and expertise. This research will be multidisciplinary, and will involve multi-agency collaborations between organisations from around the world. It will involve training new researchers, and will lead to publications in high quality journals and books. The research will be communicated widely and will result in increased scientific and public awareness of the Kermadecs region. All research in this remote and undisturbed environment will be conducted in a way that is safe to the environment and to people and is logistically efficient.

The Kermadecs offer the international science community a unique laboratory by providing a window on how undisturbed marine ecosystems are structured and function. Measurements and models of the components and connections in this environment will be used to inform management decisions elsewhere – in degraded ecosystems or where fishing, mining or bio-prospecting are proposed – and to test new ecological hypotheses, techniques and equipment to improve research and management of the marine estate.

A NEW HORIZON

The Kermadec region offers a new horizon for science discovery and collaboration. It is a place where scientists from around the world can come together to conduct high quality and leading edge research and focus on marine life processes at a large scale both within and across complex ecosystems. The Kermadecs offers the world the opportunity to explore one of the most dynamic and undisturbed geological and ocean spaces on earth in an effort to add to scientific knowledge about how natural systems work, and inform pressing resource management decisions across our planet's entire marine environment.



‘You can have a marine natural laboratory anywhere, but it’s best to choose an unmodified one, with good diversity of habitat, geographic range, and depth.’

Marti Anderson, University of Auckland

Undersea New Zealand (scale 1:4,000,000)
NIWA

Scientists sampling in a rock pool on Raoul Island, May 2011
photograph by Tom Trnski, Auckland Museum

Banded coral shrimp
photograph by Roger Grace

‘the marine environment at the Kermadecs is as close to “pristine” as it is possible to find anywhere in the world’

Jonathan Gardner, DEEP*, p.42

July 2012

This document was developed by the Pew Environment Group with contributions from Malcolm Clark (NIWA), Jonathan Gardner (Victoria University of Wellington), Karen Baird (Forest and Bird), Rochelle Constantine (The University of Auckland), Marti Anderson (Massey University), Clinton Duffy (Department of Conservation), Miles Lamare (Otago University), Tom Trinski (Auckland Museum), Kevin Faure (GNS Science), Gaven Martin (Massey University), Geoffroy Lamarche (NIWA), Richard Wysoczanski (NIWA) and Vincent Zintzen (Te Papa).

Cover
Gas bubbles from the Kermadec seabed
photograph by Malcolm Francis

***DEEP: Thoughts and Talks Celebrating Diversity in New Zealand’s Untouched Kermadecs**
PEW Environment Group and Te Papa Tongarewa, August 2010

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THE PEW ENVIRONMENT GROUP

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