Malcolm Green, PhD

Director / Estuarine, Coastal & Marine Specialist

Education

Certification as RMA Decision Maker (2010, 2018)

PhD, Virginia Institute of Marine Science, USA (1987)

BSc (1st Class Honours), Marine Science, University of Sydney, Australia (1979)

Experience Highlights

More than 30 years' experience as a coastal scientist, having worked in research and consulting in New Zealand, Great Britain, the USA and Australia

15 years as Principal Scientist (Coastal and Estuarine Physical Processes) and Core Programme Leader (Catchments to Estuaries) at the National Institute for Water and Atmospheric Research (NIWA)

6 years' research at the Bullard Laboratories, Department of Earth Sciences, University of Cambridge

Specialty areas

Estuarine and marine sediment transport

Source-to-sink models

Limits-based management

Risk assessment

Stormwater contaminant modelling

Independent RMA commissioner

Mal has been deeply involved in the shift to limits-based management under the National Policy Statement for Freshwater Management. He led a MBIE-funded NIWA research programme for 6 years that provided the science, information and tools needed for limits-based management of aquatic ecosystems, including estuaries. Mal has developed analytical methods and applied source-to-sea models for calculating catchment contaminant load limits to achieve environmental targets in estuaries. He is currently providing science and modelling support to collaborative planning processes in Southland and Wellington (Porirua Harbour).

Mal has a BSc (1st Class Honours) from the University of Sydney (Australia) and a PhD from the Virginia Institute of Marine Science (USA). Before emigrating to New Zealand, he spent 6 years at the University of Cambridge (UK) researching sediment dynamics in the shallow seas around the British Isles. His current research interests, which have brought him into shallower water, include wave-driven sediment transport in estuaries, boundary-layer flows over shellfish beds, sediment transport in tidal creeks, and methods for predicting decadal-scale estuarine sedimentation.

Mal was awarded the 2009 Kudos Award for Environmental Science in recognition of his leading role in applying science to issues threatening New Zealand's coasts. Mal is very well known in the science community and amongst resource management practitioners as an excellent communicator. He has led large, multidisciplinary teams in innovative applied projects for clients, including Auckland Council, Bay of Plenty Regional Council, the Ministry for Primary Industries and the Ministry for the Environment.

Until recently, Mal was Principal Scientist, Coastal and Estuarine Physical Processes, at NIWA, as well as Leader of NIWA's Catchments to Estuaries core research programme. In 2015, Mal was awarded NIWA's Research Excellence Prize.

Mal is certified as an RMA Decision Maker and recently served as an Independent Commisioner on a panel hearing an application by Port of Napier for resource consents for dredging and wharf construction.

Mal joined Streamlined Environmental in 2016.

Honours/Awards

Member, Science Review Panel, Ministry for the Environment (2016)

2015 NIWA Research Excellence Prize

Winner of 2009 Kudos Award for Environmental Science in recognition of leading role in applying science to issues threatening the coasts of New Zealand

Best presentation, New Zealand Coastal Society Annual Conference, 2008

Paper published in Continental Shelf Research (senior author) top-20 most-cited paper award for the period 2003–2007, Elsevier Science

Paper published in Marine Geology (senior author) in top 10 downloaded from Elsevier Science's website in 2001

W.S. Ocean Systems Award for Best Oceanography paper, NZ Marine Sciences Society Annual Conference, 1993

J.M. Zeigler Outstanding Student Achievement Award, Virginia Institute of Marine Science, 1987

Selected examples of recent experience

Independent commissioner, port expansion (2018). Service on a panel of three convened by Hawke's Bay Regional Council to hear an application by the Port of Napier for resource consents to construct a new wharf, capital dredging to create deepwater access to the Port, maintenance dredging, and occupancy of the CMA.

Kaipara Sediment Mitigation Study, for Northland Regional Council, Auckland Council and Ministry for the Environment (2016–2017). Key role in study conception; led multi-disciplinary, multi-agency project team. Devised methods for predicting change in harbour sedimentation rate and change in seabed muddiness in response to sediment mitigation applied in the catchment. Methods incorporated into a catchment economic model that was used to determine feasibility and cost of achieving sediment objectives in Kaipara Harbour and streams in surrounding catchment.

National Estuary Review, for Dairy NZ (2016–2017). With Cawthron Institute, conducted a wide-ranging review of NZ estuaries, including ecosystem services, functions and values; adverse effects of contaminants; how the National Policy Statement for Freshwater is changing the way we manage estuaries; use of ecological thresholds to inform standards and objectives; methods of determining contaminant load limits; methods for assessing ecological condition; assessment of the trophic state of New Zealand's estuaries; and mitigation case studies.

Marine water quality standards, for Waikato Regional Council (2015–2016). With Cawthron Institute, undertook extensive review of the New Zealand and international literature on estuarine/marine ecological thresholds, covering eutrophication (nitrogen and phosphorus, chlorophyll a, dissolved oxygen and pH), sediments (suspended-sediment concentration, visual clarity, light penetration, light for seagrass), water temperature, microbial contamination, toxicants, and emerging contaminants. The information is being used by WRC to develop estuarine/marine water quality standards as part of its review of the Waikato Regional Coastal Plan

Assessment of potential adverse effects of urbanisation on Okura Estuary, for Todd Property Group (2015–2017). Led multi-disciplinary study team, and conducted component of study investigating deposition in the estuary of catchment sediment runoff, accumulation of heavy metals, and connectivity between Weiti and Okura estuaries. Results presented at Auckland Unitary Plan hearings and before the Environment Court.

Member, Modelling Leadership Group, convened by Greater Wellington Regional Council (2016–ongoing) to design an architecture for a suite of models to be used to support the Te-Awarua-o-Porirua Whaitua collaborative catchment planning process under the National Policy Statement for Freshwater Management.

Lead science writer for the Hauraki Gulf Tai Timu Tai Pari Marine Spatial Plan, for Sea Change and Auckland Council (2016). Provided science, including water quality state and trends, SMART objectives and management actions, for inclusion in the Plan.

Member, Science Review Panel, convened by the Ministry for the Environment (2016–2017) to advise on the continued development and extension of the National Objectives Framework under the National Policy Statement for Freshwater Management.

Whangarei Harbour Sediment and *E. coli* Study, for Ministry for Primary Industries and Ministry for the Environment. Key role in study conception; led multi-disciplinary, multi-agency project team. Devised sediment budget for Whangarei Harbour that was incorporated into an economic model that was used to determine feasibility and cost of achieving sediment and E. coli objectives in Whangarei Harbour and streams in surrounding catchment.

Limits-based management of Porirua Harbour, for Greater Wellington Regional Council and Porirua City Council. Sedimentation targets set for Pauatahanui Inlet to achieve a range of environmental objectives; developed a method for calculating catchment sediment load limits to achieve sedimentation targets; harbour and catchment management plans developed and published.

Programme Leader, Cumulative Effects contestable research programme (NIWA), Ministry for Business, Innovation and Employment, 2010–2016 (ca. $2.5m per year). Provision of science, information, models and tools to support limits-based management of aquatic ecosystems, including estuaries, under the National Policy Statement for Freshwater Management.

Programme Leader, Effects-Based Management of Aquatic Ecosystems contestable research programme (NIWA), Foundation for Research, Science and Technology, 2004–2010 (ca. $2m per year). Provision of science, models and tools to support management of aquatic ecosystems, including estuaries, under the Resource Management Act.

Environmental risk assessment, for Auckland Regional Council. Developed environmental risk assessment method. Applied to catchment development at Okura and Whitford. Method successfully defended in Environment Court and now used as benchmark for assessing resource consent applications. Culminated in publication of monograph with ARC staff member (C. Hatton).

Mangroves and communities, for Waikaraka Estuary Managers and Bay of Plenty Regional Council. Developed guidelines and tools to assist community groups managing mangroves.

Southeastern Manukau Harbour / Pahurehure Inlet Contaminant Study, for Auckland Regional Council. Key role in study conception; led multi-disciplinary project team comprising catchment modellers, estuary modellers and marine ecologists. Study part of the 10-year Stormwater Action Plan to increase knowledge and improve stormwater management outcomes in the region. Results ultimately used to assess potential adverse effects of shifting the southern rural–urban boundary.

Tauranga Harbour Sediment Study, for Bay of Plenty Regional Council. Lead role in conception, management and execution of study. Results used to prioritise management practices and develop rules for minimising adverse sediment effects in harbour associated with landuse intensification and change in the catchment and with climate change over the next 50 years.

Central Waitemata Harbour Contaminant Study, for Auckland Regional Council. Key role in study conception; led multi-disciplinary project team comprising catchment modellers, estuary modellers and marine ecologists. Developed innovative model to predict sedimentation and accumulation of heavy metals in bed

sediments of harbour over a 100-year period associated with different stormwater mitigation and heavy-metal source-control scenarios. Results used by ARC to write rules and plan for stormwater.

Kaipara Sand Study for Auckland Regional Council and consortium of sand miners. Led field component of the study, measuring tidal currents, waves and sediment transport in subtidal and intertidal locations around the mouth of the harbour. Data used to develop a quantitative description of sediment-transport patterns in the harbour, informing assessment of effects of sand mining. Data and interpretation presented and defended at Environment Court hearing.

Independent commissioner, mangrove removal. Service on a panel of three convened by Northland Regional Council to hear an application by the Mangawhai Harbour Restoration Society under the Resource Management Act for resource consent to remove mangroves in Mangawhai Harbour, Northland.

Technical expert on Stormwater Action Plan, for Auckland Regional Council. Member of Stormwater Technical Advisory Committee, convened to provide technical oversight to ARC's implementation of a Stormwater Action Plan.

Shellfish contamination early warning system, for Clevedon Coast Oysters. Developed a shellfish contamination early-warning system based on a neural network algorithm.

Desktop tool for predicting urban contaminant runoff, for Auckland Regional Council. Translated the Contaminant Load Model (for predicting urban contaminant runoff) into an executable language for further development and incorporation into a desktop tool for use by regional council staff.

Selected Recent Refereed Journal Articles

Quinn, J. M., Green, M.O., Schallenberg, M., Young, R.G., Tanner, C.C. and Swales, A. (2017). Management and rehabilitation of aquatic ecosystems: introduction and synthesis. *New Zealand Journal of Marine and Freshwater Research*, 51(1): 1–6.

Pritchard, M.P. and Green, M.O. (2017) Sequestration and episodic flushing of suspended sediment from a tidal river: the Wairoa River estuary, Kaipara Harbour, New Zealand. *Continental Shelf Research*, 143: 286–294, doi: 10.1016/j.csr.2016.07.007.

Green, M.O. and Coco, G. (2014) Review of wave-driven sediment resuspension and transport in estuaries. *Reviews of Geophysics*, 52: 77–117, doi:10.1002/2013RG000437.

Green, M.O. (2013) Catchment sediment load limits to achieve estuary sedimentation targets. *New Zealand Journal of Marine and Freshwater Research*, 47(2): 153–180.

Green, M.O. and Hancock, N.J. (2012) Sediment transport through a tidal creek. *Estuarine, Coastal and Shelf Science*, 109: 116–132.

Green, M.O. (2011) Dynamics of very small waves and associated sediment resuspension on an estuarine intertidal flat. *Estuarine, Coastal and Shelf Science*, 93(4): 449–459.

Coco, G., Green, M.O. and Davies-Colley, R.J. (2009) Predicting shellfish microbial contamination using a neural network: towards an early-warning system. *Royal Society of New Zealand Miscellaneous Series*, 71: 71–75.

Selected Book Chapters

Cornelisen, C. and Green, M.O. (2016) Freshwater–marine interactions. In: Jellyman, P.G., Davie, T.J.A., Pearson, C.P. and Harding, J.S., (Eds.), *Advances in New Zealand Freshwater Science*, New Zealand Hydrological Society / New Zealand Limnological Society, ISBN 978-0-473-37603-1.

Green, M.O. (2015) Wave-driven sediment transport in estuaries. Invited article for *Encyclopedia of Estuaries*, M.J. Kennish (Editor), Springer.

Green, M.O. (2008) Predicting decadal-scale estuarine sedimentation for planning catchment development. In: Schmidt, J., Cochrane, T., Phillips, C., Elliot, A., Davies, T. and Basher, L. (Eds.) *Sediment Dynamics in Changing Environments*, IAHS Publication 325, pp. 550–558.

Selected Recent Reports

Green, M.O. and Daigneault, A. (2017) *Kaipara Sediment Mitigation Study: Summary*. Streamlined Environmental, Report NRC1701–1, prepared for Northland Regional Council, Auckland Council and Ministry for the Environment, 63 pp.

Green, M.O., Swales, A. and Reeve, G. (2017) *Kaipara Harbour Sediment Mitigation Study: Methods for Evaluating Harbour Sediment Attributes*. Streamlined Environmental, Report NRC1601–2, prepared for Northland Regional Council, Auckland Council and Ministry for the Environment, 77 pp.

Green, M.O., Phillips, N.R., Cornelisen, C.D., Stewart, M. and Dunsmuir, A.K. (2016) *Contaminants in New Zealand Estuaries: Effects, Sources, Current State, Management and Research Needs*. Streamlined Environmental, Report DNZ1601–1, prepared for Dairy NZ, 210 pp.

Robertson, B.M, Stevens, L., Robertson, B., Zeldis, J., Green, M., Madarasz-Smith, A., Plew, D., Storey, R., Hume, T. and Oliver, M. (2016) *NZ Estuary Trophic Index Screening Tool 1. Determining Eutrophication Susceptibility using Physical and Nutrient Load Data*. Wriggle Ltd, Nelson, 47 pp.

Green, M.O. and Cornelisen, C. (2016) *Marine Water Quality Standards for the Waikato Region – Literature Review*. Streamlined Environmental, Report WRC1507–1, prepared for Waikato Regional Council, 123 pp.

Green, M.O. (2015) *Assessment of Potential Effects of Land Development on Okura Estuary. Estimates of Metal Accumulation in the Estuary*. NIWA Client Report No. HAM2015–114, prepared for Todd Property Group Ltd, September 2015, NIWA Hamilton.

Green, M.O. and Reeve, G. (2015) *Assessment of Potential Effects of Land Development on Okura Estuary. Estuary Sediment Transport Modelling*. NIWA Client Report HAM2015–043, prepared for Todd Property Group Ltd, March 2015, 72 pp.

Green, M.O. and Zeldis, J. (2015) *Firth of Thames Water Quality and Ecosystem Health – A Synthesis*. NIWA Client Report HAM2015–016, prepared for Dairy NZ and Waikato Regional Council, April 2015, 81 pp.

Green, M.O. (2015) *Northland Sediment Study. Whangarei Harbour Sediment Budget*. NIWA Client Report HAM2015–042, prepared for Ministry for Primary Industries, April 2015, 26 pp.

Green, M.O. (2015) *Drivers of Estuary Ecological Health and Water Quality in the Southland Region*. NIWA Client Report No. HAM2015–017, prepared for Dairy NZ and Environment Southland, March 2015, 25 pp.

Green, M.O. (2014) Integrating estuary and freshwater management under the NPSFM. Chapter in Hickey, C.W., Williamson, R.B., Green M.O. and Storey, R.G., *Technical Aspects of Integrating Water Quality Science in the Freshwater and Coastal Environments*. NIWA Client Report HAM2014–082, prepared for Auckland Council, 174 pp.

Green, M.O. and MacDonald, I.T. (2013) The fate of sand extraction pits and mounds. Chapter in Hume, T.M., Gorman, R., Green, M.O., MacDonald, I.T., *Coastal Stability of the South Taranaki Bight – Phase 2 Potential Effects of Offshore Sand Extraction on Physical Drivers and Coastal Stability*. NIWA Client Report HAM2012–083, prepared for Trans-Tasman Resources, October 2013, 135 pp.

Green, M.O., Parshotam, A., Elliott, A.H., Moores, J.K. and Hreinsson, E. (2010) *Project Twin Streams Value Case: Stage 3. Effects of Climate Change on Sediment Generation and Accumulation in the Central Waitemata Harbour and on Stream Erosion in the Project Twin Streams Catchment*. NIWA Client Report AKL-2010-032, September 2010, 39 pp.

Green, M.O. (2007) Central Waitemata Harbour Contaminant Study. *USC-3 Model Description, Implementation and Calibration*. NIWA Client Report HAM2007–167, NIWA Hamilton, 298 pp.