Dredging, dumping and the **Great Barrier Reef**

Dredge plume from dredging at Abbot Point in 2008 where 300,000 m3 of sediment was removed. (Note this is one tenth of the capital dredging recently approved for the Abbot Point expansion)

<Credit: NQBP PER>

INTRODUCTION

The Great Barrier Reef is under threat from massive new industrial developments along its coastline. The proposed expansion of coastal ports and industrial development is unprecedented in the Reef's history. This will see a near doubling in shipping, major coastal reclamation works, and massive seabed dredging and dredge spoil disposal – all either immediately adjacent to, or within the Great Barrier Reef World Heritage Area.

The impacts of dredging and the dumping of dredge spoil are of particular concern to many people who have an interest in the future health of the Reef. This report provides an overview of what dredging involves, the current status of dredging projects along the Reef's coast and the latest research on the impacts of dredging and dumping.

What is dredging?

Dredging is undertaken in coastal waters so that large ships can access ports. Dredging involves cutting away large swathes of seafloor, lifting or sucking it up and dumping it somewhere else – usually into deeper water further out to sea or to "reclamation" areas where sea is turned into land.

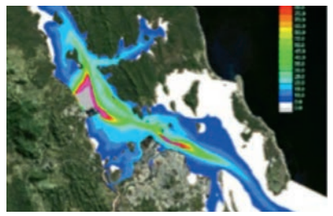
Dredging can either be capital or maintenance. *Capital dredging* is the removal of an area that has not been dredged before. Capital dredging creates new or enlarges existing shipping channels, berths or terminals where ships load and unload, marinas and boat harbours and areas where the ships turn known as swing basins.

Maintenance dredging is the removal of sediment from already dredged areas. As the ocean's currents are continually moving sediment around and river flooding delivers sediment from the catchments into estuaries where many ports are located, areas that are dredged often require maintenance dredging. Maintenance dredging typically occurs every one to five years (depending on the area) and although not as large as capital dredging can add up over the years. For example the proposed shipping channel in Cairns, which will require five million cubic metres of capital dredging, will require 580,000 m3 per year of maintenance dredging [(1)] to keep the channel at the necessary depth.

There are a number of different types of dredges. Mechanical dredges such as bucket, grab or backhoe dredges with large cutting blades involve mechanically scooping sediment from

PROPOSED Gladstone dredge plume

Western Basin Dredging EIS Appendix K 'Numerical Modelling Studies' p.4-16



ACTUAL Gladstone dredge plume

Petus, C., and Devlin, M. (2012). Satellite maps of actual dredging. Reef Research Group, James Cook University

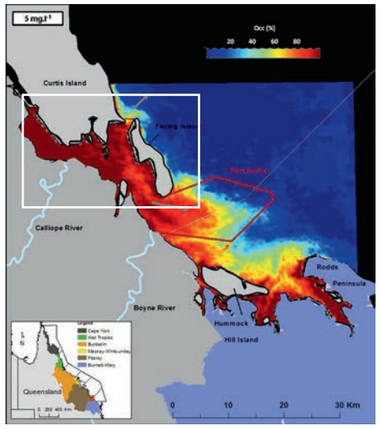


Figure 1a

the seabed and are generally used at a fixed point. Hydraulic dredges such as suction hopper, cutter suction and trailing suction hopper dredges are usually more mobile and suck the sediment up from the sea floor. Water injection dredges move sediment by injecting water into it so that it becomes fluid and is moved either by gravitational forces or by currents.

Some dredgers use piles driven into the seabed to hold them in position while dredging occurs. In each case the machinery is loud and disruptive to inshore marine life, especially marine mammals such as dolphins and whales, which rely on sound to communicate.

THE IMPACTS

When an area is dredged the seabed, any seagrass and marine animals living on the sea floor in the dredged area are totally eradicated. Dredging can also cause the direct death of larger mobile species such as turtles by being drawn into the path of the dredgers [2].

Dredging can also stir up toxic chemicals, such as heavy metals, that have settled and become trapped by the sediments. Ports are exposed to a range of pollutants through land run off, leaching of anti-fouling paints from shipping hulls and chemical spills. For example at the port of Abbot Point, sandblasting waste, including paint, was released into the ocean for several months in 2010. The paint released had zinc, chromium and other heavy metal contaminants in it [3], which can be toxic to marine life in high doses.

Dredging causes the water around the area to become cloudy for days to weeks. It also creates dredge plumes which can travel great distances and be highly concentrated, which is often underestimated by the computer modelling used in environmental impact assessments (Figure 1/1a on Gladstone dredge plume which travelled much more than modelled and also was much more concentrated).

Sediment plumes reduce the light available for seagrass and coral to grow and can hinder the reproduction of coral [4]. Good light is essential to the survival and health of these underwater plants and animals, which in turn support many other animals of the Reef. Healthy seagrass beds, for example, are the main source of food for threatened animals like dugongs.
Dredge spoil that is dumped in offshore waters causes a further wave of problems as finer sediments become suspended in the water. These suspended sediments are then transported by currents (wind, tidal and ocean currents), drifting for kilometres before settling again on the seabed which can include seagrass beds and corals, potentially smothering them. A study released by the Great Barrier Reef Marine Park Authority [5] in 2013 suggests these fine sediments may drift up to 80 kms away from the dumping site.

The dumping of dredge spoil is not a one-off problem. Once dumped the finer sediments of the dredge spoil will be churned up and re-suspended many times over, potentially affecting the water quality for years. Two years after dredging occurred at Hay Point, corals at Victor Islet (6kms away) were still being impacted by the sedimentation caused by the dredging operation [6]

Sediment on coral at Victor Island after dredging at Hay Point in 2006 (Smith 2007)

These impacts and the flow-on effects may be immediate (within days) or long term (months to years) and may be temporary or permanent in nature.

DREDGING PLANS FOR THE GREAT BARRIER REEF

There are twelve existing ports alongside the Great Barrier Reef and about 4000 port calls by large ships per year [7].

As a result of major expansion in the mining and coal seam gas industry, there are plans for either large expansions to major trading ports or creation of new ports, in most cases requiring significant amounts of dredging and dumping in the reef's waters. The proposals currently on the drawing board include further expansion at Gladstone, new developments in the Fitzroy Delta, major expansions for Mackay, Abbot Point (north of Bowen) and Townsville ports, and a new port at Bathurst Bay on Cape York Peninsula.

There is also a proposal for a large cruise ship terminal at Trinity Inlet which will also require significant dredging. Known projects are listed in Table 1 and are in the planning stage, undertaking environmental impact assessments, awaiting approval or final investment decisions.

If they all proceed, these developments would result in approximately 83 million cubic metres of dredging in the Reef's waters. When cubic metres are converted to tonnes (on the basis of 1.8 sediment density [8]) this equates to over 149 million tonnes dredging.

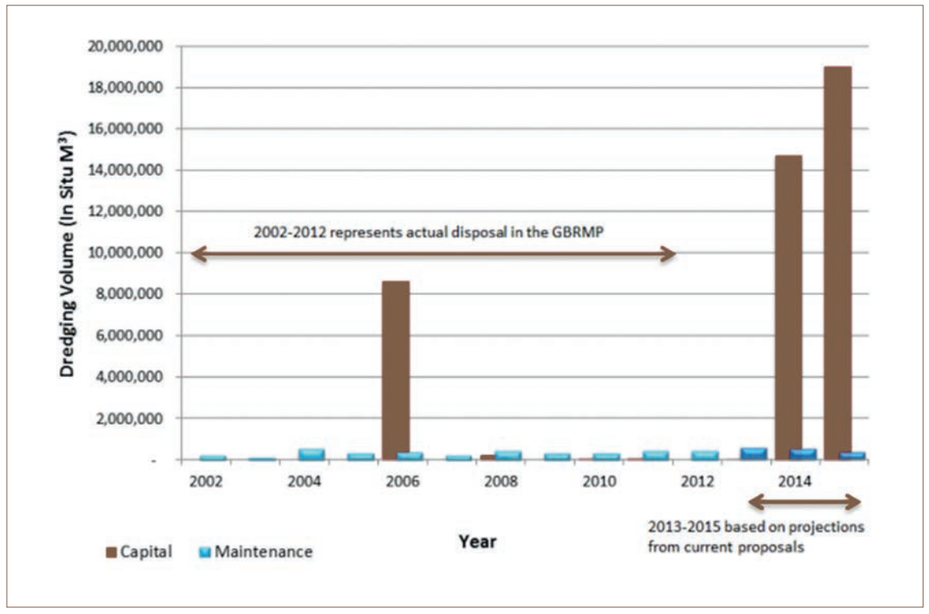
Table 1 An overview of the current port expansions and channel deepening and the associated dredging proposals planned or underway for the Great Barrier Reef.

Port [5]	Nature of development	Current status	Proposed dredging (cubic metres)	Issues of Concern
Wongai (Cape York)	New coal loading facility using barges and transhipping at Bathurst Bay near Princess Charlotte Bay. There is no infrastructure there at present.	EIS in preparation; Qld Government designated significant project	unknown	This would involve construction of a completely new port. Coal would be transferred within the marine park in deep water to coal ship. The northern section is the most pristine section of the Great Barrier Reef WHA. Very important dugong population / habitat. Limited dredging expected.
Cairns (Trinity Inlet)	Dredging in Cairns Harbour and Trinity Inlet to facilitate large cruise ships direct access to Cairns	EIS in preparation; Qld government funding commitment of $40 million	5,000,000	Seagrass in Cairns harbour already in severe decline. Will require ongoing annual maintenance dredging of some 260,000 tonnes.
Townsville	Major expansion of Port of Townsville to double its size involving dredging a new channel within 1.6km of Magnetic Island.	Supplementary EIS in preparation	10,000,000	Cleveland Bay is a particularly shallow andsheltered bay and dugong protection area so dredging is likely to have significant impacts. Expansion will require ongoing annual maintenance dredging. 5 million cu m to be dumped in Reef waters, 5 million cu m to be used for reclamation area.
Abbot Point - capital dredging	Major expansion of existing coal port (T1) to allow three new terminals: T0, T2 and T3.	Approved by state and federal governments; under legal challenge; awaiting FID	3,000,000	The current condition of seagrass and corals in this region is considered poor. The coal stock piles will cover a large area of the Caley Valley Wetland, adjacent to beaches where turtles nest.
Abbot Point - further developments	Further expansion plans include the state government proposed Terminal AP-X and waratah coal (if it is not successful in obtaining T2).	AP-X status currently unclear following withdrawal of two preferred suppliers; Waratah coal EIS stage	Unknown; estimated minimum of 13,000,000	If these developments proceed, Abbot Point would become the world's biggest coal port just 50 km from the Whitsunday Islands. This would also see further damage to the Caley Valley Wetlands.
Dudgeon Point	New coal port terminal to be built to add capacity to existing coal ports at Hay Point and Dalrymple Bay	EIS under preparation	14,000,000	Capital dredging program undertaken in 2005/06 affected adjacent coral reefs and seagrass beds (see impact section below). This port is currently the largest in the Reef. If expansion plans take place, it could be the second largest coal port in the world, just south of the Whitsundays. 2011/12 capacity for Hay Point: 62%
Gladstone -Western Basin Dredging Project Stg 2	Stage 1 of this project to facilitate LNG processing and ships in Gladstone Harbour was completed in 2013.	Approved by state and federal governments.	25,000,000	Significant environmental problems have been documented since dredging for Stage 1 of this project began in 2010 but there has been no adequate acknowledgement by authorities of the issues and means to avoid any further damage.
Gladstone - channel duplication	Proposed new shipping channel to facilitate movement of coal and new gas ships in the harbour	EIS under preparation	12,000,000	Gladstone Harbour is a dugong protection area. This will require ongoing annual maintenance dredging.
Arrow LNG gas plant	The fourth gas LNG processing hub on Curtis island requires dredging for the ship terminal.	Approved by state and federal governments; awaiting FID	1,000,000	As above
TOTAL			**83,000,000** (cubic metres)	

*based on conversion rate of 1.8

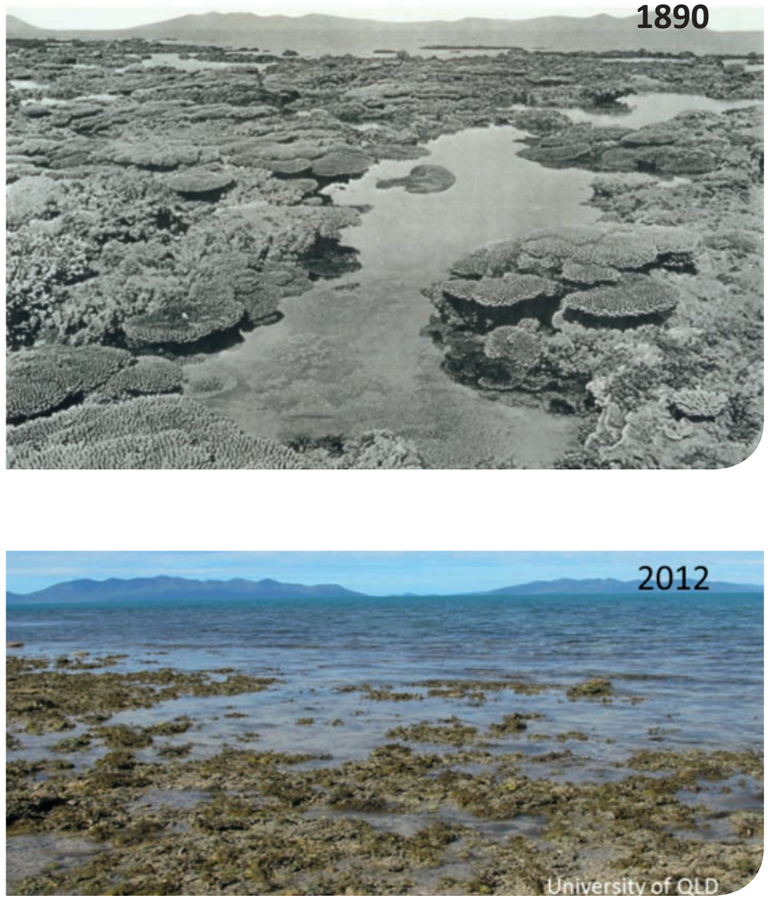
In the past, the level of dredging and dumping was considered relatively small and because the impacts were limited to a few specific locations, the impacts were considered to be a medium risk to the Great Barrier Reef Marine Park. However there has been a marked increase in the past few years in the level of dredging and dumping, with plans for even greater amounts in the pipeline. On average, over the last 10 years, 902,154 cubic metres of capital dredge material and 362,392 cubic metres of maintenance dredge material were disposed each year within the Marine Park [9]. If all plans proceed then there could be a 3000% increase in the dumping of dredge spoil in the Great Barrier Reef World Heritage Area.

The figure below shows the volume of actual historical dredge disposal volumes from 2002 and projected future dredge disposal volumes (up to 2015) to the Marine Park for both capital (new developments) and maintenance dredging [9].

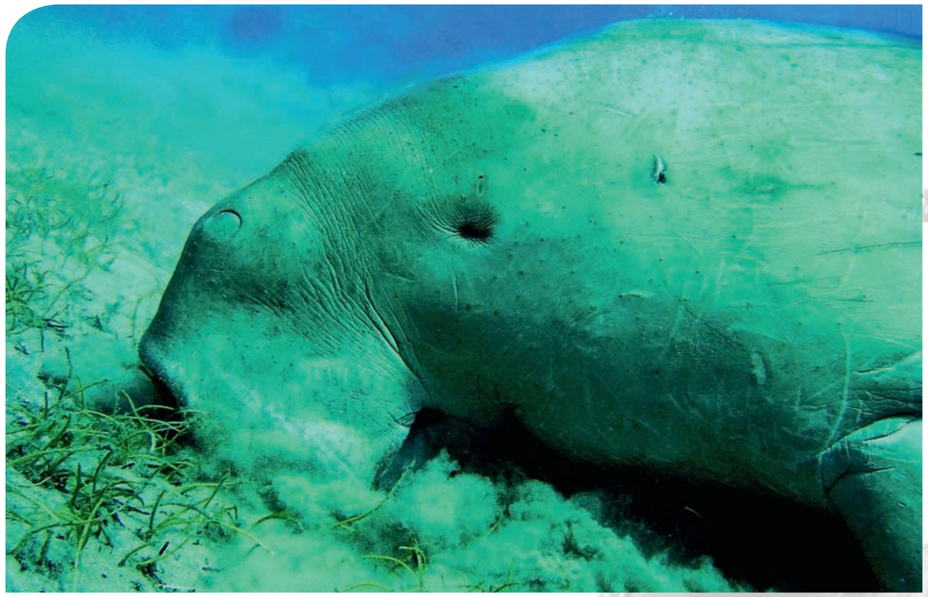


Sources:
GBRMPA (2013) Ports and Shipping Information Sheet, May 2013.

In recent years it has become clear that the health of the Great Barrier Reef is deteriorating and will continue to decline without urgent management intervention [10]. A history of increased nutrient and sediment loads entering the Reef, crown-of-thorns starfish outbreaks and a decade of extreme weather is taking its toll on the Reef. Key habitats such as coral reefs and seagrass meadows are in serious decline and iconic animals like dugongs will be unable to recover without very strong management intervention to improve water quality and seagrass habitat [11].



Inshore coral reef decline
Photographs of the Reef flat at Stone Island, offshore Bowen. These two photos are taken from the same location, the first in 1890 and the second in 2012.



PAST IMPACTS OF DREDGING IN THE GREAT BARRIER REEF

There is a poor understanding of the full impacts that past dredging has had in the Great Barrier Reef. Much of the information available on the impacts of past dredging projects has come from Environmental Impact Assessments (EIA) and monitoring programs, which are undertaken by environmental consultants on behalf of developers (e.g. Port Authorities). These EIAs can underestimate the impacts of a development because of the lack of independent oversight surrounding the process [12]. Consultants are chosen and employed by the proponents who also oversee the design of the EIA. There is obvious potential for conflict of interests with this process. The full monitoring data and experimental design is usually not independently reviewed or made publically available making it difficult to understand if monitoring that occurred was accurate and carried out appropriately [12]. Below we highlight some problems with the monitoring of dredging impacts on the Great Barrier Reef with Hay Point as an example.

Dugong populations will not recover unless very strong management action occurs to improve water quality and seagrass habitat in the Reef.

Hay Point

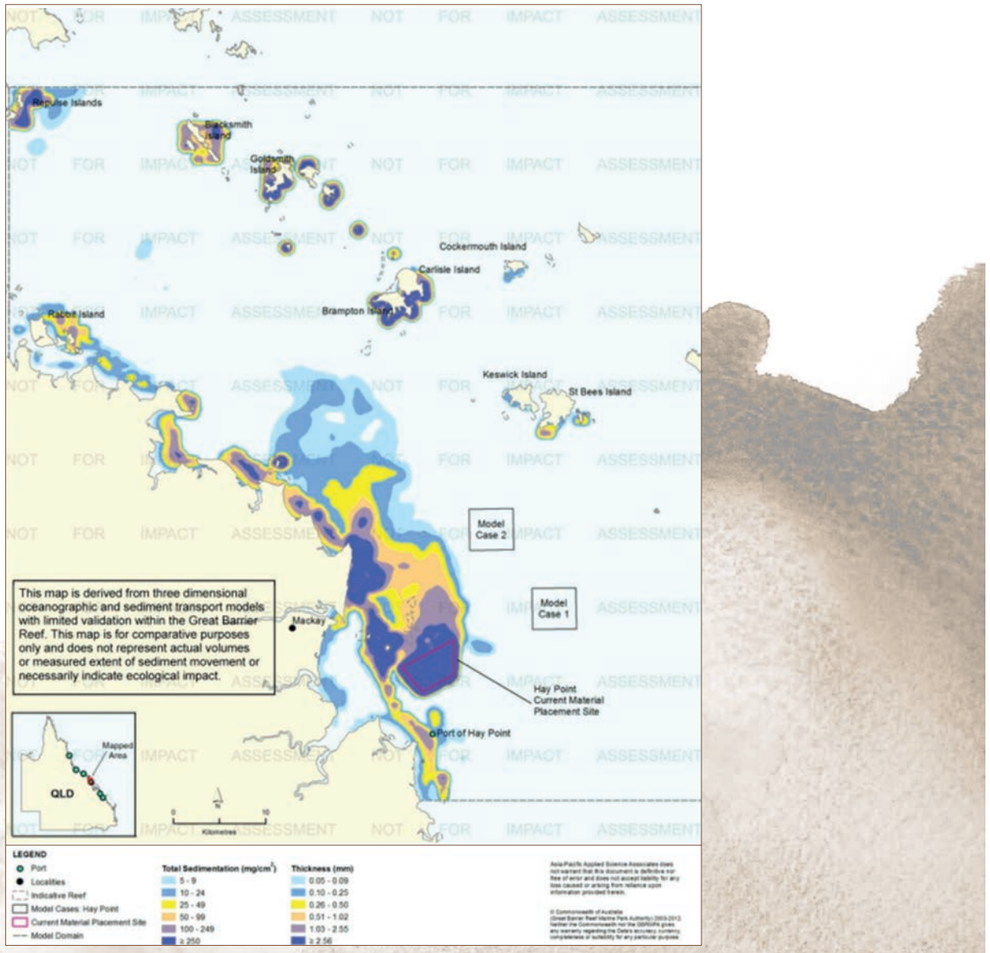
In 2006 North Queensland Bulk Ports (formally Ports Corporation Queensland) dredged 8.3 million cubic metres of seabed at Hay Point Port and dumped it offshore within the Great Barrier Reef Marine Park. Prior to the dredging, a number of study sites were identified to monitor the impact of the sediment. For this particular project these sites were monitored during the dredging and then for 6 months after. North Queensland Bulk Ports (NQBP) has stated that there were no significant or long term environmental impacts from the dredging apart from increased water turbidity during the dredging [13]. However to be able to make a meaningful claim about the nature of environmental impacts requires effective monitoring programs over an extended period. A review of the monitoring at Hay Point has revealed significant problems, and therefore potentially erroneous claims from NQBP.

Problem 1: *Control sites were not out of the reach of the dredge material.*

Control sites are used in monitoring programs to ensure that any changes documented are change are due to the impact of an action being assessed (e.g. decrease in coral health because of dredging) and not due to something else (e.g. water temperature rise). Control sites need to be similar to the impact sites so that they are comparable but be outside the reach of the impacting process [14]. The sites chosen as control sites in the monitoring program for the dredging at Hay Point were not outside the area exposed to the dredge plume [15]. Satellite photos of the dredging at Hay Point illustrated that the dredge plume travelled as far north as 46kms [16] potentially compromising control locations, which were 21 kms and 37 kms north of the dredging project.

Recent modelling commissioned by the Great Barrier Reef Marine Park Authority predicted that the sediment plume from the dredge spoil dumping could extend beyond the control sites and into the Whitsundays (Figure x) [17]. There was no monitoring done at these more northern sites, so the full extent of the impacts are unknown. At Hay Point the 'control sites' had rates of sediment cover and disease comparable to those at the impact sites [18] but, because the control sites were deemed to be out of the impact zone, the conclusion was that there was no effect of the dredging material. Given the recorded movement of the dredge material, this logic is flawed.

Figure 2



New modelling showing sediment plume from dumping spoil. Source: Modelling sediment migration from current to hypothetical alternative placement sites, SKM, APASA, 12 July 2013'

Problem 2: *Impacts on corals were not adequately assessed.*

The evaluation of the impacts at Hay Point dredging stated that most of the coral colonies were healthy and that more than 95% of corals were undamaged [18]. However, the way that health and damage of corals was recorded at Hay Point clouds this interpretation. Corals that had dead patches, but that were believed to be recovering because of new growth, were grouped together with corals that had no damage at all [6]. Recording damage in this way has obscured the fact that these corals were damaged and underestimated the impacts of the dredging.

Percentage coral cover was also used as the main method for determining the impact of dredging on corals. However, measuring percentage cover alone does not take into consideration other impacts that increased sedimentation will have on corals. Increased sedimentation in the water column reduces the light available for the microalgae within coral cells to convert to energy. This turbidity reduces the ability of the coral to grow, reproduce and repair themselves [4]. Sediment that falls on the coral creates additional stress and corals will often divert valuable energy reserves into ridding themselves of the sediment using mucus layers and cilia action. This will be ineffective when confronted with heavy and/or constant sediment loads as was seen at some fringing reefs near Hay Point. There are many additional methods of measuring coral health that could have been used for this work to give a clearer indication. Coral colour cards [19] could have been used to give an estimate of changes in the density of the algal symbionts that provide the corals with much of their energy. Other useful measures would have been actual measures of the density of these algal symbionts, measures of protein in the tissues or assessment of reproductive state of the corals. Coral lipids (used for energy storage and reproduction) can be depleted by 30-50% in a matter of weeks during stress events [20], yet these were also not sampled as part of the impact study.

Sedimentation also reduces the survival of coral larvae in the water column and inhibits the establishment of new coral recruits [21] [22] thus reducing the ability of degraded reefs to recover [23]. Long term monitoring of the Mackay Whitsundays area has found that although coral cover still remains moderate to high, coral recruitment to the area has steadily declined since 2005. The lack of new recruitment suggests a lack of resilience within coral communities of the area and potential vulnerability to major events, such as mass bleaching, storm damage or crown of thorns outbreaks [24]. As the monitoring of coral reefs near Hay Point was only conducted for 6 months after the dredging and did not cover the reproductive period or consider juvenile corals, it is unclear what the results provide in terms of long term health and resilience of the area.

The study also states that less than 1% of coral cover was impacted by dredging. However this percentage appears to have been derived using averages across locations as well as not including the corals which were assessed to be damaged but 'recovering'. The problem with using averages is that the sites monitored at each location had different levels of impact as they had different exposure to the dredge plume. Sites 5 and 6 at Victor Island for example were more exposed to the dredge plume than the sites on the other side of the island, which were more sheltered from the impact [18]; 77% of the sediment damaged corals at Victor Island were at these two sites. Taking an average across sites with different impacts will naturally give you a lesser impact. The study also discusses that on average 10% of a coral's surface was covered by sediment. However the range shows that the surface of some corals had up to 60% coverage, which again hides localised impacts from sites that were most exposed to the sediment plume.

Problem 3: *Short term monitoring.*

Ceasing the monitoring program after six months when corals were still covered in sediment and suffering with lesions, does not allow an accurate measure of impact. Monitoring was also not undertaken over the summer months thus precluding the hottest part of the year and potentially the time when coral disease would increase the most. This also precluded the part of the year with greatest storm impact, and therefore potential for the dredge spoil to be mobilised.

No more monitoring was done at Hay Point until 2 years later when monitoring was undertaken for another capital dredging project [6]. As this used the same methodology as in 2006 it gave no clearer indication of reef health than the initial monitoring program.

A longer, more detailed monitoring program that assessed other elements of coral health as well as recruitment would have given a better picture of the true impact the dredging had on the corals near Hay Point. It is impossible to conclude that no damage was done to the corals of the area and therefore erroneous for NQBP to use this as the basis that large scale dredging will have no impact on the inshore coral reefs of the Great Barrier Reef.

Sediment plumes from dredging associated with the further development of the harbour. Gladstone Harbour_2 © WWF-Australia-2 >

CONCLUSION

Dredging in the waters of the Great Barrier Reef is an increasing threat to a Reef which is already struggling from the long term impacts of poor water quality and a changing climate. Whilst historical levels of dredging have been relatively low, currently proposed dredging activity is at a scale not previously known and it brings significant risks to the Reef's health, particularly for inshore waters.

Clearly a precautionary approach is needed.

Greater understanding about the impacts of dredging from both capital and maintenance dredging is required.

This means that in the short term all dredging activity needs to be absolutely minimised and all dumping in the Reef's world heritage waters should be banned.

Where ever possible alternative options should be considered: these include greater efficiency in the use of existing ports to avoid the need for port expansions, the extension of jetties and trestles into deeper water to avoid dredging, and restrictions on the size and depth of vessels accessing particular ports.

THERE SHOULD BE NO NEW PORT EXPANSIONS OUTSIDE THE CURRENT EXISTING FOOTPRINT OF PORT INFRASTRUCTURE ON THE REEF.

There is also a need for independent peer review of the monitoring of all dredging activities and the modelling of dredging proposals and regular public reporting of results and studies. Additionally these activities need to be assessed within an effective cumulative impact framework. This means considering all activities taking place across the breadth of the Reef supported by long term ambient monitoring of the Reef's water quality and ecosystem health.

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