

## Curriculum Vitae: Dr Malcolm Clark

Personal details				
<b>Full name</b>	Title	First name	Second name(s)	Family name
	Dr	Malcolm	Ross	Clark
<b>Present position</b>		Principal Scientist (Fisheries)		
<b>Organisation/Employer</b>		National Institute of Water & Atmospheric Research (NIWA)		
<b>Email</b>		malcolm.clark@niwa.co.nz		

### Academic qualifications

- 1977 BSc, Victoria University of Wellington, Zoology
- 1978 BSc (Hons 1<sup>st</sup> class), Victoria University of Wellington, Zoology
- 1982 PhD, Victoria University of Wellington, Marine biology

### Professional positions held

- 2012 - 14 Programme Leader, Marine Biological Resources
- 2000 - Principal Scientist, Fisheries, NIWA
- 1995 - 99 Project Director, Deepwater Fisheries, NIWA.
- 1993 – 95 Deepwater Group Leader, MAF Fisheries
- 1986 – 93 Scientist, Deepwater Group, MAF Fisheries.
- 1985 – 86 Contract scientist, Fisheries Research Division (MAF)
- 1983 – 84 Research scientist, NZ Department of Lands and Survey
- 1982 – 83 Research Assistant, V.U.W Marine Laboratory

### Present research/professional speciality

- Deep-sea biodiversity and ecology
- Seamount ecology
- Deep-sea management and conservation
- Fishing and mining impact assessment
- Ecological risk assessment
- Stock assessment of deepwater fish species
- Fisheries abundance estimation methods and design

### Total years research experience

34 years

### Professional distinctions and memberships (including honours, prizes, scholarships, boards or governance roles, etc)

- 1977 Senior Scholar, V.U.W
- 1978 Postgraduate Scholarship, V.U.W
- 1978 Offered Commonwealth Scholarship, U.K
- 1980 DAAD Fellowship, Institut fur Seefischerei, Hamburg, Germany
- 1988 – 91 Secretary and Council Member, NZ Marine Sciences Society.
- 2002 – 05 Member Irish Research Evaluation Panel
- 2004 – 11 Steering Committee, Principal Investigator Census of Marine Life project CenSeam
- 2006 – 11 Steering Committee Census of Marine Life project SarEco
- 2008 – 10 Advisory Committee on the UK Indian Ocean Seamounts programme
- 2009 – Editorial Board, The Open Fish Journal
- 2011 – 13 Senior Advisory Committee, INDEEP
- 2011 – 13 Steering Committee of SOPAC Deep Sea Minerals Assessment Project
- 2012 New Zealand Marine Sciences Society Award
- 2012 – Oversight Steering Committee, INDEEP
- 2013 – Lead of Deep Sea ecosystems and mining Thematic Group of the IUCN CEM.
- 2014 – Member of Independent Science Panel, Great Australian Bight research programme

2014 – Editorial Board, Marine Ecosystem Ecology (Frontiers in Marine Science)  
 2015 – International Advisory Board, SponGES EU research programme

Total number of <i>peer reviewed</i> publications and patents	Journal articles	Books, book chapters, books edited	Conference proceedings	Patents
	83	15	30	

## Research publications and dissemination

### Peer-reviewed journal articles

#### 1. Major Publications (selection from last 10 years)

- Rowden, A.A., **Clark, M.R.**, Wright, I.C. (2005). Physical characterisation and a biologically focused classification of “seamounts” in the New Zealand region. *New Zealand Journal of Marine and Freshwater Research* 39: 1039–1059.
- Tittensor, D.P., Baco-Taylor, A. R., Brewin, P., **Clark, M.R.**, Consalvey, M., Hall-Spencer, J., Rowden, A.A., Schlacher, T., Stocks, K., Rogers, A.D. (2009). Predicting global habitat suitability for stony corals on seamounts. *Journal of Biogeography* 36 1111–1128.
- Parker, S.J.; Penney, A.J.; **Clark, M.R.** (2009) Detection criteria for managing trawl impacts on vulnerable marine ecosystems in high seas fisheries of the South Pacific Ocean. *Marine Ecology Progress Series* 397: 309–317. [Doi: 10.3354/meps08115].
- Clark, M.R.** (2009). Deep-sea seamount fisheries: a review of global status and future prospects. *Latin American Journal of Aquatic Research* 37(3). 501–512.
- Clark, M.R.**; Rowden, A.A. (2009). Effect of deepwater trawling on the macro-invertebrate assemblages of seamounts on the Chatham Rise, New Zealand. *Deep Sea Research I* 56: 1540–1554
- Clark, M.R.**; Rowden, A.A.; Schlacher, T.; Williams, A.; Consalvey, M.; Stocks, K.I.; Rogers, A.D.; O’Hara, T.D.; White, M.; Shank, T.M.; Hall-Spencer, J. (2010) The ecology of seamounts: structure, function, and human impacts. *Annual Review of Marine Science* 2: 253–278
- Clark, M.R.**; Watling, L.; Rowden, A.A.; Guinotte, J.M.; Smith, C.R (2011). A global seamount classification to aid the scientific design of marine protected area networks. *Journal of Ocean and Coastal Management* 54: 19–36. (doi:10.1016/j.ocecoaman.2010.10.006.)
- Clark, M.R.**; Tittensor, D.P. (2010). An index to assess the risk to stony corals from bottom trawling on seamounts. *Marine Ecology* 31(suppl 1): 200–211.
- Yesson, C.; **Clark, M.R.**; Taylor, M.; Rogers, A.D. (2011). The global distribution of seamounts based on 30-second bathymetry data. *Deep Sea Research I*. 58: 442–453 (doi: 10.1016/j.dsr.2011.02.004)
- Rowden, A.A.; Dower, J.F.; Schlacher, T.A.; Consalvey, M.; **Clark, M.R.** (2010). Paradigms in seamount ecology: fact, fiction, and future. *Marine Ecology* 31(suppl1): 226–239.
- Ramirez-Llodra, E.; Tyler, P.A.; Baker, M.C.; Bergstad, O-A.; **Clark, M.R.**; Escobar, E.; Levin, L.A.; Menot, L.; Rowden, A.A.; Smith, C.R.; Van Dover, C.L. (2011). Man and the last great wilderness: human impact on the deep sea. *PLoS ONE* 6(7): e22588. doi:10.1371/journal.pone.0022588
- Clark, M.R.**; Dunn, M.R. (2012). Spatial management of deep-sea seamount fisheries: balancing exploitation and habitat conservation. *Environmental Conservation* 39(2): 204–214
- Clark, M.R.**; Schlacher, T.A.; Rowden, A.A.; Stocks, K.I.; Consalvey, M. (2012). Science priorities for seamounts: research links to conservation and management. *PLoS ONE* 7(1):
- Boschen, R.E.; Rowden, A.A.; **Clark, M.R.**; Gardner, J.P.A. (2013). Mining of deep-sea seafloor massive sulfides: a review of the deposits, their benthic communities, impacts from mining, regulatory frameworks and management strategies. *Journal of Ocean and Coastal Management* 84: 54-67.
- Ardron, J.A.; **Clark, M.R.**; Penney, A.J.; Hourigan, T.F.; Rowden, A.A.; Dunstan, P.K.; Watling, L.E.; Shank, T.; Tracey, D.M.; Dunn, M.; Parker, S.J. (2014). A systematic approach towards the identification and protection of Vulnerable Marine Ecosystems. *Marine Policy* 49: 146–154
- Schlacher, T., Baco, A., Rowden, A.A., O’Hara, T., **Clark, M.R.**, Kelley, C., Dower, J. (2013): Seamount benthos in a Cobalt-rich crust region of the Central Pacific: implications for

conservation challenges posed by future seabed mining. *Diversity and Distributions* 20(5):491–502.

**Clark, M.R.**; Rowden, A.A.; Schlacher, T.; Guinotte, J.; Dunstan, P.; Williams, A.A.; O'Hara, T.; Watling, L.; Niklitschek, E.; Tsuchida, S. (2014). Identifying Ecologically or Biologically Significant Areas (EBSA): a systematic method and its application to seamounts in the South Pacific. *Ocean and Coastal Management* 91: 65-79.

Wedding, L.M., Reiter, S.M., Smith, C.R., Gjerde, K.M., Kittinger, J.; Friedlander, A.M., Gaines, S.D., Clark, M.R., Thurnherr, A., Hardy, S., Crowder, L. (2015). Protecting the Common Heritage of Mankind: exploitation of the deep seabed. *Science* 349 (6244): 144-145.

#### Peer reviewed books, book chapters, books edited

**Clark, M.R.**, Koslow, J.A. (2007). Impacts of fisheries on seamounts. Chapter 19. p. 413–441 In: Pitcher, T.J., Morato, T., Hart, P.J.B., Clark, M.R., Haggan, N. Santos, R.S. (eds). *Seamounts: ecology, fisheries, and conservation*. Blackwell Fisheries and Aquatic Resources Series 12. Blackwell Publishing, Oxford. 527 pp.

**Clark, M.R.**, Vinnichenko, V.I.; Gordon, J.D.M.; Beck-Bulat, G.Z.; Kukharev, N.N.; and Kakora, A.F. (2007). Large scale distant water trawl fisheries on seamounts. Chapter 17. p. 361–399. In: Pitcher, T.J., Morato, T., Hart, P.J.B., Clark, M.R., Haggan, N. Santos, R.S. (eds). *Seamounts: ecology, fisheries, and conservation*.

Consalvey, M.; **Clark, M.R.**; Rowden, A.A.; Stocks, K.I. (2010). Life on Seamounts. Chapter 7 in: McIntyre, A.D. (ed). *Life in the World's Oceans: diversity, distribution, and abundance*. Wiley Blackwell, U.K. p. 123–138.

**Clark, M.**; Smith, S. (2013). Environmental management considerations. Chapter 3. pp. 27-42. In: Baker, E., Bedouin, Y. (eds.). 1A. Deep Sea Minerals: Sea-floor massive sulphides-a physical, biological, environmental, and technical review. SOPAC- GRIDArundel.

**Clark, M.** (2013). Biology associated with cobalt-rich ferromanganese crusts. Chapter 2. pp. 15-22. In: Baker, E., Bedouin, Y. (eds.). 1C. Deep Sea Minerals: Cobalt-rich ferromanganese crusts-a physical, biological, environmental, and technical review. SOPAC- GRIDArundel.

**Clark, M.R.**; Consalvey, M.; Rowden, A.A. (eds) (2016). Biological sampling in the deep sea. Wiley-Blackwell, Oxford. 437 p.

#### Refereed conference proceedings

Rowden, A.A.; **Clark, M.R.**; Consalvey, M. (2009). The biological science required to support deep-sea mining and ocean management of New Zealand's EEZ. Proceedings of the AusIMM New Zealand Branch conference 2008.

**Clark, M.R.**; Rowden, A.A.; Schnabel, K.; Tracey, D.M. (2010). Deep-sea benthic sampling in the Kermadec region: past, present, future. Pp. 56–58. In PEW Environment Group (comps). Proceedings of DEEP: talks and thoughts celebrating diversity in New Zealand's untouched Kermadecs, August 30-31 2010. Wellington, New Zealand.

Lamarche, G.; **Clark, M.** (2013). Enabling management of offshore mining through improved understanding of environmental impacts – a New Zealand perspective. In: Pacific Economic and Cooperation Council (PECC) (ed) PECC International Project 2011-2012. Sustainable Management of Marine Resources. Seminar 3: Management of Deep Sea Marine Resources and Oceans as a Means of Communication, p 153-165.

#### Other forms of dissemination (reports for clients, technical reports, popular press, etc)

**Clark, M.R.**; Kelley, C.; Baco, A.; Rowden, A. (2011). Fauna of cobalt-rich ferromanganese crust seamounts. *International Seabed Authority Technical Study No. 8*. 83 p

**Clark, M.R.**; Williams, A.; Rowden, A.A.; Hobday, A.J.; Consalvey, M. (2011). Development of seamount risk assessment: application of the ERAEF approach to Chatham Rise seamount features. *New Zealand Aquatic Environment and Biodiversity Report No. 74*.

Baird, S.J.; Tracey, D.; Mormede, S.; **Clark, M.** (2012). The distribution of protected corals in New Zealand waters. *NIWA Client Report WLG2012-43*. 93 p.

Dunn, D.C.; **Clark, M.**; Sutton, T.; Halpin, P.N.; Bernal, P. (2013). Bringing the deep pelagic zone into the light. *GOBI Newsletter, August 2013*. 5-6.

**Clark, M.R.**; Tsuchida, S. (2013). Scientists explore New Zealand's deep sea (Parts I and II). Scientific American blog site. [http://blogs.scientificamerican.com/expeditions/2013/11/25/scientists-explore-new-zealands-

<b>Previous research work</b>
<p><b>Research title:</b> Seamount biodiversity  <b>Principal outcome:</b> Improved knowledge on seamount biodiversity, levels of endemism, conservation needs  <b>Principal end-user and contact:</b> MPI (Livingston, Cryer), DoC (Angus), CoML (Ausubel)</p>
<p><b>Research title:</b> Orange roughy stock assessment  <b>Principal outcome:</b> Knowledge on status of stocks, and introduction of management (e.g. quota changes) where appropriate  <b>Principal end-user and contact:</b> MPI (Mace, Sullivan)</p>
<p><b>Research title:</b> High Seas fisheries  <b>Principal outcome:</b> Recommendations on research data needs and management options for fisheries in international waters, including SPRFMO. To ensure sustainability of deep-sea fisheries and habitat conservation.  <b>Principal end-user and contact:</b> FAO (Sanders), MPI (Willing, MFAT (Riding).</p>
<p><b>Research title:</b> International deepwater fisheries development  <b>Principal outcome:</b> Improved development of deepwater fisheries in other countries  <b>Principal end-user and contact:</b> Namibian Ministry of Fisheries, Irish Marine Institute, Chilean Directorate of Fisheries, Peruvian Ministry of Fisheries</p>
<p><b>Research title:</b> Environmental Risk Assessment  <b>Principal outcome:</b> Development of risk assessment methodology for deepwater fisheries in New Zealand, and analysis of seamounts and protected corals.  <b>Principal end-user and contact:</b> MFish (Livingston, Cryer, Ford), Deepwater Group (Clement, Wells), DoC (Angus, Arlidge)</p>
<p><b>Research title:</b> Management of mining impacts  <b>Principal outcome:</b> Description of biodiversity associated with mineral resource habitats, and development of environmental baseline and impact assessment guidelines for various minerals resources.  <b>Principal end-user and contact:</b> Neptune Minerals (Feenan, Turner), International Seabed Authority (Odunton), SOPAC (Swaddling, Tawake), GridArundel (Beaudoin)</p>
<p><b>Research title:</b> Deep-sea conservation  <b>Principal outcome:</b> 19 seamounts throughout the NZ EEZ closed to commercial trawling and dredging. Sites in SW Pacific nominated as Ecologically or Biologically Significant Areas (EBSAs) to CBD, identification of Vulnerable Marine Ecosystems and criteria.  <b>Principal end-user and contact:</b> MPI (Brodie), CBD (GOBI)-Bernal, Marine Conservation Institute (Norse), FAO (Sanders)</p>

#### **Commercial, social or environmental impact of previous research work**

Dr Clark is active in carrying out research, and ensuring its uptake through publication of results, presentations at conferences, and personal interaction with clients and end-users. Examples include research and commercial consultancy undertaken for other countries developing deepwater fisheries (e.g. Namibia 1996-2000, New Caledonia 1997, Ireland 2001-03, Chile 2002, Peru 2007), member of New Zealand delegation in trans-Tasman deepwater fishery discussions covering several years in the 1990s, member of Irish Research Evaluation Panel (2002, 2003), Head of Secretariat and international Steering Committee for CenSeam (Global Census of Marine Life on Seamounts) science project, lead research programmes in collaboration with the fishing industry on exploratory surveys to develop new orange roughy fisheries (1991, 1992, 1995), provide advice and recommendations to MFish on protection of seamounts in the New Zealand EEZ, invited by the Fishing Industry to contribute to Environmental Assessment workshops for hoki and orange roughy fisheries, invited member of 2 FAO Expert Consultations on high seas fisheries (2006, 2007) and Vulnerable Marine Ecosystems (2007); NZ representative to a CBD Regional Workshop in 2011 to evaluate sites of Ecologically or Biologically Significant Areas; IUCN representative to a United Nations General Assembly Workshop on High Seas fisheries (2011); ISA workshops leading to the development of environmental guidelines for

deep-sea mining (2004, 2006, 2010); extensive involvement with SOPAC in Fiji providing input and training in environmental issues associated with development of deep-sea mineral resources (2011-15).

#### **Demonstration of relationships with end-users**

Dr Clark has helped organise, and lead, several international surveys, including off New Caledonia in 1997, and the Ross Sea in January 2004. Within New Zealand he has been responsible for research on most New Zealand orange roughy fisheries, and has designed and lead over 50 deepwater fish and biodiversity surveys, including chartered commercial fishing vessels, requiring a cooperative approach between scientists and fishing industry. He has made numerous presentations to fishing industry stakeholder groups, and has been invited to industry workshops on benthic habitat protection and MSC certification (Hoki Management Company, Deepwater Fishery Stakeholders Group, Deepwater Group).

He has extensive research experience on the biodiversity associated with deep-sea minerals resources. He lead biological surveys in 2005 and 2007 in collaboration with Neptune Minerals, and with US and other NZ agencies in the 2005 “Ring of Fire” expedition, and 2011 OceanSurvey 2020 voyage to the Kermadec Ridge. He was invited by the International Seabed Authority to participate in 5 workshops related to the establishment of environmental baseline information, monitoring needs, environmental management planning, and requirements for environmental impact assessments. This has been published or used by the ISA in setting their regulations. He is currently working with SOPAC and Pacific Island countries on environmental issues associated with mining operations. This has involved 3 training workshops, and joint work with SOPAC developing guidelines for marine scientific research associated with the prospecting and exploration for deep-sea minerals.

He heads the NIWA research programme on the biology and ecology of deep sea communities, including the impacts of deepwater trawling and mining on their benthos. This and an earlier programme on seamounts has provided information into management of seamounts (including Seamount Closures and Benthic Protected Areas) and proposals in 2011 to the CBD for several EBSAs in the Southwest Pacific. He also leads a 4 year NIWA project “Enabling the Management of Offshore Mining” (MBIE contract CO1X1224) which involves the preparation of guidance on ecological risk assessment, environmental impact assessment, baseline survey requirements, and specific research-focussed projects on ecotoxicity, sedimentation plumes, and benthic faunal sensitivity.

Dr Clark lead the Secretariat of the Census of Marine Life programme on Seamounts, which was one of 14 field projects forming part of a global census of life in the oceans (2005-2011). This necessitated a high degree of communication and collaboration with scientists around the world, as well as with the CoML administration.

He is currently engaged in collaborative deep-sea research with several countries including Japan (JAMSTEC), the UK (University of Aberdeen), China (IOCAS) and the USA (WHOI).

Dr Clark is internationally recognised in deepwater fisheries, and deep-sea ecological research, with invited participation or consultancy work in Canada, New Caledonia, Australia, England, Namibia, Portugal, Chile, and Japan. Recent work has focussed on deep-sea ecology. In 2007-2008 he lead workshop discussions and analyses on methods of designing seamount MPAs in the High Seas (PEW Foundation), in 2012 a working group on Environmental Impact Assessment (International Seabed Authority), and in 2013 he was a member of a small group workshop on High Seas marine issues at the invitation of the Global Ocean Commission in the UK in 2013. He heads an IUCN thematic group on Seabed Mining as part of the Commission on Ecosystem Management.