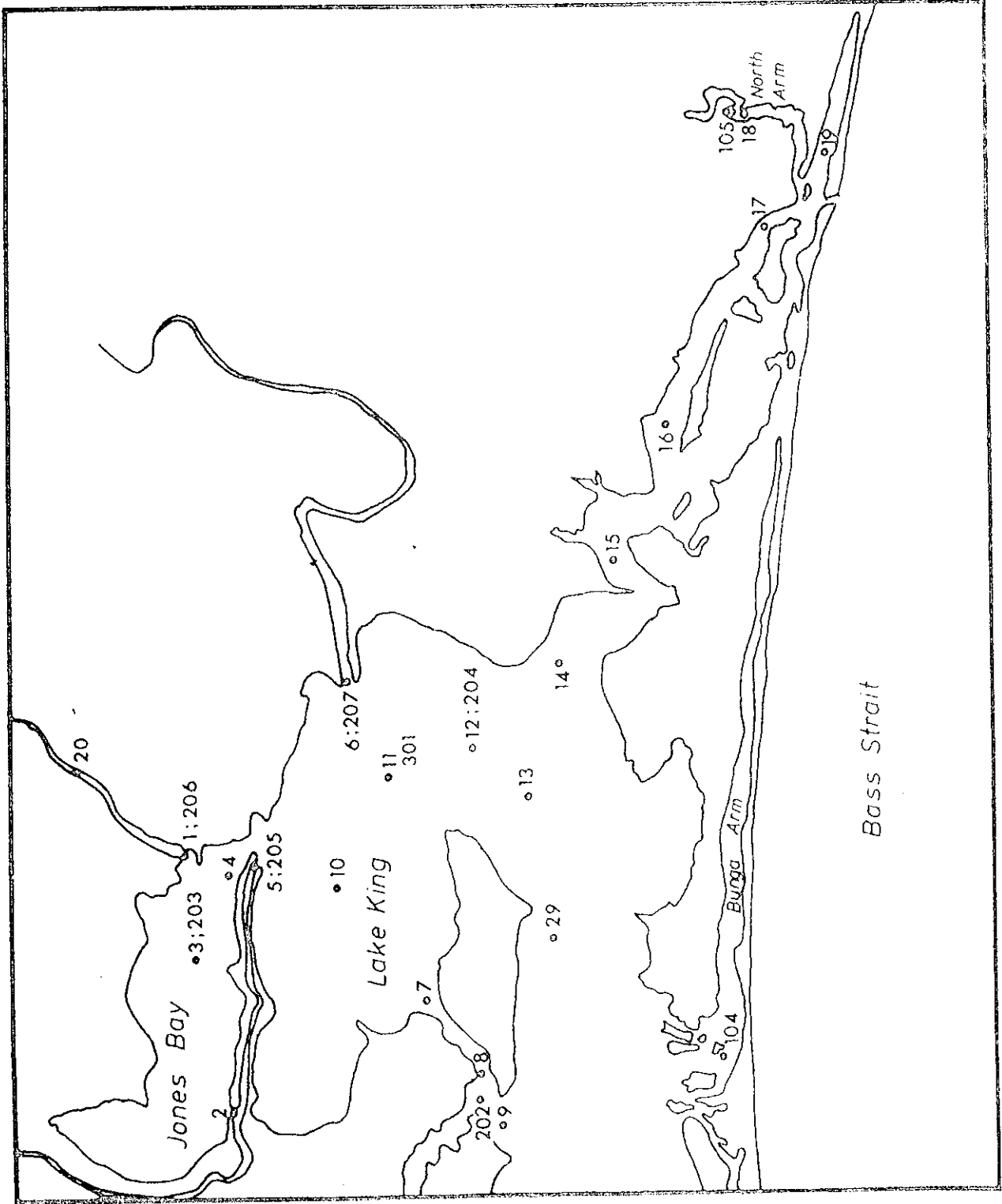


Figure 4.4 Sediment sampling stations.



Enlargement B (Sediment sampling stations).

4.4 Sediments

Surface sediments were collected on five occasions (Figure 4.4). The results obtained for the metals are listed in Appendix IX. Some locations were sampled three times. Table 4.12 lists the means, standard deviations and ranges of concentration for the metals for all samples. These data show that the concentrations of metals, other than mercury, in the sediments were similar for all sampling dates. The concentrations of mercury, however, were higher by a factor of 50-100 during August 1978, July 1979 and February 1980, compared to October 1978 and January 1979. Furthermore, in July 1979 the mercury concentrations in the sediments at a depth of about 5 cm were 10 times greater than those at a depth of about 1 cm.

Mercury concentrations in two core samples of sediment (obtained from the Department of Minerals and Energy, Victoria on 31 January 1980) corresponding to sampling stations 301 and 302 range from 0.2 to 9.2 ug/g, dry weight for the sample from Lake King and from 1.9 to 19 ug/g, dry weight for that from Lake Victoria. In both cases concentration increases with depth in the sediment with maxima at about 60 cm for Lake King and 130 cm for Lake Victoria.

The core sample from Lake King was taken on 30 March 1979, and that from Lake Victoria on 7 May 1979. The samples were not frozen at collection, but stored at ambient temperatures in plastic bags until analysis on 31 January, 1980.

The variation of mercury concentration between sampling dates is not associated with any change in the concentrations of organic carbon, silt or sulphur in the sediments, as these parameters remained relatively constant throughout the period concerned. Table 4.13 illustrates this point for samples from Lakes King and Victoria.

Table 4. 12 Mean, standard deviation, and range (in brackets) of concentrations of metals (ug/g, dry weight) in sediment, from the Gippsland Lakes according to date of sampling.

Sampling date	No. of samples	As	Co	Cr	Cu	Fe	Hg	Mn	Ni	Pb	Zn
8, 9, 10. 8. 78	5		8.1 +2.1 (6.0-11)	21 +6.0 (12-27)	15.4 +6.6 (6.0-24)	15600 +6800 (5000-22750)	18.4 +10.5 (6-30)	124 +37 (73-174)	11 +3.3 (5.5-14)	13 +6.4 (6.5-23)	34.8 +8.9 (22-46)
24. 10. 78	5		3.5 +2.2 (1.1-6.8)	16.8 +7.8 (6.0-26)	15.3 +2.5 (12-18)	10290 +2270 (7150-12250)	0.24 +0.25 (0.03-0.60)	162 +122 (45-275)	8.7 +3.9 (5.4-15)		32.8 +6.8 (26-40)
8. 1. 79	24	4.6 2.6 1.6-9.0	5.5 +2.4 (<2.0-9.5)	15.3 +8.3 (<2.5-29)	11.1 +6.8 (<0.5-23)	10330 +7805 (<500-20500)	0.49 +0.38 (0.05-1.3)	103 +63 (10-215)	8.5 +3.8 (<2.0-13)	8.7 +6.0 (<2.0-18)	34.9 +21.7 (5.5-110)
25. 7. 79	4		1.2 +0.1 (1.1-1.3)		18.7 +1.7 (17-21)	15,600 +2,500 (13,000-18,400)	44 +44 (7.2-100)	284 +182 (130-548)	N.A.	27 +2 (25-30)	40 +4 (36-45)

N.A. not analysed

Table 4.13 Mercury concentration (ug/g, dry weight), organic carbon and sulphur (percent, dry weight), in sediment from Lakes King and Victoria.

Date	Location	Mercury concentration (ug/g, dry wt.)	Organic carbon (%)	Silt (%)	Sulphur (%)
8.8.78	Lake King	28	14	88	1.4
	Lake Victoria*	30	12	87	2.3
8.1.79	Lake King	0.1	12	99	1.3
	Lake Victoria	0.9	15	98	1.2
25.7.79	Lake King	7-58	23.5-21.0	97	0.74-1.9
	Lake Victoria	9-100	25.0-20.0	97	0.74-1.2

* Newlands Arm, next to Lake Victoria

Table 4.14 Mercury concentrations in surface sediments from water bodies throughout the world, from Craig and Morton (1976).

Sample Area	No. of samples	Concentration (ug/g, dry weight) of mercury	
		Mean	Range
Gippsland Lakes, July 1979*	4	43	7.2 - 100
Gippsland Lakes, February 1980*	4	21	1.8 - 51
Gippsland Lakes, August 1978 *	5	18.4	6.0 - 30.0
Pallanza Bay, Italy	34	7.65	0.24 - 20.10
River Mersey, England	136	2.23	0.01 - 14.30
Lake Huleh, Israel	15	1.07	
Lake Windermere, England	1	1.05	
Lake Ontario, USA	248	0.66	0.03 - 2.10
Lake St. Clair USA	55	0.63	0.07 - 2.57
Everglades, USA	10	0.62	0.12 - 1.50
Lake Erie, USA	243	0.61	0.13 - 7.49
Gippsland Lakes, Jan. 1979 *	24	0.49	0.05 - 1.3
Mobile Bay, USA	4	0.38	0.22 - 0.60
Mississippi River, USA	4	0.38	0.08 - 0.57
La Have River, Nova Scotia	5	0.34	0.09 - 1.06
Southampton water, England	3	0.30	0.19 - 0.64
Lake Huron, USA	117	0.26	0.01 - 9.50
Gippsland Lakes, Oct. 1978*	5	0.24	0.03 - 0.60
Swansea Bay, Wales	11	0.19	0.04 - 0.76
Lake Michigan, USA	86	0.15	0.03 - 1.11
Thames Estuary, England	15	0.132	0.02 - 0.49
Lake Superior, USA	405	0.08	0.58

*This study

Table 4.15 Ranges of concentrations (ug/g, dry weight) of metals in samples (number in brackets) of sediments from:

	Western Port*	Port Phillip Bay **	World wide, # deep sea	Present study.
Cd	<0.10-0.67 (9)	0.12-12 (20)	<0.1-0.42	<0.5 (29)
Co	<0.6-7.5 (71)		7-74	1.1-11 (34)
Cr	<1.3-8.0 (70)		11-90	<2.5-29 (34)
Cu	<0.8-2.0 (3)	1.4-87 (20)	30-250	<0.5-24 (34)
Fe	<143-9238 (153)	535-45800 (20)	9000-65000	<500-22750 (34)
Mn	<1.7-345 (139)	6.9-519 (20)	1000-6700	10-275 (34)
Ni	<0.4-6.1 (90)		30-225	<2.0-15 (34)
Pb	<0.6-13.3 (113)	4.6-183 (20)	9-80	<2.0-23 (29)
Zn	<0.9-34.9 (147)	3.3-278 (20)	35-165	5.5-110 (34)
Hg	0.002-0.042## (26)		0.001-0.4	0.03-100 *** (38)

* Statham (1977).

** Talbot et al (1976).

Turekian and Wedepohl (1961)

***Bostrom and Fisher (1969) ## Anon. (1975b)

The mercury concentrations in the sediments collected from the Gippsland Lakes during August 1978 and July 1979 and February 1980 are higher than any reported in sediments from other parts of the world by Craig and Morton (1976). Those in sediments taken in October 1978 and January 1979 are similar to the lowest reported (Table 4.14). Smith (1976) reports mercury concentrations in the sediments of Lake Wellington and input rivers as 0.05-0.52 ug/g, dry weight. These samples were taken at the end of a drought, and the concentrations are comparable with those found in our sediments collected in October 1978 and January 1979.

The concentrations of metals obtained in this study and those in sediments in other Victorian waters and the world's oceans are given in Table 4.15. Western Port has concentrations similar to those from the Gippsland Lakes with the exception of mercury, but those from Port Phillip Bay are higher and have much wider ranges, especially cadmium, copper, lead and zinc.

In this study, mercury is the only metal whose concentration depends on the date of sampling. It is difficult to explain the discrepancy between the low mercury concentrations found in October 1978 and January 1979 and the relatively high concentrations found in August 1978, July 1979 and February 1980. It is possible that the discrepancy could be due to variation in sampling technique. The samples taken in October 1978 and January 1979 were from the upper 2 cm of sediment, whereas those taken in August 1978 could have been from depths of up to 10 cm.

It is not possible to make firm conclusions as to the form of the mercury in the sediments. The fact that it is readily soluble in 2 M nitric acid, but not in 0.01 M nitric acid, suggests that it is finely divided metallic mercury, rather than mercuric sulphide.

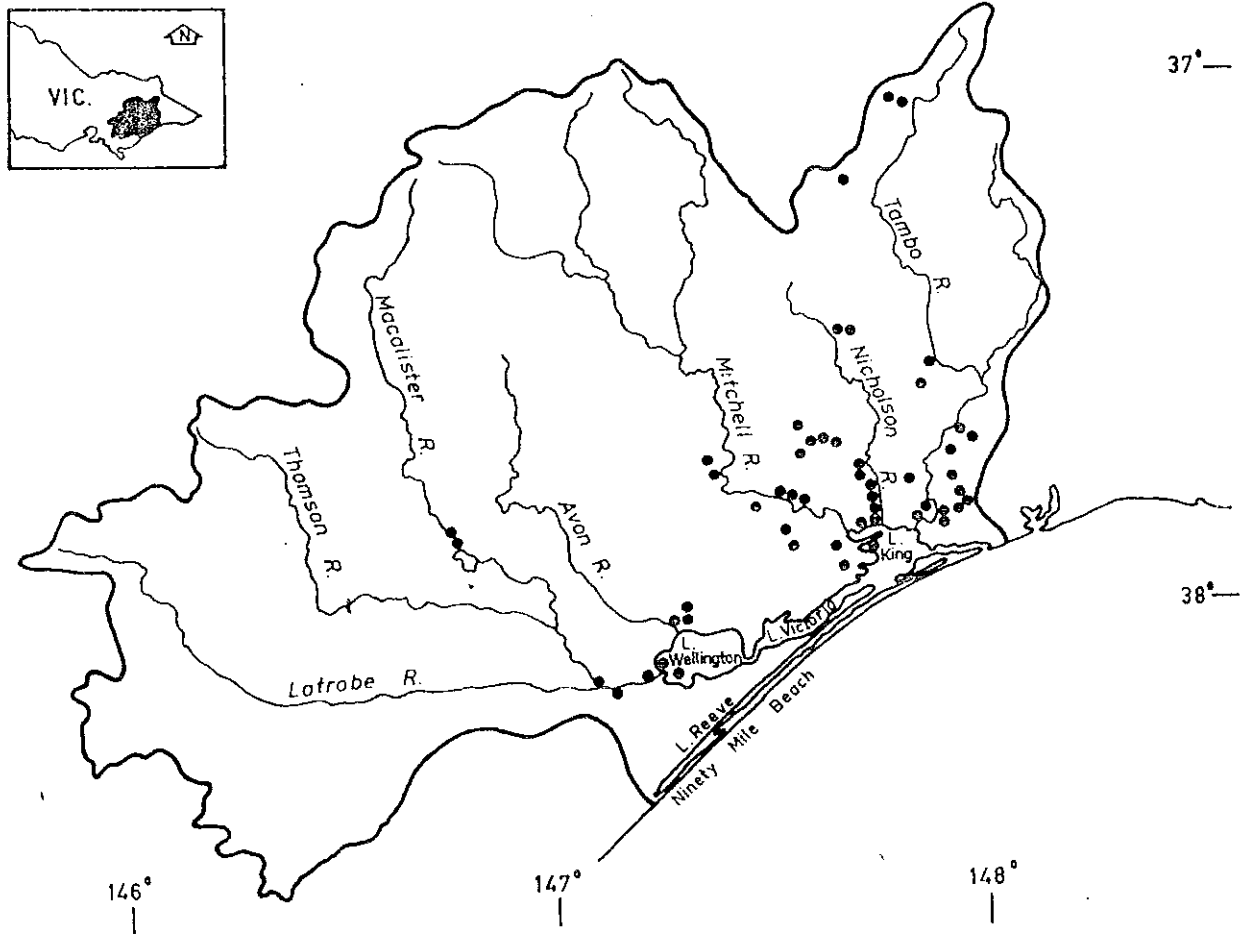


Figure 4.5 Sites of capture of bird and mammal specimens.

Table 4.16 Mean mercury concentrations (ug/g, wet weight) and number of samples (in brackets) of birds and mammals from catchment areas of the Gippsland Lakes.

Species	Locality	Muscle	Liver	Kidney
Cormorant	Tambo, Nicholson	0.57(6)	3.16(5)	2.41(6)
	Mitchell	1.18(5)	3.12(5)	3.55(4)
	Avon, Thomson, Macalister	-	40.7(1)	21.7(1)
	Snobs Creek	0.52(21)	4.43(21)	5.00(21)
	Lake Buffalo	0.57(7)	2.52(7)	4.57(7)
	Lake Modewarre	0.34(1)	1.22(1)	1.63(1)
Kookaburra	Tambo, Nicholson	0.05(5)	0.10(5)	0.11(5)
	Mitchell	0.03(6)	0.08(3)	0.08(6)
	Avon, Thomson, Macalister	0.04(6)	0.07(5)	0.10(6)
	Latrobe	0.09(4)	0.20(4)	0.23(4)
Coot	Tambo, Nicholson	<0.01	0.19(2)	0.01(3)
	Mitchell	0.01(5)	0.03(4)	0.05(4)
	Avon, Thomson, Macalister	0.04(10)	0.26(10)	0.13(8)
Crimson Rosella	Tambo, Nicholson	<0.01(5)		
	Mitchell	0.19(4)		
	Avon, Thomson, Macalister	<0.01(6)		
	Latrobe	0.01(5)	<0.01(1)	<0.01(1)
Feral Cat	Tambo, Nicholson	0.05(1)	0.07(1)	0.09(1)
	Mitchell	0.06(1)	0.17(1)	0.06(1)
Brushtail Possum	Tambo, Nicholson	0.01(4)	0.05(4)	0.92(4)
	Mitchell	<0.01(4)	0.12(4)	0.42(4)
	Avon, Thomson, Macalister	<0.01(5)	0.18(5)	0.14(5)
Eastern Water Rat	Tambo, Nicholson	0.26(1)	0.68(1)	1.10(1)
	Mitchell	0.58(4)	1.17(4)	1.48(4)
	Avon, Thomson, Macalister	1.23(2)	3.62(2)	3.76(2)
Eastern Grey Kangaroo	Tambo, Nicholson	<0.01(2)	<0.01(2)	0.04(1)
	Mitchell	<0.01(5)	-	0.01(5)

4.5 Birds and Mammals

Tissues from six species of mammals and six species of birds caught in the catchment of the Gippsland Lakes were analysed (Figure 4.5). Muscle, liver and kidney of most animals and other tissues such as heart, fat, bone and skin of a few animals were analysed for mercury. The results obtained from mammals are listed in Appendix X and those for birds in Appendix XI. Of all the animals examined cormorants had the highest mercury concentrations and the Eastern water rat the next highest. The other species, except the Brushtail possum (kidney) had concentrations about one-tenth or less than these. The relatively high mercury concentration in cormorants and water rats is probably due to a high fish (and therefore high mercury) diet. Some specimens of grebes, although not from the Gippsland Lakes, also showed similar mercury concentrations, characteristic of a fish diet. The relatively high concentration of mercury in feathers and fur is a further indication of this.

Table 4.16 lists the mean concentrations for all species according to area of collection.

The concentration of mercury in the livers of the specimens of Eastern water rat decrease in the order, Avon-Thomson-Macalister catchment, Mitchell catchment, Tambo-Nicholson catchment. Since this animal is relatively territorial these results may indicate that mercury concentration in the fish and crustaceans in these rivers decrease in the same order. Unfortunately, lack of time prevented the collection of further samples.

5. SAMPLING METHODS

Samples of fish, mussels, Zostera and sediment were taken on separate occasions from various stations (Figure 4.1 & 4.4). Salinity and temperature were recorded sometimes when samples were taken. Salinities are listed in Appendix II.

5.1 Fish

All fish were captured in seine or mesh nets. After identification, the length, weight and sex of each fish was recorded. Whenever possible tissue was removed from fresh, rather than frozen specimens. If the fish had been frozen the specimen was allowed to thaw partially to prevent undue loss of fluids from the tissues.

Tissues from gill, liver and muscle, the latter taken from above the lateral line behind the operculum, were taken from most fish. During dissection, care was taken to prevent cross contamination of the tissues with metals. After the initial incision through the skin contact of skin with other tissues and the dissecting instruments was avoided, because the concentration of metals in skin was up to ten times higher than that in muscle tissue. Similarly, concentrations in liver were as much as 100 times those of muscle tissue (Table 5.1). All tissues were stored in plastic screw top containers at -20° C.

5.2 Mussels

Common mussels Mytilus edulis were collected by hand from jetties and rocks. Little Black Horse mussels Modiolus pulex were collected from jetties and also from sediment and the root system of Zostera muelleri growing along the shallow margins of the lakes.

TABLE 5.1 Metal concentrations in skin, muscle and liver tissues from individual fish of various species.

Species	Element concentration (ug/g, wet wt.)				
	Hg	Cu	Fe	Mn	Zn
Sand Mullet					
skin	0.02	1.3	19	0.2	50
muscle	0.04	0.04	2.0	<0.2	5.9
Yellow-eye Mullet					
skin	0.08	0.7	12	0.3	41
muscle	0.10	0.3	3.5	<0.2	4.8
liver		3.1	635	0.8	29
Sea Mullet					
skin	0.02	1.2	17	<0.2	75
muscle	0.01	0.3	2.1	<0.2	2.6
Trevally					
skin	0.11	1.3	12	0.3	50
muscle	0.11	0.2	2.7	<0.2	2.6
liver		7.0	100	2.1	46
Bream					
skin	0.25	0.9	8	<0.1	39
muscle	0.52	0.1	1.5	<0.2	3.8
liver	0.17	19	190	1.2	145
Luderick					
skin	0.01	1.0	8	0.3	60
muscle	0.17	0.2	1.4	<0.2	5.3
liver		36	105	0.5	44
Flathead					
skin	0.25	0.4	9	<0.1	62
muscle	0.54	<0.1	1.1	<0.2	4.9
liver		3.1	3.17	0.4	25
Sole					
skin		0.4	7	3.6	12.5
muscle		<0.1	1.5	<0.2	4.6
liver		39	107	1.1	22

Whole soft parts of mussels were removed from their shell immediately after collection, or after partial thawing of frozen specimens. The shells were wiped clean before being opened, to prevent contamination of the sample by sediment, weed or barnacles. The soft parts of M. edulis were stored individually in plastic containers, those of M. pulex were combined to give samples large enough for analysis. Individual organs were dissected from a few M. edulis to establish the distribution of the metals in the animals. All samples were frozen and stored at -20°C .

5.3 Zostera

Clumps of Zostera muelleri were uprooted from the shallow margins of the lakes and the sediment was washed off the roots. Mussels attached to the root system were removed and retained for analysis.

The whole plants were placed in polythene bags and refrigerated at 2°C for several days. Undamaged green leaves were cut off at the roots, rinsed in distilled water and the epiphytes were removed. Sufficient leaves were selected from each clump to obtain a sample of approximately 3 g. Samples of epiphytes were retained for analysis. All samples were stored in plastic "Whirl Paks" and frozen at -20°C .

5.4 Sediments

Surface sediments were collected with an EKMAN - BERGE dredge 15 cm square. A sample of sediment was taken by removing the top 4-5 cm of sediment from the centre of the dredge. Samples were placed in plastic "Whirl Paks" and kept at 2°C .

In the laboratory, excess water was drained off, large particles of shell rock and wood were removed, and the samples were mixed by stirring in a 500 mL glass beaker. About 40 mL was placed into a plastic screw top container and frozen at -20°C . The remainder of the sample was retained for analysis of particle size.

6. ANALYTICAL METHODS

6.1 Tissue digestion for metals other than mercury

Freeze-dried tissue (200-400 mg) was weighed into a 50 mL pyrex test tube, and 5 mL of concentrated nitric acid and 3 mL of 70% perchloric acid was added. The tubes were placed in a heating block and the temperature was gradually raised to 220°C over about 8 hours. Digestion was complete when white fumes of perchloric acid were seen in the tubes. The acid solution was cooled to room temperature, diluted to 10 mL with distilled water, and boiled to dissolve all soluble material. After cooling further the solution was made up to a final volume of 20 mL in the graduated tube; a clear solution was usually obtained. In some digests however, particularly those of Zostera and mussel tissue, a white insoluble residue, probably silica, remained. This was allowed to settle and did not interfere during analysis.

6.2 Tissue digestion for mercury

Freeze dried tissue (200-400 mg) was weighed into 50 mL graduated pyrex test tubes, and 5 mL of concentrated nitric acid and 2.5 mL of concentrated sulphuric acid were added to each tube. The tubes were placed in a heating block and kept at 100°C for 4 hours. After cooling to room temperature distilled water and 5 ml of 10% hydroxylamine hydrochloride were added to bring the volume to 50 mL.

6.3 Sediment digestion.

All the samples of sediments were freeze dried at -50°C and a vacuum of 0.05 mm of mercury for about 50 hours before being ground in an acid-washed mortar and pestle. Samples (900-1100 mg) of sediment were weighed into 250 mL. conical flasks and stirred magnetically overnight with 30 mL of 2 M nitric acid.

Most of the sediment in the digest was filtered off and the filtrate was centrifuged at 2000 rpm for 10 min to remove fine sediment. The supernatant liquid was removed by pipette and made up to a final volume of 50 mL with 2 M nitric acid.

6.4 Analysis of cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel, and zinc.

Aqueous solutions of the acid digests were analysed directly by flame atomisation atomic absorption spectrophotometry. Detection limits for each element are given in Table 7.1.

Standard solutions of inorganic salts were prepared in dilute acid at the same concentration as in the sample solutions. Standard additions on selected samples revealed that suppression or enhancement of absorbance by the sample matrix was negligible.

Table 6.1 Summary of Atomic Absorption Techniques

Element	Atomisation Method	Type of Flame	Detection Limit
As	Hydride Generation	H ₂ /N ₂ /Entrained Air	0.02 ug
Se	"	" "	0.02 ug
Cd	Flame	Acetylene/Air	0.02 ug/mL
Co	"	"	0.10 "
Cu	"	"	0.05 "
Fe	"	"	0.20 "
Mn	"	"	0.05 "
Ni	"	"	0.1 "
Pb	"	"	0.2 "
Zn	"	"	<0.1* "
Cr	"	Acetylene/N ₂ O	0.2 "
Hg	Mercury Vapour Generation	None	0.02 ug

*maximum sensitivity was not used for Zn, and the limit of detection was not determined.

6.5 Analysis for arsenic and selenium

A 5% solution of sodium borohydride (4 mL) in 1% sodium hydroxide was added to 10 ml of 1:3 hydrochloric acid solution containing a known volume (up to 7.5 ml) of the sample solution and the hydride generated was measured by atomic absorption spectrophotometry. Pre-reduction of the acid digest with 1 mL of 10% sodium iodide for arsenic and by boiling in 1:1 hydrochloric acid for selenium was necessary to ensure these elements were reduced to their III and IV oxidation states respectively. Inorganic standards were made up in the same acid matrix as the samples.

6.6 Analysis for mercury

A 20% solution of stannous chloride (1 mL) in 1:10 hydrochloric acid was added to the aqueous solution of acid digest, the mixture was stirred for 90 seconds and the mercury vapour generated was measured by atomic absorption spectrophotometry.

6.7 Estimation of organic carbon in sediment

The organic carbon content of freeze dried sediments was estimated by ignition of 800-1,200 mg samples at 500°C until constant weight was obtained.

6.8 Measurement of fraction of sediment particles of diameter less than 64 um

5,000-10,000 mg of freeze dried sediment was mixed with 100 mL of dispersant solution (0.1% sodium polyphosphate). The mixture was sieved using a 64 um mesh and a soft brush. The mixture which passed through and the particles retained were collected, dried and weighed. After allowing for the weight of dispersant in the finer of the two fractions, the proportion of particles less than 64 um in diameter was calculated.

6.9 Determination of sulphur in sediment

Sulphur was determined in sediments using the wet process of Vogel (1939) for sulphur in iron pyrites.

6.10 Analytical precision of heavy metal analyses

Analytical precision was estimated by repeatedly analysing several samples. The results obtained (Table 7.2) show that the precision expressed as coefficient of variation is about 10% or better in all cases at the concentrations shown. Precision was not determined for cobalt, chromium and nickel, as these metals were rarely detected.

Table 6.2 Precision of heavy metal analyses.

Metal	No. of replicate analyses	Mean (ug/g)	Standard deviation	Coefficient of variation.
As	3	6.5	0.4	6
Cd	3	1.5	0.05	3
Cd	3	57	1	2
Cu	6	5.2	0.7	13
Fe	6	139	7	5
Hg	6	0.26	0.03	12
Hg	4	2.1	0.1	5
Mn	6	4.0	0.3	8
Pb	3	30	2	7
Se	6	5.1	0.4	8
Zn	6	87	2	2

7. CONCLUSIONS

The results from this study of metal concentrations in the biota and the sediments of the Gippsland Lakes indicate that the metals arsenic, cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel, selenium and zinc are present at concentrations that are normal in an unpolluted environment, except from some instances of slightly elevated concentrations of cadmium, copper, nickel, lead and zinc near towns and boating harbours. On the other hand, high concentrations of mercury were found on some occasions in biota and sediments.

The relatively high concentrations of mercury which were found in the livers of the mullet in May 1978, and in mussels and Zostera in August 1978, indicate the presence of relatively high concentrations of mercury in the water from May until August 1978. This corresponds to the period in 1978 when the lakes were in flood. The obvious conclusion is that sediments containing mercury are scoured from the beds of at least some of the rivers during time of flood and swept downstream into the lakes. A similar phenomenon was found to occur in the Carson River system in Nevada, U.S.A. (Richins and Risser, 1975). A significant proportion of the sediment containing the mercury remains suspended as it moves through the lakes, and is swept out to sea, as demonstrated by the high mercury concentrations found in mussels near the Entrance in August 1978.

The possibility that turbulence during flood could resuspend mercury from the bottom of the lakes themselves, leading to elevated mercury concentrations in biota, is ruled out by evidence (Pooley, personal communication) that during flood a layer of relatively saline and anoxic water remains undisturbed on the bottom in the deeper parts of the lakes.

It seems likely that mercury containing sediments are swept down river each time floods occur. Over many years the concentrations of mercury in the sediments of the lakes have increased to the point where those of Lakes King and Victoria are now high by world standards.

Table 7.1 Discharge of mercury into the Gippsland Lakes Catchment from known sources.

Source	Period	Area of release	Estimated weight of mercury discharged (tonnes)	Estimated rate of discharge at present (tonnes/year)
Gold mining	1850-present	Creeks,rivers.	63-76	unknown
S.E.C. stack emissions	1924-present	Atmosphere	40*	2.3
A.P.M. chloralkali waste water	1956-1974	Latrobe river	10	0
A.P.M. waste water	-present	Latrobe river	<8#	<0.2

*Estimate is based on consumption of 400 megatonnes of coal since 1924, and an average mercury concentration of 0.1 ug/g in coal.

#Estimate assumes an annual discharge of 0.2 tonnes per year for 40 years.

The relatively high concentration of mercury in the sediment could presumably cause accumulation of mercury in benthic organisms and consequently in the tissues of bottom feeding fish. Richins and Risser (1975) showed that the concentration of mercury in bottom dwelling animals (crayfish and Tahoe sucker) was significantly correlated with the concentration in the sediment. However, nine specimens of dusky flathead were the only fish captured which had accumulated mercury above the statutory level of 0.5 ug/g, wet weight.

The high concentrations of cadmium, copper, nickel, lead and zinc in Zostera from the North Arm, Metung, Paynesville and Seacombe Landing are probably attributable to urbanisation nearby and to recreational boating.

It would be a complex task, and outside the scope of this report, to account for the concentration of each metal found in significant quantity in the lakes. As has already been stated, most metals have concentrations "normal" for an unpolluted area, as far as comparison is possible. This is not to say that the concentrations of some metals such as arsenic, copper, iron and zinc have not changed in the last 100 years, as they are likely to be higher due to erosion from mining areas in the catchment. However, it would be necessary to carry out a comparative survey with a relatively pristine lakes system if definite data on this point were needed.

It is possible though, to attempt to account for the high concentration of mercury in the sediment of the lakes. Table 7.1 lists the contributions of mercury from all known sources, as detailed in Section 3. The contribution from mining is the most significant of the sources known. Assuming that atmospheric fallout of mercury in rain and dust resulting from power generation by the S.E.C. occurs solely over the catchment of the

lakes, this source could increase the mercury load by about 2.3 tonnes/year* at the present rate of power generation. This is a significant addition, although it is unlikely that the catchment receives all of the mercury lost from the burning of coal in the S.E.C. plants. More precise information about the extent and ultimate fate of mercury emission from this source seems desirable.

In conclusion some effective indicators of mercury and other metals have been identified. The liver of mullet accumulates mercury more rapidly and to a greater extent than the muscle, and is therefore a better indicator of mercury concentrations in the water and food organisms than muscle. M. edulis and M. pulex are also indicators of mercury, but M. pulex due to its tolerance of low salinities and its consequent wider distribution in the lakes, is a better indicator than M. edulis.

*This estimate could be inaccurate to the extent that it does not allow for the moisture content of brown coal, and assumes an average mercury concentration in brown coal of 0.1 ug/g, dry weight.

8. RECOMMENDATIONS.

1. Further investigation is required to determine the distribution of mercury throughout the lakes, and whether significant quantities of mercury are still entering the lakes or being discharged from the lakes.
2. The effects on the biota of the lakes of the high concentrations of mercury in the sediments and in the water during floods should be investigated.
3. The amount of mercury entering the catchment area via rain or dust as a result of coal burning in the power stations of the Latrobe Valley should be determined.
4. The high concentrations of mercury in the sediment should be considered when any operation in the lakes or catchment is being proposed. The possibility that some of the mercury may re-dissolve or become re-suspended in the water should always be borne in mind. In particular the following operations could mobilise some of the mercury.
 - a) Mechanical disturbance of the sediment such as dredging.
 - b) A decrease in the organic content of the sediment, particularly the organic sulphur content.
 - c) Addition of substances which could react chemically with the mercury in the sediment.
 - d) Changes in pH or temperature of the lakes.
5. Mining activities in the catchment should be carefully scrutinised vis a vis the possibilities of release of acidic waste and heavy metals, from mines or from existing tailings dumps.

9. REFERENCES

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