Government of Western Australia
Department of Fisheries

Fish kill incident

Cockburn Sound, Western Australia
November-December 2015

Prepared: December 2015

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Contents

Acronyms and Glossary

CSMC	Cockburn Sound Management Council
DER	Department of Environmental Regulation
Department	Department of Fisheries
DO	Dissolved oxygen
DOH	Department of Health
DPaW	Department of Parks and Wildlife
DoW	Department of Water

1 Executive Summary

A fish kill event was first reported by a member of the public to the Department of Fisheries' (the Department) Fish watch service at 0648 Thursday 19 November 2015. The Department's Fish Kill protocol was immediately triggered, sending email notifications to a range of agencies including the departments of Health, Environment Regulation, and Parks and Wildlife. Fisheries and Marine Officers were dispatched at 0910 to investigate the reports and five dead fish were found in the reported location. Samples of the fish and water were taken for analysis.

The Department of Environment Regulation (DER) commenced investigating possible industrial causes on Friday 20 November, and continued these investigations throughout the period.

By Friday afternoon, about 30 dead fish had been found after other Fish watch calls were received.

The numbers of dead fish increased to more than 700 over the weekend of 21/22 November, washing up on the eastern beaches of Garden Island and triggering the Department's Incident Management Protocol. Departmental staff were on site, in daily contact with Recfishwest, and issued a media statement at 7am Sunday 22 November. A second media release, incorporating Department of Health messages was issued on Monday 23 November, and a Situation Report was issued to a range of external and internal stakeholders.

Reports of dead fish continued to come through FishWatch for the next 10 days, but most fish were decomposed and not useful for scientific analysis.

The Department of Health 'cleared' the Sound for recreational activities on Friday 27 November after receiving the results of its tests.

During the week 30 November – 4 December hundreds of dead and dying blow fish washed up on the Sound beaches providing the Department with better samples for analysis.

Based on the observations of Department staff responding to FishWatch calls, approximately 2000 fish and invertebrates were affected representing over 15 species. Significantly over 250 large pink snapper were involved in the event since pink snapper congregate in the Sound for spawning during this time of the year.

The Department, together with a multi-agency team including the Department of Health (DOH), the Department of Environment Regulation (DER) and the Department of Water (DOW) conducted a comprehensive and systematic investigation into the cause of the fish kill incident. All reports of potential chemical and industrial sources of the event were investigated by the Department of Environment Regulation, and none were substantiated other than a spillage of 500 kilograms of canola grain from the grain loading jetty. Water and fish samples were analysed and results interpreted by experts from the relevant agencies and from independent laboratories and consultants.

Results from the samples analyses identified that a bloom of diatoms of the genus *Chaetoceros* had occurred around the time of the event. Blooms of this group of diatom have been implicated in fish kills both internationally and around Australia.

These diatoms are about the diameter of a hair, have spine-like setae made of silica, and can cause physical irritation to fish gills. During the event algal numbers reached significant concentrations and the sectioned gills of freshly dead fish showed considerable physical irritation.

Potential contributing factors to the observed spike in *Chaetoceros* numbers include nutrients, higher than normal water temperatures, and reduced flushing conditions.

Spatial modelling indicated that the southern section of Cockburn Sound was the most likely initiation area of the event. This area has been historically associated with poor water quality issues including low dissolved oxygen levels associated with poor flushing of the embayment. Notably there were weak tides during this event which may also have been a contributing factor.

On 8 December, the Department announced that the most likely cause of the event was this bloom of algal diatoms. A monitoring regime was put in place to measure levels of *Chaetoceros spp* in the Sound. A multi-agency debrief will be held in January 2016 to integrate monitoring across agencies, and potentially improve multi-agency management of, and incident responses in, Cockburn Sound.

2 Background

2.1 Emergency Management and the Western Australian Fish Kill Program

The Department's Fish Health team developed and maintains Australia's first dedicated Fish Kill response protocol, which includes detailed incident management and sampling protocols, training, and response kits to equip authorities responding to emergency fish kills. Since its introduction, the Commonwealth and other states have used the framework as a basis for the National Investigation and Reporting Protocol for Fish Kills Strategy.

The Department's Incident Management Protocol has been developed to deal with major incidents and emergencies. In this instance, it was triggered on Saturday 21 November as the numbers of dead fish reached into the hundreds.

2.2 Fish Kills

About 20-30 fish kills are reported and investigated each year in Western Australia. The majority of fish kills occur in inland waters and are caused by a combination of (natural and man made) factors. The numbers of fish involved can range from a few, to the estimated 29,000 tonnes of pilchards killed by a disease event in 1998-1999 (Gaughan *et al* 2000). The most common factors known to contribute to fish kills include:

- Contaminants – natural and unnatural (e.g. hydrogen sulphide, carbon dioxide, ammonia, methane and other contaminants such as metals, pesticides, fertilisers);
- Disease;
- Algal toxins (toxic to fish);
- Physical irritants (suspended sediment, siliceous algal cells e.g. diatoms, bacteria); and
- Low dissolved oxygen (due to oxygen consumption associated with algal blooms, decay of algal blooms, or poor mixing).

2.3 Cockburn Sound and its Management

The Cockburn Sound Management Council (CSMC) coordinates and reports annual monitoring to gauge seagrass health and water and sediment quality. Water quality and seagrass monitoring is conducted from December to March each year once rivers stop flowing into the Sound and water quality is relatively stable. This allows for robust analysis of results and for monitoring to provide a ready measure of the condition of the Sound. Because of the December start date, monitoring data were not available for the period of this incident.

2 Timeline of investigation – Cockburn Sound November 2015

- 0648 Thursday 19 November - first FishWatch report received
- 0845 Thursday 19 November - reporting member of the public contacted and more details received.
- 0910 Thursday 19 November - Fisheries and Marine officers dispatched to site of report, 5 dead fish found. Fish and water samples taken for analysis.
- 0945 Thursday 19 November - departments of Health, Environmental Regulation, Parks and Wildlife, notified via email.
- Morning, Friday 20 November, further FishWatch calls, all responded to, no large numbers of dead fish found, but samples taken. All samples in poor condition. Water samples taken and sent to independent laboratories for testing.
- Afternoon/evening Friday 20 November - more reports, 108 dead fish found along 1.5kms of the Sounds beaches. All decomposed. Department researcher collects more floating dead fish overnight.
- Saturday 21 November – hundreds of dead fish found at Garden Island. The Department's Incident Management Protocol triggered. Recfishwest informed. Media released prepared for early Sunday morning release.
- Sunday 22 November – more dead fish washed onto Garden Island. Media release issued, ongoing contact with Recfishwest throughout the day. Further water and fish samples taken for testing.
- Monday 23 November – liaison with other agencies – Departments of Health (public health matters), Environment Regulation (investigations into potential industrial causes), Parks and Wildlife (impacts on marine mammals and birds), and Defence (Garden Island). First Situation Report distributed to internal and external stakeholders, second media release issued, with Department of Health messages incorporated.
- Tuesday 24 November to Sunday 29 November – second and third Situation Reports distributed (25 November, and 27 November), third media release (in partnership with DOH) issued, modelling commences to try to establish source of event. DER continues investigating all reports of potential sources of the event. The Department continues testing fish and water samples (see Appendix 1 for summary). Cities of Kwinana, Rockingham and Cockburn, and the Department of Defence undertake water quality monitoring in accordance with DOH requirements. DOH advises (27 November) that the Sound is cleared for fishing and swimming as long as people avoid dead fish, murky or smelly water.

- Monday 30 November to Friday 4 December – Reports of hundreds of dead blowies near the causeway (30 November and 1 December). Moribund and fresh samples are collected for analysis by Department staff from the mussel farm area. Situation Report number 4 issued to internal and external stakeholders. Reports of a dead pelican, seagull and penguin received and examined by the Department of Parks and Wildlife (DPaW) – no evidence to suggest deaths related to the fish kill. Media release issued. The *Naturaliste*, the Department's research vessel, conducts its normal stock research activities in the Sound during the week. The usual range of species and numbers of fish are found.
- Tuesday 8 December – The Department announces that the likely cause was a bloom of microscopic algae (*Chaetoceros spp*) associated with low dissolved oxygen levels. All other natural and pollution events were investigated and eliminated as the likely cause. Monitoring of the Sound will continue to assess the low term impacts of the incident.

3 Extent of mortality and lines of investigation

3.1 Extent of Mortality

Based on the FishWatch calls investigated by the Department, the mortality event appears to have been confined to the southern section of Cockburn Sound. Dead fish reported from the ocean side of the Garden Island causeway and northern reaches of Cockburn Sound were determined to be due to prevailing wind and tidal conditions.

Investigations and monitoring data also indicate that the bloom was a relatively short lived event.

3.2 Involvement of Contaminants

Testing of both water and tissue samples was undertaken for (see Table 1):

- Hydrocarbons
- Pesticides
- Herbicides
- Organic fertilisers
- Nitrogenous products (e.g. Ammonia, Nitrates)
- Shellfish toxins
- Heavy Metals

Results showed no evidence of the presence of any of these contaminants.

3.3 Involvement of Harmful Algae

Water and tissue samples were analysed for algae species that are known to produce toxins that can harm fish and humans via exposure to skin or through ingestion. Testing revealed no significant harmful algae species or associated toxins were associated with this fish kill event (Table 1).

Increased numbers of diatoms of the genus *Chaetoceros* were notably present in water samples collected near Mangles Bay during and after the fish kill. Species of

Chaetoceros possess many long, thin, highly spined setae, which can cause damage and irritation to fish gills. It has been previously implicated in mass fish kill events in other parts of the world.

Table 1. Summary of water and fish tissue sampling for chemical contaminants, toxins, harmful algae and environmental conditions in southern Cockburn Sound (see Appendix 1 for details)

Tests Conducted	**# of Water samples tested**	**# of Fish tissues tested (3 spp. – Snapper, Flathead and puffer fish)**
Histopathology	**N/A**	**50**
Bacteriology (fish)	**N/A**	**20**
Enterococci (water)	**18**	**N/A**
Hydrocarbons	**5**	**26**
Pesticides	**5**	**26**
Herbicides	**5**	**26**
Organic fertilisers	**5**	**26**
Nitrogenous products	**5**	**26**
Brevetoxins	**5**	**10**
Neurotoxic shellfish poisons	**5**	**10**
Paralytic shellfish poisons	**5**	**10**
Amnesic shellfish poisons	**5**	**10**
Diarrhetic shellfish poisons	**5**	**10**
Total algal ID and enumeration	**8**	**N/A**
Harmful/toxic algae identification		
Pseudonitzschia 'd group'	**14**	**N/A**
Pseudonitzschia 's group'	**14**	**N/A**
Dinophysis acuminata	**10**	**N/A**
Gymnodinium/Karenia spp.	**12**	**N/A**
Prorocentrum minimum	**12**	**N/A**
Temperature	**62**	**N/A**
Salinity	**62**	**N/A**
pH	**62**	**N/A**
Dissolved oxygen	**62**	**N/A**
Turbidity	**62**	**N/A**
Chlorophyll a	**62**	**N/A**

3.4 Involvement of Disease

Disease was ruled out as a contributor to the fish kill after examination of the tissues of snapper and other species. Usually fish kills caused by disease impact a single species or group. The wide range of finfish and invertebrates involved in this event indicated that it was not disease-related.

3.5 Involvement of Physical Irritation

Histopathological examination of gill tissues from freshly dead fish showed distinct inflammation, haemorrhage and excess mucous production. These symptoms indicate the presence of an external irritant, or an acute exposure to poor water quality, and results in decreased respiratory ability of the fish. This irritant, combined with the low dissolved oxygen levels and the warmer water temperatures, is likely to have contributed to the fish kill.

3.6 Involvement of Low Dissolved Oxygen Conditions

Low levels of dissolved oxygen (DO) are relatively common in southern Cockburn Sound. Levels well below the CSMC Environmental Quality Guidelines occur many times in any year (see previous State of Cockburn Sound reports). This is primarily due to the sheltered nature of the southern section of the Sound and the low levels of water exchange. Previous reports examining this 'flushing' activity estimate that it can take up to 25 days for water in the Mangles Bay area to replenish or exchange with the surrounding oceanic waters.

Low dissolved oxygen events due to eutrophication or other factors in marine estuarine or embayment areas are often acute and relatively short events (e.g. 12-24 hours). Finfish and invertebrates that succumb to such events may take many hours or days to wash up on beaches.

CSMC's monitoring of DO and other water quality parameters such as temperature, salinity, pH, and phytoplankton abundance, were scheduled to begin on 1 December so this data were not available for the period.

3.7 Involvement of other Factors

Other events, such as the severe lightning storms that occurred around the time of the fish kill have been considered as causes or contributory factors to the incident. The direct correlation of storms and this event are unlikely as there was not a significant amount of rain and resulting runoff entering the Sound during that time. However, the unseasonably warm air temperatures and high UV exposure experienced in Perth the week leading up to the fish kill and around the time of these storms and the fish kill are more likely contributors.

4 Environmental Conditions

Sources of data used to assess environmental conditions at the time of the event were:

- Permanent temperature loggers maintained in the Sound by the Department to support ongoing fisheries management;
- Sea surface temperature imagery provided by LandGate;
- Historical weather and tide reports;
- Phytoplankton samples associated with ongoing Department of Health management of the mussel aquaculture industry; and
- Results of a dedicated post fish event Department of Fisheries assessment of environmental conditions.

Data from these activities has informed the investigation.

4.1 Water Temperatures

Both satellite imagery and Department data indicated that water temperatures in the Sound were higher than in previous years (Figures 1 & 2).

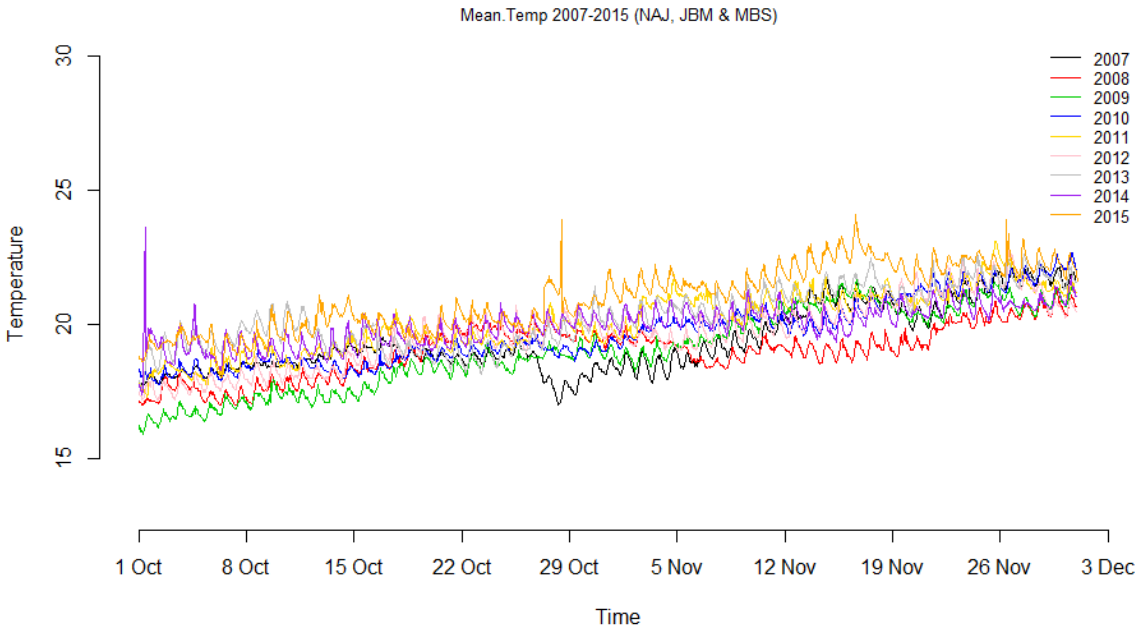

Figure 1. Mean temperature data across 3 Department monitoring sites within Cockburn Sound for the period 1 Oct-3 Dec since 2007. *JBM is the Jervois Bay Marker on the Alcoa jetty, NAJ is on the Navy Ammunition Jetty and MBS is on the Mangles Bay Ski Marker located on the Blue Lagoon mussel site*

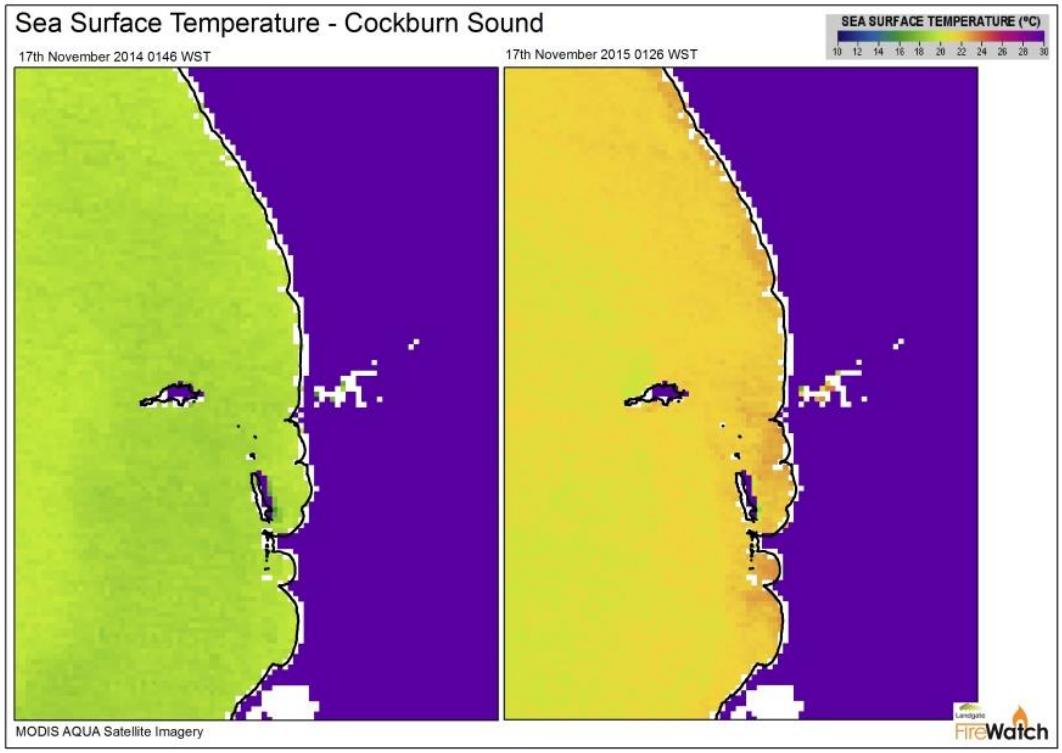

Figure 2. Sea surface temperatures recorded in Cockburn Sound on November 17th 2014 and 15.

4.2 Dissolved Oxygen

A systematic survey by Department staff conducted in the southern section of Cockburn Sound on 3 December 2015 did not identify evidence of continuing low dissolved oxygen levels (Figure 3).

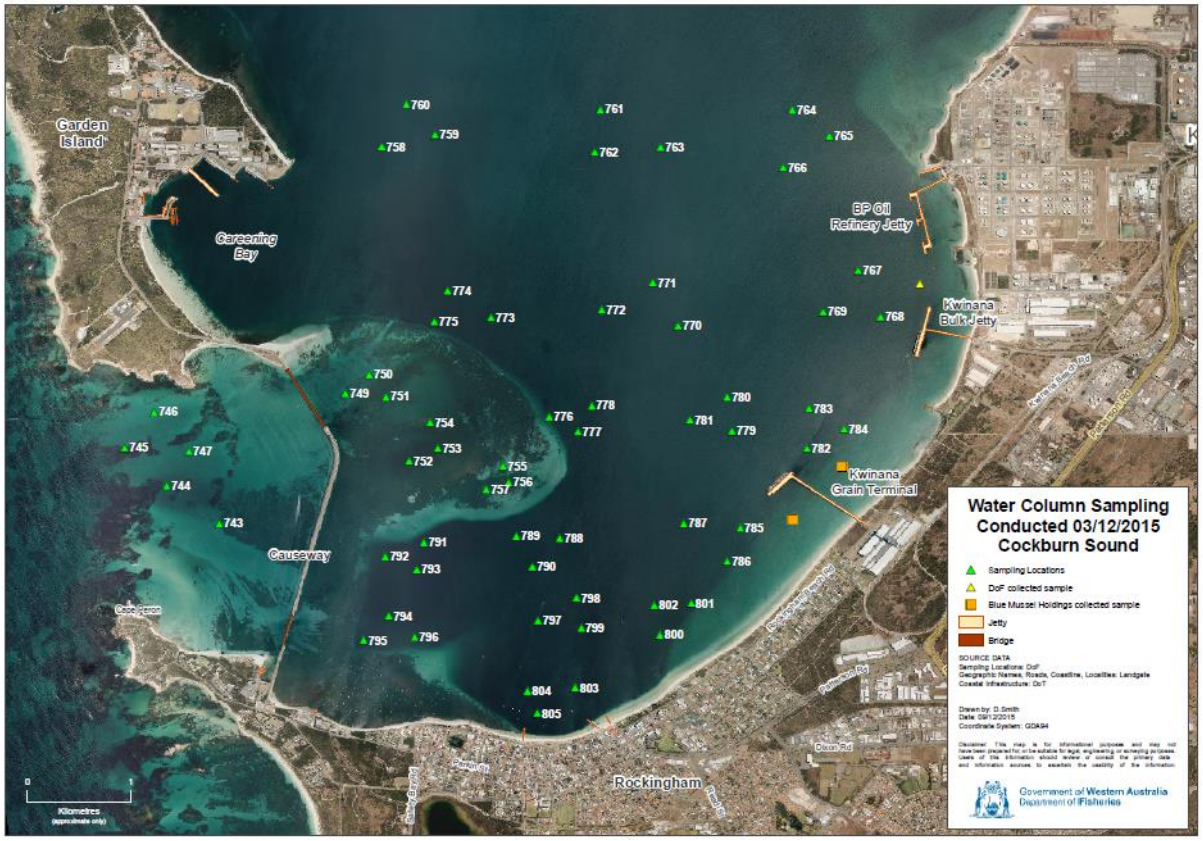

Figure 3. Location of sampling sites for environmental water quality assessment conducted by Department staff.

4.3 Tide and Weather Conditions

Weather conditions were unremarkable for the time of year with the exception of significant electrical storm activity preceding the event (Figure 4). Predicted tidal flushing was low in the area during the period of the fish kill (Figure 5).

Garden Island, Western Australia
November 2015 Daily Weather Observations
Observations from a site at the southern end of Garden Island.

Australian Government
Bureau of Meteorology

Date	Day	Temps		Rain	Evap	Sun	Max wind gust			9am						3pm					
		Min	Max				Dirn	Spd	Time	Temp	RH	Cld	Dirn	Spd	MSLP	Temp	RH	Cld	Dirn	Spd	MSLP
		°C	°C	mm	mm	hours		km/h	local	°C	%	eighths		km/h	hPa	°C	%	eighths		km/h	hPa
1	Su	14.4	22.8	0			W	33	23:32	17.4	81		NE	13	1014.4	22.0	66		WNW	13	1009.4
2	Mo	14.7	22.0	17.6			SW	35	16:28	17.4	83		SSW	9	1010.8	20.7	74		SW	22	1012.5
3	Tu	14.8	22.8	0			S	35	21:56	20.1	65		ENE	9	1019.1	20.6	72		SW	24	1017.2
4	We	16.0	22.3	0			SSW	35	01:11	19.1	68		S	13	1016.1	20.0	64		SW	20	1012.1
5	Th	15.0	22.7	0			WNW	33	15:50	19.9	69		NNE	7	1008.5	20.5	61		WNW	20	1006.9
6	Fr	17.5	22.0	0			SSW	54	18:28	19.6	73		S	22	1007.9	20.5	81		SSW	43	1004.6
7	Sa	17.5	20.7	0			S	56	04:28	18.2	73		S	30	1014.2	19.7	77		SSW	37	1014.3
8	Su	15.1	20.8	0			SSW	50	20:20	17.8	76		SSW	19	1019.7	20.1	83		SSW	39	1017.9
9	Mo	16.5	25.6	0			SSW	48	13:59	20.5	70		SSE	15	1020.7	21.6	77		SSW	35	1017.1
10	Tu	17.3	25.2	0			SSW	43	17:47	23.0	57		NE	7	1018.1	21.2	79		SSW	31	1015.4
11	We	17.1	24.4	0			SSW	41	18:03	19.5	84		SSW	20	1017.6	21.6	79		SSW	30	1016.3
12	Th	18.1	27.0	0			SSW	46	16:33	24.1	60		ESE	11	1019.8	22.4	78		SSW	30	1018.1
13	Fr	20.2	31.3	0			E	41	01:46	26.4	38		E	15	1018.9	24.3	74		SW	24	1015.6
14	Sa	21.7	36.6	0			WNW	39	19:36	31.3	34		NE	20	1012.2	26.1	70		SW	15	1009.3
15	Su	20.0	24.5	0.2			SSW	41	21:00	23.4	68		SSE	7	1012.8	21.9	81		SSW	30	1012.8
16	Mo	17.5	25.4	0			S	31	00:14	23.1	59		S	6	1012.8	23.2	66		SW	15	1010.1
17	Tu	15.0	25.1	0			WSW	44	18:17	23.4	71		WNW	19	1005.9	19.9	81		W	33	1009.3
18	We	17.5	21.6	1.0			WSW	56	09:15	19.8	53		W	30	1016.0	19.9	53		WSW	31	1016.5
19	Th	15.1	20.6	1.6			S	46	22:50	18.2	58		SW	24	1023.6	19.3	53		SSW	26	1023.2
20	Fr	12.9	25.8	0			SSW	50	17:22	20.4	49		E	17	1026.7	20.4	69		SSW	37	1022.0
21	Sa	16.6	34.9	0			ENE	41	07:37	25.1	38		ENE	19	1021.1	25.3	63		SSW	22	1017.2
22	Su	22.1	33.5	0			N	48	10:49	28.8	30		NE	22	1014.6	25.1	69		NNW	30	1013.6
23	Mo	19.9	24.8	0			NNW	30	05:45	22.8	73		NNW	22	1014.7	23.3	69		W	15	1012.8
24	Tu	19.4	22.1	0			SSW	63	20:14	20.3	73		S	28	1015.9	21.3	69		SSW	46	1013.8
25	We	15.7	22.0	0			SSW	59	15:00	19.2	73		S	24	1017.8	20.7	70		SSW	48	1014.5
26	Th	14.8	25.7	0			SSW	50	16:20	21.7	47		E	20	1018.0	21.7	70		SSW	39	1013.2
27	Fr	17.0	23.9	0			SSW	41	20:05	22.6	55		SSE	9	1012.8	22.5	74		SSW	33	1010.8
28	Sa	17.9	22.3	0			SSW	52	21:47	20.7	70		SSW	19	1015.1	21.7	75		SW	35	1014.4
29	Su	17.9	21.2	0			SSW	59	20:10	19.2	76		SSW	28	1017.1	20.7	70		SSW	39	1016.0
30	Mo	15.1	20.6	0			SSW	67	18:34	18.9	66		S	26	1021.0	19.8	63		SSW	46	1018.2
Statistics for November 2015																					
Mean		17.0	24.7							21.4	63			17	1016.1	21.6	71			30	1014.2
Lowest		12.9	20.6							17.4	30		S	6	1005.9	19.3	53		WNW	13	1004.6
Highest		22.1	36.6	17.6			SSW	67		31.3	84		#	30	1026.7	26.1	83		SSW	48	1023.2
Total				20.4																	

Observations were drawn from Garden Island HSF (station 009256)

IDCJDW6046.201511 Prepared at 13:08 GMT on 2 Dec 2015
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Users of this product are deemed to have read the information and accepted the conditions described in the notes at
http://www.bom.gov.au/climate/dwo/IDCJDW0000.pdf

Figure 4. Weather observations for the period of November 2015

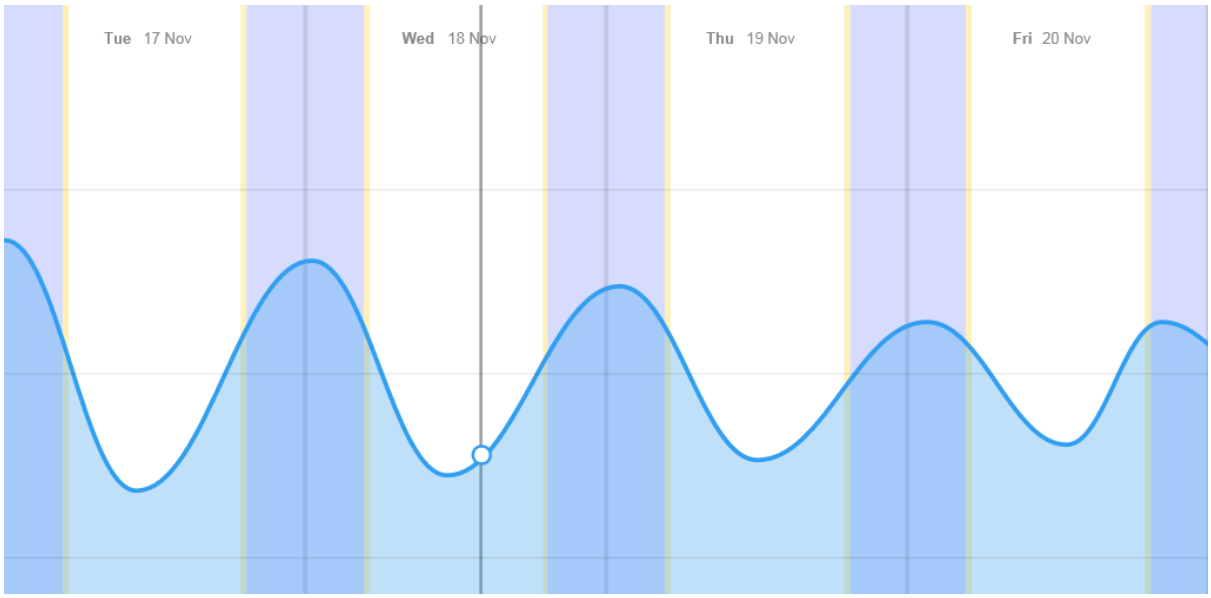

Figure 5. Tidal information for the period 17 November -20th November

5 Summary of Investigations

Analysis of fish tissues, water samples and mussel samples during the event revealed no evidence of biotoxins harmful to humans or involvement of any toxin producing algal species.

Examination of affected fish identified bacteria and tissue damage associated with the event, though disease was not identified as being a primary cause in this case.

Results from the investigation identified a bloom of diatoms of the genus *Chaetoceros* which occurred around the time of the event. Blooms of this group of diatom have been implicated in fish kills both internationally and in Australia. These diatoms of ~10-50um in diameter have spine-like setae made of silica, can form chains and can cause physical irritation to fish gills. Algal numbers reached up to 740,000 cells per litre - deemed a significant concentration and likely primary contributor to the event. Coupled with this, evidence of physical irritation was observed in the sectioned gills of freshly dead fish. This irritation was likely to have been caused by fish encountering an irritant like these diatoms.

Contributing factors to algal blooms include nutrients, elevated water temperatures and reduced flushing. The modelling work determined that the source area of the fish kill (based on water currents and the distribution of dead fish) was likely to have been in the southern section of Cockburn Sound. This area has been historically associated with poor water quality issues including low dissolved oxygen levels associated with poor flushing of the embayment. Notably there were weak tides during this event which may have been a contributing factor. Low dissolved oxygen levels are also associated with algal blooms, as algae are a net consumer of oxygen at night time and following their breakdown by bacteria following a bloom event. Whilst there was no direct evidence of involvement of low dissolved oxygen conditions such conditions likely contributed to the fish kill event.

The Department of Environment Regulation also conducted investigations into all reports of potential pollution or industrial cause of the fish kill. As part of the investigation, the Department of Environment Regulation also assessed industry monitoring data and inspected local drainage systems. No potential pollution sources were identified and no report was substantiated other than the spillage of approximately 500 kilograms of canola grain at the grain loading jetty. There was no evidence of chemical contaminants in the spilt canola.

6 Where to next?

The Department will continue to monitor the levels of *Chaetoceros* spp. and other algal species at locations in the southern part of the Sound. It will also continue monitoring the Sound, in particular for crabs, and juvenile and snapper larvae as part of its normal fisheries monitoring work. Together this should assist in determining the impact of the kill on the fish of the Sound.

A multi-agency debrief is planned for early 2016. The outcomes are expected to improve responses and management of future potential fish kill events in the area.

Prepared by Department of Fisheries

7 Appendix 1: Department of Fisheries Summary of Tests and Results

Water Samples

Sample	Locality	Collection Date	Lab	Tests performed	Results
FH15-177	Kwinana Jetty	19/11/2015		Ammonia	All within acceptable limits
FH15-177	Kwinana Jetty	19/11/2015		TRH Hydrocarbons	All within acceptable limits
FH15-177	Kwinana Jetty	19/11/2015		PAH Hydrocarbons	All within acceptable limits
PE103000	Dibbens farm	2/11/2015	SGS	Shellfish toxin (Pseudo-nitzschia)	All within acceptable limits
PE103000	Dibbens farm	2/11/2015	SGS	Shellfish toxin (Pseudo-nitzschia)	All within acceptable limits
PE103397	Dibbens farm	17/11/2015	SGS	Shellfish toxin (Pseudo-nitzschia)	All within acceptable limits
PE103397	Dibbens farm	17/11/2015	SGS	Shellfish toxin (Pseudo-nitzschia)	All within acceptable limits
PE103397A	Dibbens farm	17/11/2015	SGS	Karenia/Gynodinium	All within acceptable limits
PE103397A	Dibbens farm	17/11/2015	SGS	Karenia/Gynodinium	**80 cell/mL Karenia-Gymnodinium (Swan River trigger 500/mL)**
PE103397A	Dibbens farm	17/11/2015	SGS	Prorocentrum minimum	All within acceptable limits
PE103397A	Dibbens farm	17/11/2015	SGS	Prorocentrum minimum	All within acceptable limits
PE103554	Dibbens farm	23/11/2015	SGS	Shellfish toxin (Pseudo-nitzschia)	All within acceptable limits
PE103554	Dibbens farm	23/11/2015	SGS	Shellfish toxin (Pseudo-nitzschia)	All within acceptable limits
PE103554	Dibbens farm	23/11/2015	SGS	Dinophysis acuminata (PTP)	All within acceptable limits
PE103554	Dibbens farm	23/11/2015	SGS	Dinophysis acuminata (PTP)	All within acceptable limits
PE103554	Dibbens farm	23/11/2015	SGS	Karenia/Gynodinium	All within acceptable limits
PE103554	Dibbens farm	23/11/2015	SGS	Karenia/Gynodinium	**620/mL (exceeds Swan River trigger levels)**
PE103554	Dibbens farm	23/11/2015	SGS	Prorocentrum minimum	All within acceptable limits
PE103554	Dibbens farm	23/11/2015	SGS	Prorocentrum minimum	All within acceptable limits
PE103754	Dibbens farm	1/12/2015	SGS	Total Algae ident and enumeration	**Chaetoceros levels concerning**
PE103754	Dibbens farm	1/12/2015	SGS	Total Algae ident and enumeration	**Chaetoceros levels concerning**
PE103830	Dibbens farm	17/11/2015	SGS	Total Algae ident and enumeration	**Chaetoceros levels concerning**
PE103830	Dibbens farm	17/11/2015	SGS	Total Algae ident and enumeration	**Chaetoceros levels concerning**
PE103830	Dibbens farm	23/11/2015	SGS	Total Algae ident and enumeration	**Chaetoceros levels concerning**
PE103830	Dibbens farm	23/11/2015	SGS	Total Algae ident and enumeration	**Chaetoceros levels concerning**
PE103830	Dibbens farm	1/12/2015	SGS	Total Algae ident and enumeration	**Chaetoceros levels concerning**
PE103830	Dibbens farm	1/12/2015	SGS	Total Algae ident and enumeration	**Chaetoceros levels concerning**
FH15-201			ChemCentre	Total phosphorus	PENDING
FH15-201			ChemCentre	Total Sulfur	PENDING
FH15-201			ChemCentre	Total nitrogen, and nitrates (TKN and NOx)	PENDING
FH15-201			ChemCentre	Heavy metals suite (inc. Vanadium)	PENDING
FH15-201			ChemCentre	Pesticides suite	PENDING
FH15-201			ChemCentre	Phenoxyacid herbicides (2,4-D and 2,4,5-T, “Agent Orange”)	PENDING
FH15-201			ChemCentre	Organics screen (GC-MS)	PENDING
62 Sites in Cockburn Sound		3/12/2015		Env. Quality (Temp, Salinity, Turbidity, pH, DO, Chlorophyll a)	PENDING
DoH	Naval Base	23/11/2015	Pathwest	Enterococci	Clear
DoH	Kwinana Beach	23/11/2015	Pathwest	Enterococci	Clear
DoH	Kwinana Beach South	23/11/2015	Pathwest	Enterococci	Clear
DoH	Kwinana Beach North	23/11/2015	Pathwest	Enterococci	Clear
DoH	Risley St. Horse Beach	23/11/2015	Pathwest	Enterococci	Clear

Sample	Locality	Collection Date	Lab	Tests performed	Results
City of Rockingham	Kwinana Beach	24/11/2015	Pathwest	Enterococci	Clear
City of Rockingham	Rockingham Beach	24/11/2015	Pathwest	Enterococci	Clear
City of Rockingham	Palm Beach Jetty	24/11/2015	Pathwest	Enterococci	Clear
City of Rockingham	Palm Beach	24/11/2015	Pathwest	Enterococci	Clear
City of Rockingham	North Hymus Street	24/11/2015	Pathwest	Enterococci	Clear
City of Rockingham	Education Dept. Camp	24/11/2015	Pathwest	Enterococci	Clear
City of Cockburn	Jervoise Bay Boat Ramp	24/11/2015	Pathwest	Enterococci	**31 - not sure if significant**
City of Cockburn	Jervoise Bay Beach	24/11/2015	Pathwest	Enterococci	Clear
City of Cockburn	Woodman Point Camp	24/11/2015	Pathwest	Enterococci	Clear
City of Cockburn	John Graham Reserve	24/11/2015	Pathwest	Enterococci	Clear
City of Cockburn	Coogee Beach	24/11/2015	Pathwest	Enterococci	Clear
City of Cockburn	Port Coogee	24/11/2015	Pathwest	Enterococci	Clear
City of Cockburn	CY O'Connor Beach	24/11/2015	Pathwest	Enterococci	Clear

Fish Samples

Sample	Species	Histology	Bacteriology	Tissues for Toxicology	ChemCentre	CC Results	Advanced Analytical Labs	AA Results
FH15-177	Snapper	NO	YES	Flesh	Hydrocarbons, Organics (inc. pesticides)	Negative		
FH15-182	Snapper	YES	YES	Liver, Flesh, Stomach Contents, Brain	Hydrocarbons, Organics (inc. pesticides), Metals	Negative	Shellfish toxins (PSP,ASP, DSP, NSP)	Negative
FH15-189	Snapper	YES	NO	Kidney, Liver	Hydrocarbons, Organics (inc. pesticides), Metals	PENDING	Shellfish toxins (PSP,ASP, DSP, NSP)	Negative
FH15-189	Flathead x6	YES	NO	Liver	Hydrocarbons, Organics (inc. pesticides), Metals	PENDING	Shellfish toxins (PSP,ASP, DSP, NSP)	Negative
FH15-189	Pufferfish	NO	NO	Kidney, Liver	Hydrocarbons, Organics (inc. pesticides), Metals	PENDING		
FH15-194	Snapper	YES	YES	Kidney, Liver, Flesh, Brain	Hydrocarbons, Organics (inc. pesticides), Metals	PENDING	Shellfish toxins (PSP,ASP, DSP, NSP)	Negative
FH15-195	Snapper	YES	YES	Kidney, Liver, Spleen, Flesh, Periorbital fat	Hydrocarbons, Organics (inc. pesticides), Metals	PENDING		
FH15-196	Pufferfish X1	YES	PENDING	Kidney, Liver, Flesh, Brain, Gut, Spleen	Hydrocarbons, Organics (inc. pesticides), Metals	PENDING		
FH15-198	Pufferfish x 5	YES	YES	Kidney, Liver, Flesh, Brain, Gut, Spleen	Hydrocarbons, Organics (inc. pesticides), Metals	PENDING		
FH15-199	Snapper x2 juvenile	YES	PENDING	N/A				