SENIOR THESIS PROJECT

An investigation into heavy metals in Lake Macquarie NSW.

Tayla Hammerton

Photo Credit: HCEC

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1. Introduction

This scientific report is to **investigate whether there are elevated levels of heavy metals in fish in Lake Macquarie, As a result of pollution to the Lake from the 2 operating Coal-fired power stations?** There are 5 operating coal-fired power stations in NSW, 2 of which are located on the shores of Lake Macquarie NSW, just south of Newcastle. Vales Point Power Stations is owned by Delta Energy and is located in the southern end of Lake Macquarie. Eraring power stations is owned by Origin Energy and located North of Vales Point. Once the coal has been burned through the power station, the coal ash waste that remains is transferred to into unlined dams which then have the potential to leak heavy metals into Lake Macquarie.

It is evident that there is water and sediment pollution present in Lake Macquarie from these 2 coal fired power stations. The Hunter Community Environment Centre (HCEC) is an organization that targets environmental and social justice, and their current campaign is looking at the impacts of coal-fired power stations in NSW. HCEC have been working on this campaign since March 2018 to clean up the coal ash from the 5 coal-fired power stations in NSW. They have released 2 reports around coal ash pollution to Lake Macquarie, 'Out of the Ashes' and 'Out of the Ashes 2'. In these reports their findings have shown that there are elevated levels of heavy metals in the water and sediment, some examples of the metals that can be found are, Silver, Aluminium, Arsenic, Boron, Cadmium, Chromium, Copper, Iron, Lead, Manganese, Mercury, Nickel, Selenium and Zinc (Winn, 2019).

Aside from coal ash pollution coal fired power stations are a form of fossil fuels, one of the leading contributors to climate change. Climate change or global warming is one of the most long-term global impacts on the sustainability of systems on Earth. Climate change is directly tied to the amount of carbon dioxide we release into the atmosphere. Coal is chemically mostly carbon and, when coal is burned in coal-fired power stations carbon reacts with oxygen in the air to produce carbon dioxide. Once the carbon dioxide is released into the air it acts to traps heat within the atmosphere which leads it to becomes a greenhouse gas. Global warming can lead to factors such as sea-level rise, drought, extreme weather conditions, and the eventual loss of species (Union of Concerned Scientists, July 2008, Updated Dec 2017).

As discussed above this investigation intends to test whether the heavy metals from coal ash that is being transferred into coal ash dams in Lake Macquarie is having a negative effect on the fish in Lake Macquarie NSW. It is clear there are heavy metals leaching into the water and sediment from the two ash dams located in Lake Macquarie, 101 million tonnes of coal ash waste have already accumulated in unlined damns in Lake Macquarie. (Clean Up Coal-Ash — HCEC, n.d.) If power stations do not clean up their coal ash dams heavy metals will continue leaching into Lake Macquarie and potentially working their way up the food chain causing bioaccumulation in our bodies and perhaps health effects.

2. Aim and Hypothesis

Aim

The aim of this fish study is to determine whether there are elevated levels of heavy metals in selected fish species in Lake Macquarie. These heavy metals would be from the pollution leaching from Vales Point and Eraring Power Stations coal ash dams.

Hypothesis

The hypothesis is that there will be elevated levels of heavy metals due to the close proximity of where the fish were caught and where the two coal-fired power stations are located.

3. Site description

Location- Lake Macquarie NSW Australia

Lake Macquarie is the largest saltwater lagoon in the Southern Hemisphere, located between Newcastle and Sydney NSW (Lake Macquarie, n.d.) (Figure 1)

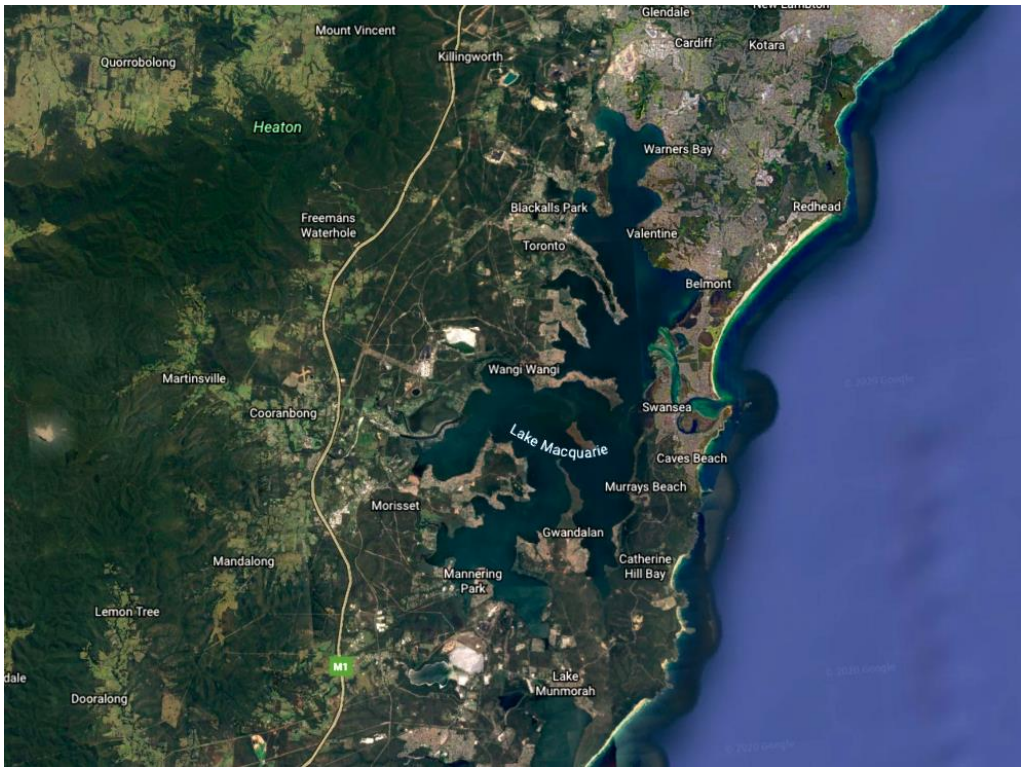

Figure 1- Location of Lake Macquarie (NSW)

History

Eraring Power Station

Awabakal People enjoyed the wealth of resources found in the Lake Macquarie area before European settlement. Originating in Newcastle the discovery of coal in the late eighteenth century. Coal mines were developed, and communities grew leading to emerging suburbs. In 1984 Lake Macquarie evolved into a city after being declared a municipality in January 1977. Eraring Power station first opened on the 29th of June 1984, by the NSW premier, Neville Wran. Lake Eraring is a nearby lake and that is where the name from this power station came from. The name Eraring was the given name for the area which is an Aboriginals term meaning "that which gleams or glitters." The Eraring power station was in an ideal spot due to the large amounts of water for cooling, the proximity of coalfields, and a large amount of land with the total project area being 936 hectares.

Eraring Power Station was one of the first power stations to be linked to the NSW electricity 'super grid.' In total this power station cost the NSW electricity commission $1.653 billion. Large components of the power stations were shipped through the Swansea channel, up through Lake Macquarie and to the Eraring site. The peak of employment involved having 2,300 workers, at the completion of the power station staff totalled close to 600. The coal for the power station was sourced from Lake Macquarie mines in Cooranbong and Myuna Collieries (Eraring Power Station: Community History - Lake Macquarie Libraries, n.d.).

4. Sampling for Fish

Fish traps were set at the following locations near Eraring Power Station (Figure 2, 4) and Vales Point Power Station (Figure 3,5)

Figure 2

Whiteheads Lagoon-33.0657 151.5453

Dora Creek -33.0792 151.4906

Figure 3

Mannering Park -33.1467 151.5364

Mannering Bay -33.1582 151.5268

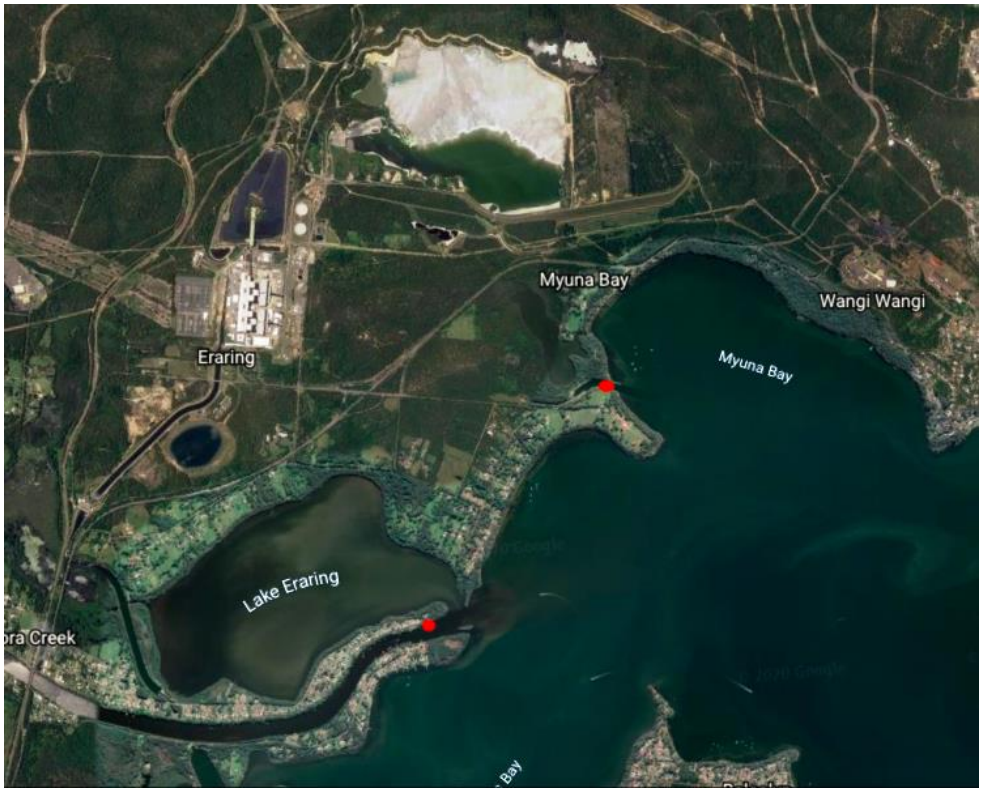

Figure 4

Whiteheads Lagoon -33.0657 151.5453

Dora Creek Boat Ramp -33.0834 151.5317

Figure 5

Mannering Park -33.1565 151.5324

Mannering Park 2 -33.1579 151.5289

Mannering Bay -33.1582 151.5268

Methods

Fish Traps

The first method that was used to try and catch fish were fish traps made out of recycled plastic bottles. The way that these bottles were designed was to cut the top quarter of the bottle off, remove the cap, flip the top of the bottle and place it downwards into the bottom of the bottle **(Figure 6a).** You would then add bait, submerge the bottle in water slowly and rest it on something, lastly adding more fish bait in the opening of the trap. This trap works by fish going through the mouth of the bottle and once they are in the bottom of the bottle where the bait is, it becomes difficult for the fish to see and find their way out **(Figure 5b).** As time went on the design of this trap changed to adapt to the results we were getting.

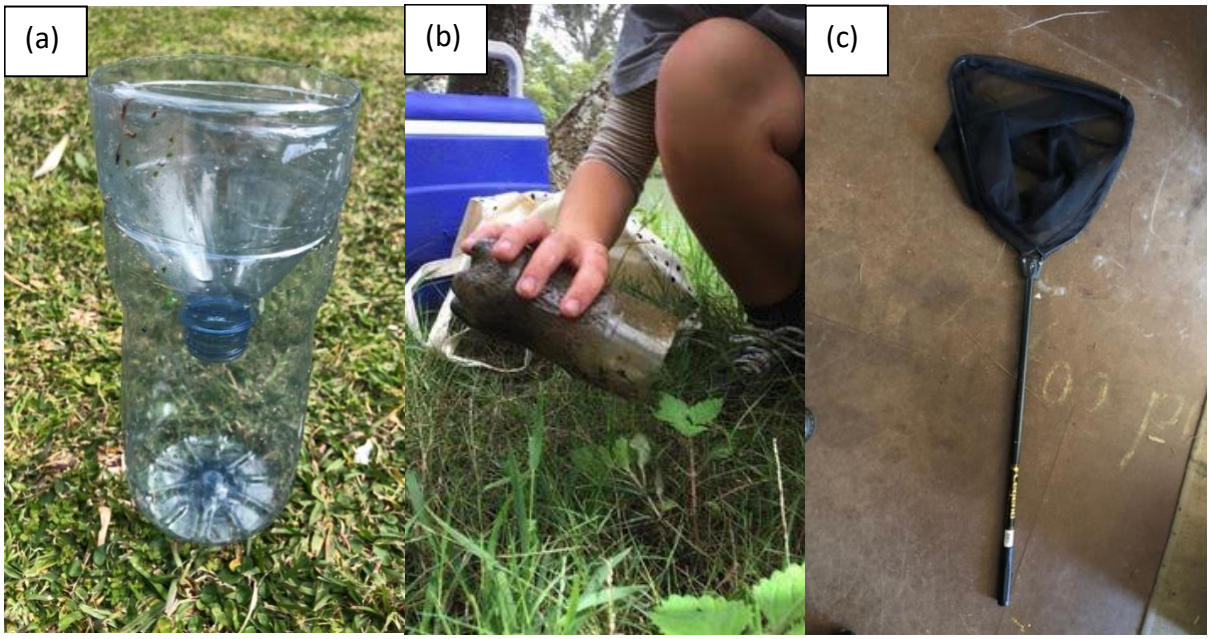

Figure 6- (a) The fish trap design, (b) Fish trap after being places in water and (c) The fish dip net used.

Fish Nets

After a few attempts at using fish traps, it was decided to also use a net method to catch fish in response to the fish traps being unsuccessful. This involved getting a handheld net long enough to put out in the water, have enough space for lots of fish to get in and most importantly have a really fine net, as the aim was to catch small fish.

5. Outcomes of Fish Sampling

Fish Trap: Attempt One 08/09/2020

For the first round of setting up the traps four 500ml bottles were used, these locations were selected due to their close proximity to Eraring and Vales Point Power Station. Two traps were set in Whiteheads Lagoon and Dora Creek located near Eraring Power Station **(Fig 2),** then two traps were set in Mannering Park and Mannering Bay which is located near Vales Point Power **(Fig 3).**

Traps were set up by cutting holes in the bottles to put rope through and tie it around a branch for easy retrieval. On the first day of setting up the traps in September 2020 we used rice crackers as bait, and we placed the 500ml bottles into the water and left them for roughly a week and would continue to check on them regularly, but we were not trapping any fish.

The traps were checked regularly so that any fish captured could be quickly retrieved. During each check, fish were firstly checked, any sediment or seaweed that built up in the trap was emptied and then the trap was rebaited. An observation was made that the bottles were floating and not staying under water, to fix this issue we got stockings, cut little sections, added some rocks and added pilchard fish bait. Adding this stocking bag into the bottle meant fish would be attracted to the seafood bait and it would also keep the bottle standing and fully submerged in water due to the rocks weighing it down.

Fish Trap: Attempt Two: 03/11/2020

Following no captures of fish in the first trapping round, it became clear a new method was needed; the first change that needed to be completed was to make the bottles bigger; this was done by using three 1.5L bottles. Using bigger bottles meant there is more room for fish to get in and stay in the bottle. In early November 2020, it was decided to use larger bottles, still with the same design but then also add the stocking in the bottle with rocks to weigh it down and pilchard bait to attract the fish.

This time only three traps were set up at Whiteheads Lagoon **(Fig 4)** and Mannering Bay **(Fig 5)** the traps were just upgraded not moved but in Mannering park it was moved closer to the power stations and also out further in the water as it was a more accessible location.

Fish Net: Attempt One 02/11/2020

The first place that fish were successfully caught was at Whiteheads lagoon **(Fig 4).** They were caught by sitting on a bridge ledge, placing the net in the water, throwing in pilchard bait and scooping the net up once fish were eating the bait. 12 fish were caught, these were quickly retrieved and euthanised by placing into an ice slurry.

Fish Net: Attempt Two- 09/11/2020

On November 9th the bait and net method was used in Lake Macquarie, the fish traps were also collected as they have proven to be unsuccessful. The net and Pilchard bait method was used at 4 different locations around Lake Macquarie. One fish was successfully caught with

this method in Mannering Park which is the suburb Vales Point Power Station is located in **(Fig 5).** This fish was euthanised as described earlier.

6. Results and Discussion

Thirteen fish were collected that all belonged to the same species The Common Silver Biddy (Gerres subfasciatus), in the Family Gerreidae. The Silver Biddy has a silver-coloured body, family to Gerreida. They are found in estuaries, harbours, sandy bottoms and can be in deep water along shores. They reportedly travel in schools and are affected by fresh water (Fishbase, n.d) The Silver Biddy use both their jaws to protrude out and down to create a tube which can suction up their food and feeds on bottom-dwelling invertebrates, meaning the Silver Biddy are carnivores (Common Silverbiddy, Gerres subfasciatus (Cuvier, 1830), n.d.) Their body size helps explain why they did not enter the fish traps and their diets would help explain why they were attracted to fish bait. Silver Biddy is perfect for this study, as they are feeding on animals that live in the sediment and would therefore be likely to have been exposed to sediment-associated heavy metals.

Each fish was sent off for analysis by EnviroLab in Sydney to be tested for heavy metals, their whole bodies were analysed.

Seen below **(figure 7,8,9)** are three graphs with the highest levels of heavy metals that were found from an analysis sent by EnviroLab. Iron, manganese and zinc were the only heavy metals with any potentially elevated levels in the fish. (Appendix)

When trying to see whether the results from the fish samples were elevated or not, it was understood that the fish tested did not have any levels of heavy metals present in their bodies, which does not match the original hypothesis. The Silver Biddy fish is rich in minerals (SILVER-BIDDY, n.d.) this means that the reason there were higher levels in Iron and Zinc were because this specific fish species has an already high level of these heavy metals in their body.

Iron

No iron was detected in Fish 7, otherwise iron concentration ranged between 10mg/kg (9 fish in total) up to 30mg/kg in Fish 1 **(Fig 7).** The average level of iron was calculated to be 12.3mg/kg.

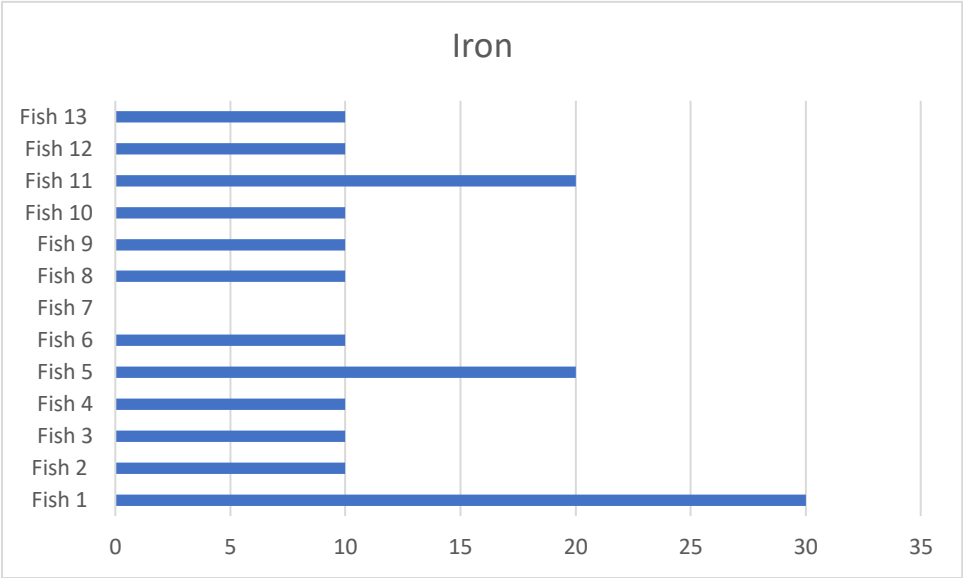

Figure 7- Iron concentrations (mg/kg) in 13 individuals of Silver Biddy.

Manganese

For Manganese **(Fig 8)** the average level in fish was 2. Fish 1 had the highest level of manganese in its body with 4mg/kg.

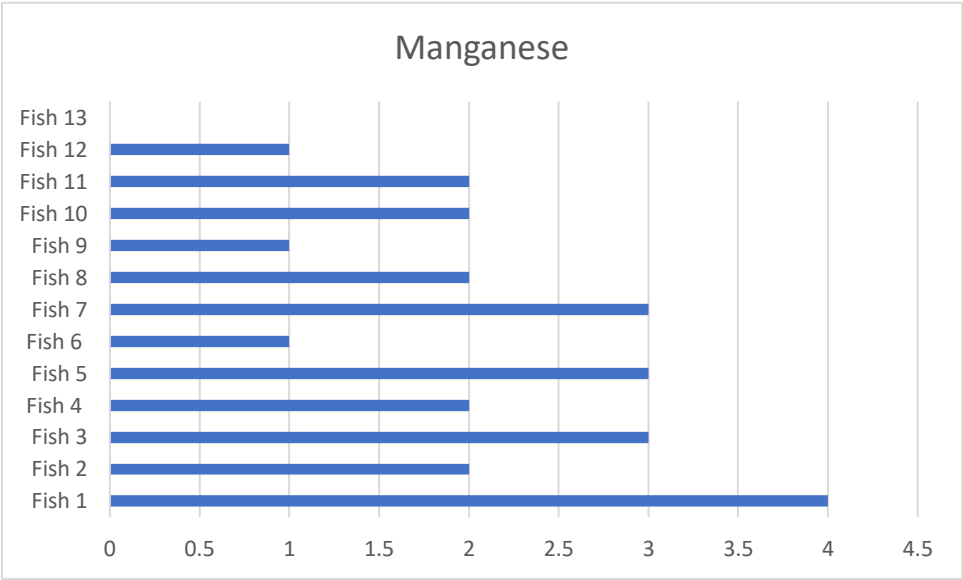

Figure 8- Manganese concentrations (mg/kg) in 13 individuals of Silver Biddy.

Zinc

The average level of zinc found in **(fig 9)** was 41.9. Most of the fish had similar levels of zinc in their bodies.

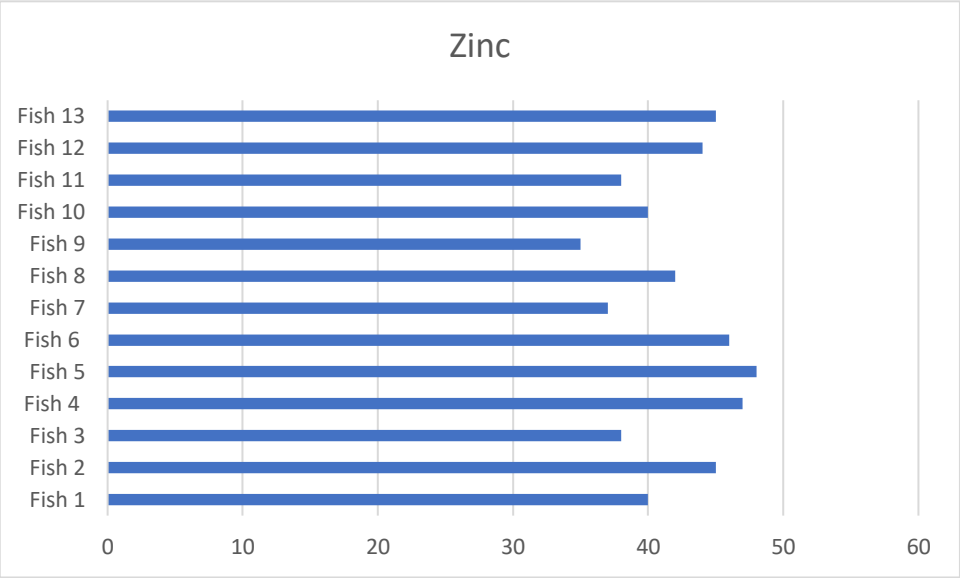

Figure 9- Zinc concentrations (mg/kg) in 13 individuals of Silver Biddy.

7. Conclusion

It was difficult to firstly develop a method to capture fish in Lake Macquarie (NSW). After many attempts at setting up fish traps made out of plastic bottles and adapting them it was evident the fish traps were unsuccessful, and a new method was created. Using a fine mesh net and bait, we successfully collected the 13 fish that were sent and tested for heavy metals by EnviroLab. This method of using a handheld net and pilchard bait was very effective and in the first attempt and worked right away, the second time using this method it took while longer as it was a different location that was not as easily accessible to the water.

The Silver Biddy fish samples that were analysed from Lake Macquarie NSW, showed no elevated levels of heavy metals in any of the 13 individuals which does not match the original hypothesis for this investigation. **Though there are no elevated levels of heavy metals present in the fish sampled** in this report, it is possible these fish species had not been present in that environment for a sufficient amount of time to accumulate heavy metals.

It was expected that Silver Biddy would show some evidence of heavy metal accumulation as there is evidence of heavy metal pollution in Lake Macquarie in other species that also feed on bottom-dwelling invertebrates. It is discussed in HCECs 'Out of the Ashes' report that there has been a study conducted in 2018 by The Office and Environmental and Heritage, the study found that any consumption of Mud Crab and Blue Swimmers Crab in Lake Macquarie would results in exposure to Cadmium. It was also found that above certain

quantities of Finfish can result in exposure to selenium (Winn, 2019). The Hunter Community Environment Centre are currently working on an ongoing report where they have traced heavy metals in bird feathers collected around Lake Macquarie, the HCEC have also undertaken water and sediment samples that evidently show elevated levels of heavy metal pollution to Lake Macquarie in both their reports 'Out of the Ashes' and 'Out of the Ashes 2'.

8. Recommendations

Recommendation 1: For the Silver Biddy to be further tested to see if bioaccumulation in this fish species occurs from the two operating coal fired power stations. The Silver Biddy is an edible human consumed fish, if this species does bioaccumulate heavy metals from coal ash pollution then it would not be safe to eat.

Recommendation 2: Eraring and Vales point power stations should consider bioremediation of the coal ash dams; as an alternative to capping.

Recommendation 3: The OEH (Office of Environment and Heritage) should undertake another mud crab and blue swimmer crab to investigate whether cadmium is high in their bodies since the most recent study in 2018.

Recommendation 4: Further research should be undertaken by the EPA and/or government to understand how fish are being affected by coal ash damn pollution in Lake Macquarie.

9. Acknowledgments

I would like the acknowledge and thank the Hunter Community Environment Centre, Johanna Lynch, Paul Winn and Naomi Jones for the assistance in conducting this fish study and providing the recourses to send the fish to EnviroLab.

10. References

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https://link.springer.com/article/10.1007/s00244-007-9027-z

11. Appendix

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ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
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CERTIFICATE OF ANALYSIS 255455

Client Details	
Client	Hunter Community Environment Centre
Attention	Naomi Jones
Address	167 Parry St, Hamilton East, NSW, 2303

Sample Details	
Your Reference	Hunter Community Env Centre- Lake Macquarie Fish
Number of Samples	13 Fish
Date samples received	11/11/2020
Date completed instructions received	11/11/2020

Analysis Details
Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details	
Date results requested by	18/11/2020
Date of Issue	24/11/2020
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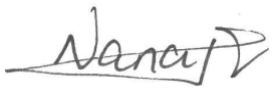
Results Approved By
Hannah Nguyen, Senior Chemist

Authorised By



Nancy Zhang, Laboratory Manager

Client Reference: Hunter Community Env Centre- Lake Macquarie Fish

Acid Extractractable metals in material						
Our Reference		255455-1	255455-2	255455-3	255455-4	255455-5
Your Reference	UNITS	1W	2W	3W	4W	5W
Date Sampled		02/11/2020	02/11/2020	02/11/2020	02/11/2020	02/11/2020
Type of sample		Fish	Fish	Fish	Fish	Fish
Date prepared	-	11/11/2020	11/11/2020	11/11/2020	11/11/2020	11/11/2020
Date analysed	-	16/11/2020	16/11/2020	16/11/2020	16/11/2020	16/11/2020
Silver	mg/kg	<1	<1	<1	<1	<1
Aluminium	mg/kg	<10	<10	<10	<10	<10
Arsenic	mg/kg	<4	<4	<4	<4	<4
Boron	mg/kg	3	<3	<3	<3	<3
Cadmium	mg/kg	<0.4	<0.4	<0.4	<0.4	<0.4
Chromium	mg/kg	<1	<1	<1	<1	<1
Copper	mg/kg	<1	<1	<1	1	<1
Iron	mg/kg	30	10	10	10	20
Lead	mg/kg	1	<1	<1	<1	<1
Manganese	mg/kg	4	2	3	2	3
Mercury	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	mg/kg	<1	<1	<1	<1	<1
Selenium	mg/kg	<2	<2	<2	<2	<2
Thallium	mg/kg	<2	<2	<2	<2	<2
Vanadium	mg/kg	<1	<1	<1	<1	<1
Zinc	mg/kg	40	45	38	47	48

Client Reference: Hunter Community Env Centre- Lake Macquarie Fish

Acid Extractractable metals in material						
Our Reference		255455-6	255455-7	255455-8	255455-9	255455-10
Your Reference	UNITS	6W	7W	8W	9W	10W
Date Sampled		02/11/2020	02/11/2020	02/11/2020	02/11/2020	02/11/2020
Type of sample		Fish	Fish	Fish	Fish	Fish
Date prepared	-	11/11/2020	11/11/2020	11/11/2020	11/11/2020	11/11/2020
Date analysed	-	16/11/2020	16/11/2020	16/11/2020	16/11/2020	16/11/2020
Silver	mg/kg	<1	<1	<1	<1	<1
Aluminium	mg/kg	<10	<10	<10	<10	<10
Arsenic	mg/kg	<4	<4	<4	<4	<4
Boron	mg/kg	<3	<3	<3	<3	<3
Cadmium	mg/kg	<0.4	<0.4	<0.4	<0.4	<0.4
Chromium	mg/kg	<1	<1	<1	<1	<1
Copper	mg/kg	<1	<1	<1	<1	<1
Iron	mg/kg	10	<10	10	10	10
Lead	mg/kg	<1	<1	<1	<1	<1
Manganese	mg/kg	1	3	2	1	2
Mercury	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	mg/kg	<1	<1	<1	<1	<1
Selenium	mg/kg	<2	<2	<2	<2	<2
Thallium	mg/kg	<2	<2	<2	<2	<2
Vanadium	mg/kg	<1	<1	<1	<1	<1
Zinc	mg/kg	46	37	42	35	40

Client Reference: Hunter Community Env Centre- Lake Macquarie Fish

Acid Extractractable metals in material				
Our Reference		255455-11	255455-12	255455-13
Your Reference	UNITS	11W	12W	1MA
Date Sampled		02/11/2020	02/11/2020	09/11/2020
Type of sample		Fish	Fish	Fish
Date prepared	-	11/11/2020	11/11/2020	11/11/2020
Date analysed	-	16/11/2020	16/11/2020	16/11/2020
Silver	mg/kg	<1	<1	<1
Aluminium	mg/kg	<10	<10	<10
Arsenic	mg/kg	<4	<4	<4
Boron	mg/kg	<3	<3	<3
Cadmium	mg/kg	<0.4	<0.4	<0.4
Chromium	mg/kg	<1	<1	<1
Copper	mg/kg	<1	<1	<1
Iron	mg/kg	20	10	10
Lead	mg/kg	<1	<1	<1
Manganese	mg/kg	2	1	<1
Mercury	mg/kg	<0.1	<0.1	<0.1
Nickel	mg/kg	<1	<1	<1
Selenium	mg/kg	<2	<2	<2
Thallium	mg/kg	<2	<2	<2
Vanadium	mg/kg	<1	<1	<1
Zinc	mg/kg	38	44	45

Method ID	Methodology Summary
Metals-020	Determination of various metals by ICP-AES.
Metals-021	Determination of Mercury by Cold Vapour AAS.

Client Reference: Hunter Community Env Centre- Lake Macquarie Fish

QUALITY CONTROL: Acid Extractractable metals in material						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			11/11/2020	[NT]	[NT]	[NT]	[NT]	11/11/2020	[NT]
Date analysed	-			16/11/2020	[NT]	[NT]	[NT]	[NT]	16/11/2020	[NT]
Silver	mg/kg	1	Metals-020	<1	[NT]	[NT]	[NT]	[NT]	103	[NT]
Aluminium	mg/kg	10	Metals-020	<10	[NT]	[NT]	[NT]	[NT]	105	[NT]
Arsenic	mg/kg	4	Metals-020	<4	[NT]	[NT]	[NT]	[NT]	108	[NT]
Boron	mg/kg	3	Metals-020	<3	[NT]	[NT]	[NT]	[NT]	104	[NT]
Cadmium	mg/kg	0.4	Metals-020	<0.4	[NT]	[NT]	[NT]	[NT]	105	[NT]
Chromium	mg/kg	1	Metals-020	<1	[NT]	[NT]	[NT]	[NT]	106	[NT]
Copper	mg/kg	1	Metals-020	<1	[NT]	[NT]	[NT]	[NT]	105	[NT]
Iron	mg/kg	10	Metals-020	<10	[NT]	[NT]	[NT]	[NT]	106	[NT]
Lead	mg/kg	1	Metals-020	<1	[NT]	[NT]	[NT]	[NT]	100	[NT]
Manganese	mg/kg	1	Metals-020	<1	[NT]	[NT]	[NT]	[NT]	104	[NT]
Mercury	mg/kg	0.1	Metals-021	<0.1	[NT]	[NT]	[NT]	[NT]	91	[NT]
Nickel	mg/kg	1	Metals-020	<1	[NT]	[NT]	[NT]	[NT]	100	[NT]
Selenium	mg/kg	2	Metals-020	<2	[NT]	[NT]	[NT]	[NT]	104	[NT]
Thallium	mg/kg	2	Metals-020	<2	[NT]	[NT]	[NT]	[NT]	97	[NT]
Vanadium	mg/kg	1	Metals-020	<1	[NT]	[NT]	[NT]	[NT]	101	[NT]
Zinc	mg/kg	1	Metals-020	<1	[NT]	[NT]	[NT]	[NT]	106	[NT]

Result Definitions	
NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.