This is a list of potential research objectives, organised into 5 themes, for possible inclusion in a National Research Strategy for Sediments in the Coastal Marine Area, being prepared for DOC.

The Strategy will identify and prioritise research required to fill gaps in knowledge, information and tools needed to inform and support actions that can be taken by a wide range of stakeholders under the RMA to variously reduce, mitigate and control the impacts of sediments on marine, coastal and estuarine ecosystems.

The document that you are now reading accompanies a Survey Monkey designed to elicit opinions on which of the potential research objectives listed below are high priority.

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THEME Coastal ecosystems

OBJECTIVE Biological, ecological and physical effects of sediment

Understanding of the biological, ecological and physical effects of sediment is the foundation of our response to the sediment threat. Although we have made good progress, there are still significant unknowns regarding sediment impacts on **coastal fisheries, birds, rocky reefs, kelp beds, microphytobenthos and macroalgae**. We also lack understanding of effects on **taonga** at the rohe scale, including in the context of human use, for example, **manaakitanga**. At a higher level, we need better understanding of effects on **ecosystem functionality**, including effects of fine sediments on light reduction on **subtidal and intertidal productivity** and the effects on **nutrient "carrying capacity"**. We need to identify **thresholds** in ecological and biological responses to sediment stress, including ecological and species thresholds for suspended sediments, and thresholds for **human amenity**. We need to understand tolerances of mid-water-column filter-feeders and visual predators to **suspended fine sediments**, and we need to extend work on **sediment dumps** to macroalgae, hard bottoms and inner-shelf subtidal habitats. Research should account for **multiple-stressor interactions**, including interactions of sediments with nutrients and with human use. Research should not focus exclusively on effects of catchment sediment: we also need to understand effects of **resuspended native marine sediment** and effects of dumping of **dredge spoil**.

OBJECTIVE Climate change

Climate change will exacerbate the adverse effects of sediments in the coastal marine area; reducing sediment impacts will improve ecosystem resilience and their capacity to adapt. To prepare, we need improved understanding of the effects of climate change on **functionality and resilience** of sediment-stressed systems. A potentially significant threat that we have limited understanding of is the ecological, physical and amenity consequences of loss of **marginal, depositional habitats** under

sea-level rise; models that forecast the effect of sea-level rise on **shoreline erosion and estuary hydrodynamics** will help us plan for the threat. Improved understanding of the way **marine heatwaves** modulate sediment impacts may inform management "safety margins".

OBJECTIVE Natural state

We need knowledge of the **natural (pre-catchment deforestation) state** to assess trends, interpret indicators of health and stress, set rehabilitation and restoration goals, and specify objectives. To apply the ANZECC sedimentation guidelines, we need to know **pre-deforestation sedimentation rates** in different parts of estuaries (e.g. upper reaches verses open tidal flats), and in subtidal coastal environments.

OBJECTIVE Requirements for freshwater

We need to understand the **requirements of coastal ecosystems for freshwater**.

THEME Management

OBJECTIVE Limits

The **case for taking a limits-based approach to managing sediments** in the CMA is not settled and needs to be critically evaluated. We also need to reappraise the case for **National Objectives Framework for the CMA**. Limits-based management centres on deciding objectives and then determining limits needed to achieve those objectives. There are fundamental issues associated with **objective** setting that need to be resolved, including accounting for spatial and temporal variability, incorporating thresholds and taking account of current state. We need simple methods for setting **sediment load limits**, which will include using mass–balance source-to-sink models, and those methods need to account for **legacy sediments**. We need to derive principles for **adaptive management frameworks** around sediment load limits, and be able to **translate sediment load limits into plan rules**.

OBJECTIVE Monitoring

Monitoring underpins effective management. Following recent ANZECC guidance, sedimentation rate is becoming an increasingly important metric, however we need **new methods for measuring sedimentation rate** that are suitable for energetic and subtidal habitats and less prone to operator error than sedimentation plates. We also need **cost-effective and practical methods** for monitoring sediments in open-coast kelp forests, mapping soft-sediment seabeds, quantifying seabed mud content, and mapping and characterising turbidity. To engage the public and make use of a potential significant resource, we need to develop opportunities for **citizen scientists** to contribute to SoE and other types of monitoring. **Interactive, online tools** for displaying regional council sediment monitoring information are needed; this may include presenting ecological/physical monitoring data in the context of **ecosystem services** to aid understanding.

OBJECTIVE Policy, planning and decision-making

Policy, planning and decision-making are at the critical interface between science and action. There are **institutional issues** that need to be addressed, including identifying and overcoming obstacles to DOC, MFE, regional councils and Treaty Partners working together in a coordinated way, and looking at whether science capacity and capability are limiting our ability to manage sediments. We already have some good **spatially explicit, integrated physical–ecological–economic catchment-scale models** for scenario testing and decision-making, but these need to incorporate new knowledge on

links between sediment metrics and ecological response, and they can be improved and complemented by new methods for **cost-benefit analyses** that also incorporate **non-market valuation** of ecosystem goods and services. There is scope for **innovative thinking**, for example, developing policy and informing decision-making by exploration of the counterfactual; charging money to discharge sediment; and developing environmental certification processes, e.g. for international marketing . We also need to be continually evaluating the **effectiveness of implemented policy** and looking for **policy gaps**.

OBJECTIVE Consenting and compliance

Regional councils require guidance and standardised procedures for consenting and compliance, including uniform exception-based procedures for council officers evaluating **consent applications**, and guidelines for producing robust, consistent and comprehensive **AEEs** for evaluating direct and cumulative sediment effects . Guidance for putting sediment load limits into **discharge and landuse consents is needed**.

THEME People

OBJECTIVE Social research

For all the science and technology, people are still at the heart of this mahi. We need better ways of **story-telling** to engage and motivate the public. To change people's behaviour, we need to understand their **values and perceptions of sediment issues** and how they are **personally** and intimately affected, and we need to understand and use ways to **motivate behaviour change**.

OBJECTIVE Kaitiakitanga/Maanakitanga

Strengthen the active use of **cultural practices** associated with the caring for marine ecosystems that are intimately linked with the ability to sustain and care for their whanau while maintaining their connections the sea.

OBJECTIVE Māori as partners

Provide for and encourage the use of a **foundation in Māori values and the retention of Māori ways of knowing** through the development of novel, innovative and unique knowledges and research. A Māori approach to sustainability research plays an important role in expanding the epistemological background from which future strategies can be developed.

THEME Doing

OBJECTIVE Sediment mitigation

The hard work starts on the land with mitigating sediment runoff. This requires **effective, practical and cheap methods** for reducing catchment sediment loss across different landuses and geology, and ways to identify and cost **best options** and **prioritise implementation**. We should be equipping **catchment management groups** as well as individual landowners. To develop **optimal management strategies** for reducing sediments at source, we need experimental and monitoring studies of **effectiveness of mitigation with respect to outcomes in the CMA**. Being able to demonstrate outcomes will encourage landowners and catchment groups to invest in mitigation and adopt GMPs.

OBJECTIVE Restoration and rehabilitation

Habitat restoration / rehabilitation needs to be planned, prepared for, and monitored. Guidance is required on how to **prioritise** restoration. To plan properly and manage expectations, we need to understand **recovery trajectories and timeframes**. We need guidance on **minimum conditions for successful intervention**, and when habitats are beyond repair. **Innovative and practical methods** for restoring and rehabilitating seagrass meadows, shellfish beds and rocky reefs are required, which may be informed by mātauranga Māori. Restoration methods need to recognise and accommodate for the fact that it may take significant time to reduce catchment sediment runoff, or even that it may not be possible in some places. We should take opportunities to explore the use of **aquaculture** to aid in habitat restoration.

THEME Tools

OBJECTIVE Source attribution

Source attribution facilitates the effective targeting of mitigation measures. It also provides basic information needed to set up source-to-sea sediment models, which can be used to plan catchment sediment load limits. Compound-specific stable isotope sediment tracing is a powerful tool that has been used to widely to good effect, but it needs more **validation** against data. New tools for source attribution at the scale of **individual activities and land parcels** are needed to really fine-tune targeting of mitigation. New tools (analytical, geochemical, biological) will also provide **converging lines of evidence**.

OBJECTIVE Sediment loads, delivery and fate

The cornerstone of management and analysis – assessment of effects, consent decision-making, planning, cost–benefit analysis – is being able to predict how much sediment is lost from the land under different circumstances and where it ends up in the CMA. Although we have good annual-load models, we lack **event-scale load models**, which are needed to predict event-scale adverse effects, such as smothering, and longer-timescale models to predict **estuary infilling**. We need to able to partition total loads into **constituent-grainsize components**, especially the finer grainsizes, which are the most ecologically and biologically damaging. Although there are numerous sophisticated numerical hydrodynamic and noncohesive-sediment transport models, **cohesive-sediment transport and flocculation** are not well understood, which significantly affects our ability to predict sediment fate in the CMA. To complement the sophisticated models we need **simple quantitative methods**, including sediment budgets, for estimating sediment dispersal, deposition and retention in the CMA. **Climate change** will bring rising sea level and changes to wind and rainfall patterns; sediment runoff, delivery and accumulation in the CMA will be affected. To plan for the future, we need models that can account for this.

OBJECTIVE Indicators, risk, drivers, calculators, guidance

Tools assimilate and organise the science to make it usable. We need improved and extended guidance on how to apply ANZECC guidelines for sedimentation. We need **indicators of mauri** at a local level based on mātauranga Māori for ecological and cultural health assessments. We need tools for assessing and mapping **risk, threat and vulnerability**, which includes ways to distinguish between **natural and anthropogenic components of sediment stress**. We also need a better understanding of **natural variability** to better distinguish between stressed and non-stressed systems. We need ways to cope with numbers, for example, **methods for translating sediment loads and concentrations in freshwater runoff into sediment metrics** such as sedimentation rate and visual clarity, and **back-of-**

the-envelope calculators for reality-checking of models and measurements. We need methods for assessing and managing **freshwater flow requirements**.

OBJECTIVE Performance assessment

We need to learn from experience and success stories – **what worked and what didn't?** This includes learning from **consent monitoring of large developments** such as the Transmission Gully Motorway and the Okura Estuary subdivisions. Experimental and monitoring studies of the **effectiveness of sediment mitigation with respect to outcomes in the CMA** are required.

OBJECTIVE National databases and datasets

We need guidelines for the **minimum requirements for national datasets**; an open-access, **national database of sedimentation-plate data**; and a **Mendeley** library of New Zealand references (peer-reviewed and grey literature) that agencies and researchers can access and contribute to.