# Enhancing the capacity for prediction and management of the environmental impacts of major capital dredging programs in Western Australia

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Dredging is a critical and costly component of most major marine infrastructure developments in Western Australia's coastal waters. There are many examples of dredging programs that have been undertaken, are planned or in progress in WA that are significant by world standards. Sediments generated by dredging can have widespread impacts on marine environments and large-scale dredging proposals are therefore subject to environmental assessments, approvals and regulatory processes, which rely on predictions of impact and strategies to monitor and manage those impacts. There is, however, surprisingly little convincing information in the scientific literature that can be used to make scientifically sound predictions of the likely extent, severity and persistence of environmental impacts associated with dredging or efficiently and effectively monitor and manage impacts during dredge operations. This generates uncertainty that can cause delays through the assessment and approvals processes and lead to onerous and costly regulatory regimes.

The Western Australian Marine Science Institution (WAMSI) is a joint venture partnership comprised of the Western Australian State Government, the Australian Institute of Marine Science (AIMS), the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the Bureau of Meteorology, Curtin University of Technology, Edith Cowan University, Murdoch University, and the University of Western Australia. WAMSI's Dredging Science Node has conducted world-class marine research to enhance capacity within government and the private sector to predict and manage the environmental impacts of dredging in Western Australia and in turn deliver outcomes to increase the confidence, timeliness and efficiency of the assessment, approval and regulatory processes associated with dredging projects. Eighty-one scientists from ten collaborating research organisations were supported by AUD$19 million in funding. The program also included a unique cross-sectoral collaboration between government and industry, which provided AUD$9.5 million invested by Woodside, Chevron and BHP as environmental offsets. In addition to the funding provided, our industry partners generously shared hundreds of millions of dollars of environmental monitoring data. By providing access to this usually confidential data, Woodside, Rio Tinto Iron Ore and Chevron enabled WAMSI researchers to better understand the real-world impacts of major dredging projects, and therefore how they can best be managed.

The Dredging Science Node addressed nine broad themes of inter-disciplinary research under four broad categories delivered through a combination of reviews, field studies, laboratory experimentation, relationship testing and development of standardised protocols and guidance for impact prediction, monitoring and management.

Themes included:

(1) Review and consolidation
    a. Review and consolidation of available environmental data collected for dredging projects
(2) Pressure field prediction and characterisation
    a. Predicting and measuring the characteristics of sediments generated by dredging
    b. Characterisation and prediction of dredge-generated sediment plume dynamics and fate
(3) Ecological response prediction
    a. Defining thresholds and indicators of Coral response to dredging-related pressures
    b. Defining thresholds and indicators of Primary Producer response to dredging-related pressures

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c. Defining thresholds and indicators of Filter Feeder responses to dredging-related pressures

(4) Critical ecological processes and windows
   a. Effects of dredging-related pressures on critical ecological processes for Coral
   b. Effects of dredging-related pressures on critical ecological processes for Finfish
   c. Effects of dredging-related pressures on critical ecological processes for Other Organisms (including potential to facilitate the establishment of invasive species)

Information from field and laboratory based studies will be presented and the development of thresholds for corals, primary producers and filter feeders discussed in the context of dredging in the North-West of Western Australia.

The following major outcomes were achieved:

- Improved understanding of near-field and far-field source terms, their usage in environmental impact assessment and management, how they can be better estimated and expressed, and recommendations for continual improvement
- Guidance on contemporary approaches to predicting the pressure fields associated with dredging; including background conditions, deposition and resuspension
- Quantification of the temporal and spatial patterns in the intensity, duration and frequency of turbidity and suspended sediment pulses associated with actual dredging campaigns in the north-west of Western Australia and flow on effects to light availability and sediment deposition
- Quantification of changes in light quality and quantity underneath plumes and development of an *in situ* sediment deposition sensor
- Guidance on contemporary approaches to sediment transport modelling including; the importance of bathymetry resolution, efficacy of 2D vs 3D models, nearfield modelling and far field modelling; accounting for the effects of benthic communities on sediment deposition and resuspension; remote sensing of turbid plumes for model validation, environmental management and compliance reporting
- Corals – the relative significance of suspended sediment concentrations, light attenuation and sediment deposition on the health and survival of five coral taxa, with differing morphologies and commonly occurring in the north-west of Western Australia; critical thresholds of sediment deposition and light availability based on laboratory experiments and analyses of industry monitoring data on coral health, survival and recovery potential;
- Seagrass – knowledge of the spatial and temporal patterns in seagrass biomass including seasonality, inter-annual variability and recruitment processes for three commonly occurring species in north-west of Western Australia; the relative significance of sediment deposition and light attenuation associated with dredging plumes on seagrass health; thresholds of sediment deposition and light-related effect and mortality
- Sponges – characterisation of the sponge taxa present in the north-west of Western Australia through analysis of museum records and field collections, development of field guides for sponge identification; the relative significance of suspended sediment concentrations, light attenuation and sediment deposition on the health and survival of five sponge taxa, with differing morphologies, nutritional pathways and commonly occurring in the north-west of Western Australia, based on laboratory experiments, field studies and analyses of industry monitoring data on sponge health the prevalence of phototrophic sponges
- Coral spawning – temporal environmental windows of key life cycle processes in the north-west of Western Australia; understanding the pathways by which dredging generated turbidity and sediment deposition affects coral reproduction, fertilisation, larval development and settlement; critical suspended sediment concentration thresholds of effect for impact prediction and dredging management
- Temporal environmental windows of sensitivity for macroalgae, fish and invertebrates that allow projects to be planned to avoid periods that are critical to their health and survival.

This work is of global significance and presents a summary of a significantly large new body of scientific literature. The results and implications of this research has utility across the dredging industry and should be of significant interest to environmental managers of large dredging campaigns.