



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

Mal has a wide range of experience in estuarine and marine science, with more than 30 years of experience as a scientist, research programme leader, consultant, educator and communicator. Mal has worked extensively with local authorities and central government providing science support to resource managers, decision makers and policymakers.

Mal was certified as an RMA Decision Maker initially in 2010 and again in 2018.

Recently, Mal served as an independent commissioner on a panel hearing an application by Port of Napier for resource consents for dredging and wharf construction. He has also served on a panel hearing an application for consent to remove mangroves from a Northland harbour.

Mal has wide experience in RMA processes, including conducting studies to support consent applications, involvement in collaborative decision making under the National Policy Statement for Freshwater Management, providing expert witness evidence at local-body and Environment Court hearings, contributing to the Hauraki Gulf Tai Timu Tai Pari Marine Spatial Plan, and mediation.

Mal currently is providing science and modelling support to collaborative planning processes in Wellington (Porirua Harbour), Northland and Auckland (Kaipara Harbour), and Southland.

Specialty areas:

Estuarine and marine sediments, sediment transport, sedimentation.

Estuarine and marine water quality.

Offshore mining.

Dredging.

Stormwater contaminants.

Numerical modelling (sediment transport, waves).

Contaminant limits.

Estuarine and coastal management.

Selected examples of recent experience

Independent Hearing Commissioner, application for port expansion, *Hawke's Bay Regional Council* (2018). Service on a panel of three hearing 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–ongoing). 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 on extension of the northern rural–urban boundary; matter currently before 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 (2016), *Sea Change and Auckland Council*. Provide 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–ongoing) 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, *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, *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, *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, *Waikaraka Estuary Managers*, *Tauranga* and *Bay of Plenty Regional Council*. Developed guidelines and tools to assist community groups managing mangroves.

Southeastern Manukau Harbour / Pahurehure Inlet Contaminant Study, *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, *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, *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 Hearing Commissioner, application for mangrove removal, *Northland Regional Council*. 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, *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, *Clevedon Coast Oysters*. Developed a shellfish contamination early-warning system based on a neural network algorithm.

Desktop tool for predicting urban contaminant runoff, *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.