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Research Review

Recent Environmental Issues in Port Curtis

February 2013

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SUMMARY

Community members raised concerns about the health of fish from Gladstone Harbour after significant rainfall in December 2010 and January 2011.

Over the same time, local surveys of seagrass showed a significant decline in meadows within Port Curtis.

Barramundi and other species were reported with signs of disease, including red eye, blindness, skin lesions and discolouration, and unsubstantiated reports were made of disease in humans following contact with unhealthy fish.

Fisheries Queensland investigated the claims and its fish health reports were reviewed by the expert Gladstone Fish Health Scientific Advisory Panel that was established to provide independent scientific advice to the Queensland Government.

The panel issued its final report in January 2012[1].

Further fish sampling and testing by Fisheries Queensland through 2012 were reviewed by the Gladstone Harbour Fish Health Interdepartmental Committee in January 2013[2].

Key findings from these reviews were consistent and indicated that dredging was not causing increased contamination in Port Curtis waters, therefore implicating flooding as the most likely cause of reported increases in fish health issues in Port Curtis.

Annual seagrass surveys as part of the Gladstone Ports Corporation's Western Basin Dredging and Disposal Project environmental monitoring and reporting program showed a significant decline in seagrass (and consequently food sources for fish) after regional flooding in late 2010.

The surveys also showed that these meadows had not recovered sufficiently during the growing seasons of 2011-12.

Seagrass is a foundation for many marine food webs in coastal tropical estuaries.

Seagrass meadows develop on shallow banks in Port Curtis and provide a nursery and habitat for many fish and invertebrates which provide food for higher level predators such as barramundi and sharks.

These meadows also provide food and shelter for dugongs and sea turtles.

After the floods, Gladstone Area Water Board reported that about 30,000 barramundi (or about 300 tonnes) washed over the Awoonga Dam spillway between December 2010 and March 2011, the first time it had overtopped since 2002.

Consequently, unprecedented barramundi catches of 18 times the average annual catch in Port Curtis between 2005 and 2010 were reported during that year.

This review summarises available information and shows:

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1 Gladstone Fish Health Scientific Advisory Panel (2012) Gladstone Fish Health Scientific Advisory Panel Final Report. 5th January 2012.
2 Gladstone Harbour Fish Health Interdepartmental Committee (2013) Gladstone Harbour Integrated Aquatic Investigation Program 2012 Report. Queensland Government. January 2013.

- Previous increases in observations of fish disease are primarily related to flooding, not dredging.
- The reported incidence of fish disease after the 2011 flood fell as the Western Basin dredging program progressed.
- Recovery of seagrass from previous floods was slow and the current rain cycle will probably extend the flood impact recovery phase further.
- The recent flood in January 2013 is likely to see a repeat of environmental conditions leading to further fish health issues.

Environment Department
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INTRODUCTION

The Gladstone Fish Health Scientific Advisory Panel issued its final report in January 2012.

The report included a review of Fisheries Queensland conclusions regarding its investigations of fish health issues In Port Curtis during 2011.

Fisheries Queensland findings included:

- Many large-sized barramundi had been under physical stress including wounds from dropping over the spillway into the Boyne River.
- Increased competition for food and from crowding combined with colder water during winter made the fish more susceptible to disease.
- If the barramundi had become a vector for disease, the infection rate was low because only 5% of other fish species sampled exhibited any signs of disease.
- Parasites and hyperaemia (skin redness) in shark species is widespread in Queensland and not specific to Port Curtis.
- Erosive shell disease in a low percentage of mud crabs has been occurring for many years (decades) and possibly is a consequence of natural conditions in Port Curtis.
- Prawns observed with erosive shell disease and/or gill parasites occurred at a similar rate (not greater) than has been previously reported from areas outside Gladstone.

The panel accepted that the condition was likely to be as a consequence of environmental stress and recommended that further studies be aimed to identify any other potential (unknown) causal agents.

A follow-up review under the Gladstone Harbour Integrated Aquatic Investigation Program by the Gladstone Harbour Fish Health Interdepartmental Committee in 2012 confirmed earlier findings and summarised investigation results on fish health, water quality and human health. They concluded there was a substantial improvement in fish health after reviewing all sample results through 2012[3]. During this time there was an substantial increase in dredging activity associated with the Western Basin Dredging and Disposal Project (WBDDP) manged by Gladstone Ports Corporation (GPC).

Current Status of Port Curtis

The marine ecosystem in Port Curtis is dominated by large shallow banks that provide a substrate for intertidal seagrass meadows that are spread throughout the bay.

A regional decline in seagrass cover was reported in Port Curtis in the annual surveys in 2010, followed significant rainfall between October and December that occurred during the growing season that extends from Winter through to early Summer.

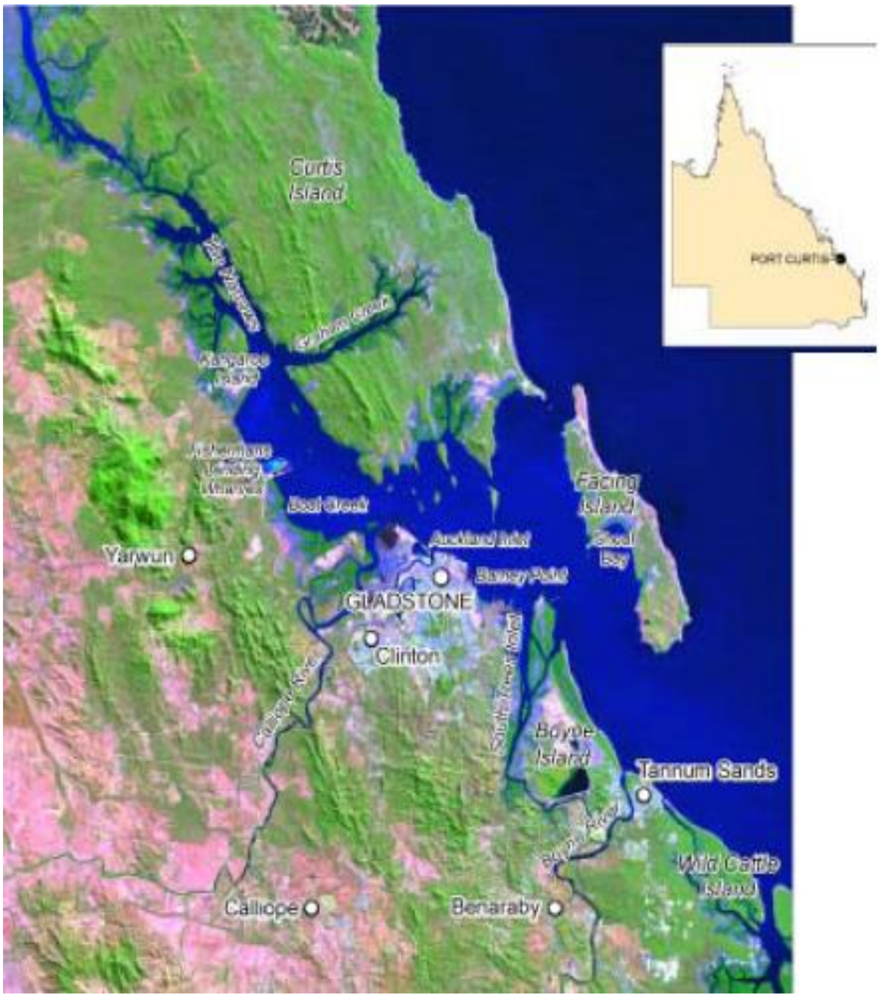
Seagrasses are vulnerable to extreme episodic weather events such as cyclones and floods which can cause widespread loss of seagrass meadows.

Extreme weather impacts on coastal marine environments involve massive freshwater flows, sediment influxes and major reductions in light availability reducing photosynthesis by benthic marine plants. Where this occurs over many days or several weeks, it can lead to a rapid decline in seagrass cover and severe ecological consequences (Preen et al. 1995).

[3] Gladstone Harbour Fish Health Interdepartmental Committee (2013) Gladstone Harbour Integrated Aquatic Investigation Program 2012 Report. Queensland Government. January 2013.

Healthy seagrass meadows provide a basis for maintaining coastal food chains or pyramids and are the primary food source for dugong in sheltered tropical and sub-tropical bays such as Port Curtis.

Figure 1: Port Curtis Region



Most seagrass losses in north-eastern Australia in recent years have been associated with extreme weather (Preen et al. 1995, Poiner and Peterkin, 1996) and have been followed by significant recovery after several years (Coles et al. 2003).

Gales et al. (2004) and Marsh et al. (2004) concluded that observed large-scale dugong movements along the Queensland coast occur principally in response to regional seagrass dieback events following floods.

In addition, heavy wet season and cyclone-associated rainfall have resulted in the overtopping of the Awoonga Dam on the Boyne River (Figure 1) resulting in massive numbers of mature-sized barramundi being introduced to Port Curtis. These fish have been stocked in the dam as fingerlings over many years.

The situation means that the supporting structure of the food chain (seagrass meadows) had been impacted when the higher end of the food chain (predatory barramundi) has become top-heavy in number.

This inevitably causes a shortage of food, even within a few weeks of the event, and signs of starvation in various marine species have been a common observation in catches and strandings in Port Curtis since the 2010-11 floods.

As a consequence of food shortages, disease outbreaks can occur from weakened immune systems in the general fish population, possibly as soon as two to three months after the event.

Turbidity-related light reduction events can also be prolonged as the forces of tide and wind drive sediment re-suspension often maintain turbidity levels beyond the life of the original freshwater and sediment plumes (Furnas 2003).

Wind-driven re-suspension follows seasonal patterns in wind regimes but, because it can be extreme and unpredictable, is included here as a factor that can prolong the reduction in sunlight-availability to seagrass.

Quality of Current Food Resources

Over the past 30 years, significant declines in the populations of dugongs and green turtles along the Queensland coast may have allowed seagrass communities dominated by *Zostera capricorni* to develop in some areas (Preen 1995), resulting in an overall increase in seagrass biomass (Coles et al. 2003).

The effect of this may have resulted in a regional reduction in high-quality dugong habitat because *Halodule* and *Halophila sp*. are generally more favoured for food by dugongs (Marsh et al. 1982).

These genera comprise pioneer species, and experiments show that excluding dugongs results in a change in seagrass community species composition with a resultant reduction in the quality of the dugong's diet (Preen 1995, Aragones and Marsh 2000) (see *Figure 2* and *Table 1*).

Abal et al. (1998) estimated that 20% of the seagrass habitat in Moreton Bay has been lost since European settlement in the 1820s because of increased turbidity resulting from agricultural and coastal development.

A similar decline could also be expected to have occurred in Port Curtis, for the same reasons.

However, Coles et al. (2003) stated that the likely effect of such anthropogenic changes is more difficult to estimate in the Great Barrier Reef region where turbidity is naturally high in inshore waters.

Seagrasses are not able to tolerate extended periods below their minimum light requirements, the tolerance threshold being location and species-specific, as species become locally acclimatised to their environment. (Coles et al. 2003).

Seagrasses are able to adapt to low light levels in various ways, such as reduced biomass. However, the specific nature of these responses are not well understood in seagrass species from Queensland.

Current Investigations to Assist Seagrass Recovery

To identify responses to stress in seagrass, such that effects can be measured and used as an early warning, QGC commissioned a large project (Phase 1; A$616,138) on seagrass health and physiology in October 2010.

Phase 2 aimed to identify the minimum light requirement of the dominant seagrass in Port Curtis and was managed by Gladstone Ports Corporation as a part of its requirements under Federal approval conditions (EPBC 2009/4403).

The Port is currently reviewing a proposal for Phase 3 studies to identify short-term sub-lethal indicators of light stress using a relatively new area of genetics research called transcriptomics.

This approach allows the whole genome of a species to be mapped and monitored for changes in gene expression due to light attenuation. The preliminary results have shown considerable promise.

Figure 2: Port Curtis intertidal habitat areas, showing seagrass comprises approximately 25% of the total area (top left quadrant) prior to 2010 flood event and subsequent decline

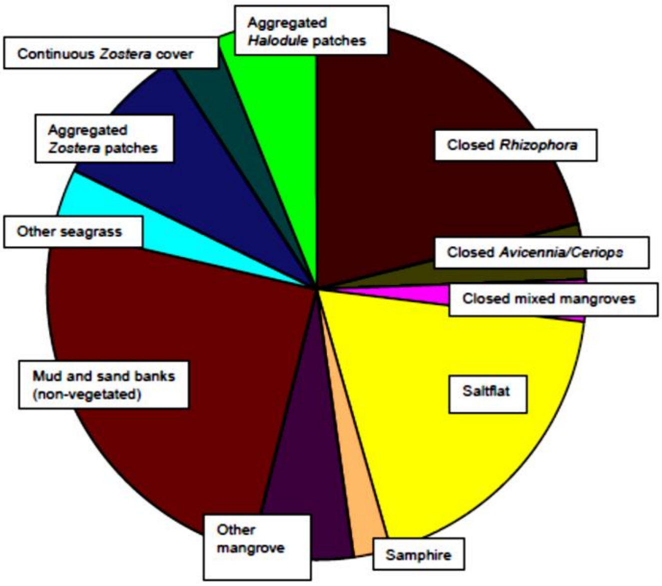


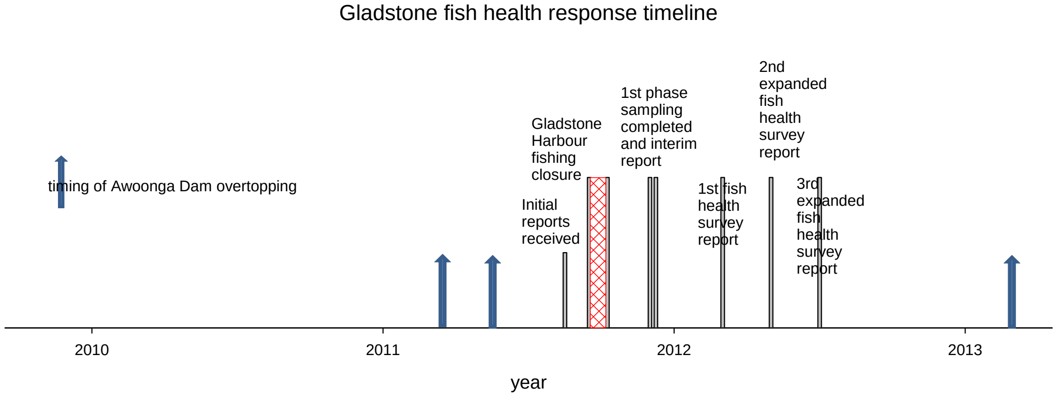
Table 1: Description and areas of habitat, including seagrass meadows in Port Curtis prior to 2010 (source QCLNG EIS, 2009)

Habitat Type	Area (Ha)	% of total	Prominent Location(s)
Salt Flats, (incl. samphires and salt grass)	4,573	10	Northern and Southern areas of harbour
Mangroves	11,417	25	Shorelines surrounding harbour including islands
Exposed mud and sandbanks	5,144	12	Eastern side of Curtis Island, Western side of Facing Island
Exposed rocky substrate	297	1	Curtis, Facing, Tide and Picnic Islands
Seagrass (coastal)	7,246	16	Pelican Banks, Quoin Island, Fisherman's Landing area
Seagrass (deepwater)	6,332	14	Facing Island, Seal Rocks, West and East Banks
Benthic macro-invertebrate communities (including coral) Open substrate, occasional individual	9,876	22	Outside Facing Island from Curtis Island to East Bank North-west of Seal Rocks Entrance to Rodds Bay
TOTAL	**44,885**	**100**	

The Impact of Rainfall on Port Curtis' Ecosystem Health

Figure 3 shows the link between flood events (demonstrated by the overtopping of Awoonga Dam) and fish heallh reports.

Figure 3: Timeline of events and studies concerning fish health in Port Curtis 2011-12, following flood events in early 2011



Scientific opinion suggests that the significant rainfall event in 2013 (greater than 1:100 years) is likely to exacerbate fish health problems in Port Curtis and Fitzroy River.

Several mass fish kills have been observed in both areas and been linked to oxygen depletion of floodwaters containing a large amount of plant and organic material from runoff (see Australian, 7 February 2013)*

*http://www.theaustralian.com.au/news/breaking-news/low-oxygen-kills-thousands-of-qld-fish/story-fn3dxiwe-1226572597507

Figure 4: Summary of rainfall in Gladstone for January 2013

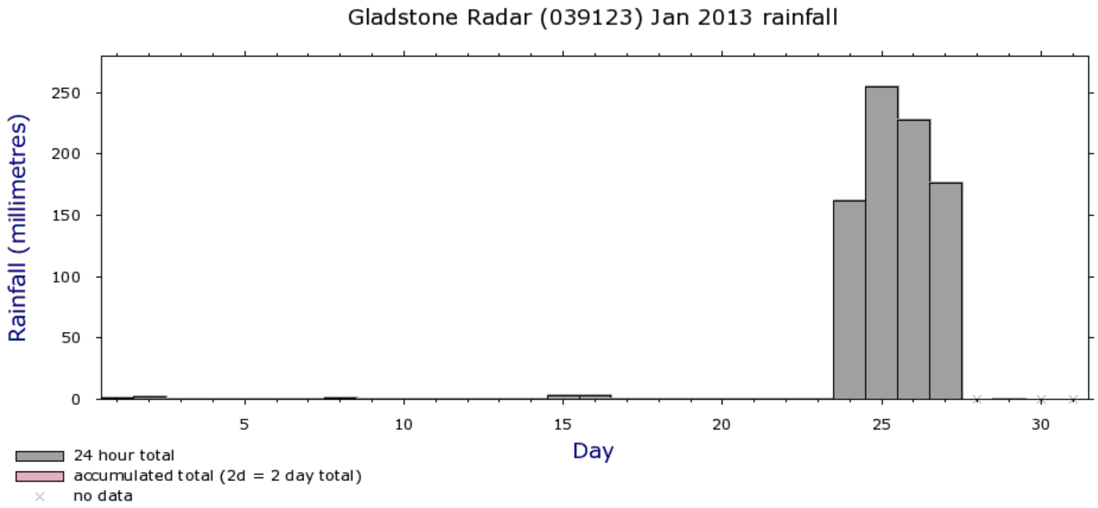


Figure 5: Port Curtis, Tuesday morning, 29 January 2013; Calliope River flood and plume extending through northern harbour on incoming tide, and other areas of sediment re-suspension including nearshore reefs

Figure 6: Fitzroy River delta, Tuesday 29 January 2013; northern end of Curtis Island, and flood plume extending close to Great Keppel Island

Among expected consequences of significant flooding in Port Curtis are impacts to seagrass meadows (see *Figure 7*.) which also undergo a (wet) seasonal senescent period when above-ground biomass "dies-off" leaving below-ground rhizomes (rootstock) to survive until mid-year when conditions including benthic light levels become more favourable for seagrass growth.

The growing season in Port Curtis usually extends from June through to January, or until significant rainfall occurs that signals with the commencement of the wet season.

Figure 7 shows changes in stress responses in seagrass to prolonged periods of light limitation from increases in turbidity in coastal water bodies, i.e., as a consequence of seasonal increases in rainfall (runoff carrying sediment) or from dredging.

Figure 7: General responses to decreasing light availability (i.e. increasing turbidity) in seagrass

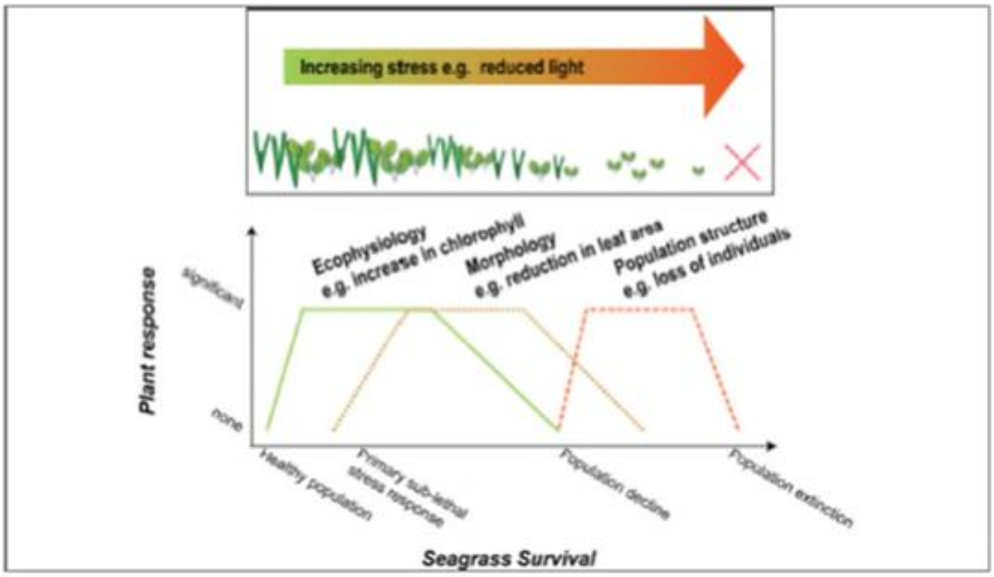
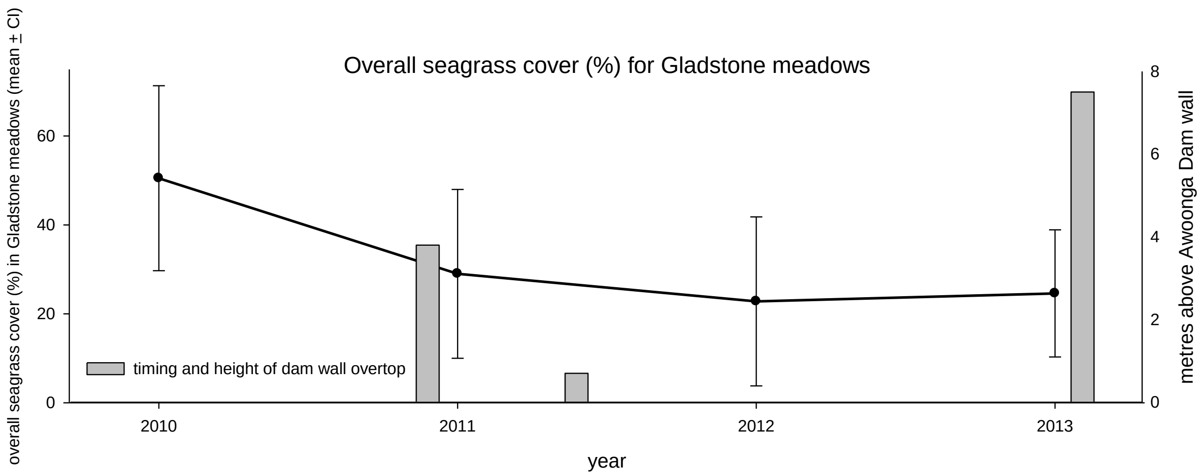


Figure 8 shows seagrass meadows in Port Curtis have not recovered from earlier impacts during 2009-10.

Figure 8: Estimated seagrass cover in Port Curtis (seasonal maxima) between 2009 and 2013. Data obtained from annual reports for surveys November-December each year



The current floods in 2013, although later in the annual seagrass growth cycle, can be expected to further delay the recovery of meadows to pre-2010 levels and supports early forecasts of further limitation of food availability for local fish, turtle and dugongs during 2013.

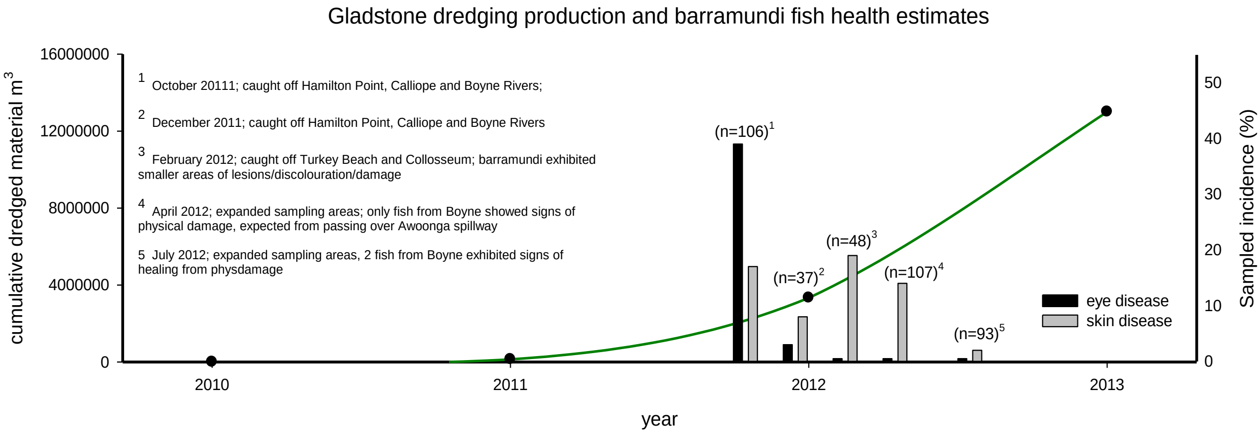
Consequently, increasing reports of fish health issues and turtle and dugong strandings are likely to occur from about mid-2013, given that another influx of barramundi from Awooga Dam has eneterd the harbour.

Timing of Dredging Activities

Figure 9 shows a clear downward trend in numbers of fish health issues identified (incidence percentage estimated on right-hand axis) over late December 2011 to mid-2012, and during this period there is a clear ramping-up in dredging production (cumulative production m^3 on left-hand axis) coinciding with completion of the Western Basin Reclamation Area for spoil disposal and operations using two large cutter-suction dredges.

The large trailer dredge TSHD Rotterdam started operations during the week of 22 October 2012, so was not operating during the time outlined above.

Figure 9: Overlay of barramundi fish health survey results using disease incidence, estimated from each sampling period (where n = total number in each sample) and progress in Western Basin dredging program (green line representing cumulative m^3)



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