

Heavy metal and organochlorine concentrations in New Zealand aquatic fish, crustaceans, and molluscs

C. M. Fenaughty,
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The Leading Edge

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INTRODUCTION

Fisheries Research Division* (FRD) of the Ministry of Agriculture and Fisheries (MAF) started analysing heavy metals in aquatic animal tissues in the early 1970s; papers have been published on the levels in New Zealand molluscs (Nielsen 1974, 1975; Nielsen and Nathan 1975) and snapper, *Chrysophrys auratus* (Robertson *et al.* 1975). A programme was then set up in 1979 to determine concentrations of mercury, cadmium, lead, copper, zinc, and organochlorine pesticides in commercially important fish. Publications have treated mercury levels in orange roughy, *Hoplostethus atlanticus*, (van den Broek and Tracey 1981) and 27 other deepwater fish species (van den Broek *et al.* 1981), as well as the possible effects of mining on mercury, cadmium, copper, zinc, and arsenic levels in Coromandel shellfish and finfish (Tracey and van den Broek 1987).

The Meat Division† of MAF has used the mercury analyses for export certification of fish and shellfish; the New Zealand Health Department is responsible for monitoring heavy metal levels in aquatic organisms to ensure that they are safe for human consumption within New Zealand. The domestic maximum permissible levels are contained in the Food Regulations 1984 (Statutory Regulations 1984/262) and replicated in Appendix 1.

Mercury is the heavy metal of most concern to human health. It is particularly toxic as methyl mercury because of its ability to bond covalently to enzyme sulphhydryl functions and its lipid solubility (Hancock *et al.* 1977). Lead and cadmium are also highly toxic to humans (Anon. 1972, D'Itri 1972, Kurland *et al.* 1960, Settle and Patterson 1980).

This report summarises the heavy metal data held at FRC, excluding that given by Tracey and van den Broek (1987), but including that by van den Broek and Tracey (1981) and van den Broek *et al.* (1981) and including some unpublished data collected by FRD.

METHODS

Tissue samples have been collected for heavy metal analysis from 78 aquatic species of fish, crustaceans, and molluscs by MAF since 1972. Most marine fish and squid samples were collected at sea, but some were supplied by New Zealand processing factories, and striped marlin (*Tetrapturus audax*) were sampled at a Bay of Islands billfish tournament in 1980. Shellfish and crustaceans were collected by dredging, diving, and shore wading; freshwater fish and eels were collected by electric fishing. All specimens were identified to the species level except for some skates which are difficult to distinguish and are often not separated commercially.

Muscle tissue was taken from the left dorsal side of fish specimens, directly posterior to the operculum, except with mixed skate (*Raja* spp.) and rough skate (*Raja nasuta*), where flesh was taken from the wings, stargazer

* Now Fisheries Research Centre (FRC), MAFFish.

† Now Meat Services, MAFQual.

(*Kathetostoma giganteum*), where flesh was taken from the posterior body, and southern bluefin tuna (*Thunnus maccoyii*), from which both tail and belly flesh were taken. An additional subcutaneous muscle sample was taken from some orange roughy (van den Broek and Tracey 1981). Mantle, digestive gland, and gonad tissues were sampled from the squids; the whole organism was homogenised for the shellfish analyses.

Heavy metal analysis before 1979 was done either at FRD or at the Meat Monitoring Division*, Wallaceville Research Centre, MAF. All analyses after 1979 were done at Wallaceville. Both MAF divisions used the following methods: total mercury was analysed by the method of Robertson *et al.* (1975), with minor modifications (van den Broek *et al.* 1981); the analytical techniques used for determining cadmium, copper, zinc, and lead concentrations were those of Gorsuch (1959) and Brooks and Rumsey (1974); selenium levels were analysed by the method of Watkinson (1966); and organochlorine levels were examined by the technique of Solly and Harrison (1972).

Detection limits were: Cd, 0.01 mg.kg⁻¹; Cu, 0.5 mg.kg⁻¹; Hg, 0.01 mg.kg⁻¹; Zn, 1.0 mg.kg⁻¹; Pb, 0.2 mg.kg⁻¹; Se, 0.02 mg.kg⁻¹; total DDT (i.e., DDT, DDD, and DDE), 0.02 mg.kg⁻¹; hexachlorobenzene (HCB), 0.01 mg.kg⁻¹; lindane, 0.01 mg.kg⁻¹; PCBs, 0.3 mg.kg⁻¹. The reliability of values below these was doubtful and has been recorded as "bd1" (below detection limits).

The analytical data were accumulated for each species and the mean, standard error, and range were calculated for the concentrations of mercury, cadmium, copper, zinc, lead, selenium, and organochlorines. Levels recorded in the raw data as "tr" (trace) or bd1 were treated as zero for statistical purposes. The mean, standard error, and range were also calculated for the corresponding lengths and weights of each species. The data were tabulated by tissue type, geographic area, and total sample for each species (Tables 1-8). Marine samples were grouped by the fisheries management areas current in 1979; these are shown in Figure 1 with the collection sites for freshwater species. Samples supplied by fishing companies were grouped into a "factory" category. Where the area was not recorded, samples were put in the "unknown" category.

Lengths and weights were not recorded for all samples, so the number of fish in the length or weight column of the tables may be less than the number of fish in the corresponding heavy metal column. In some instances only partial lengths and weights (i.e., of trussed and gutted fish) were recorded, particularly with factory samples. Lengths were measured by the appropriate FRC convention (Appendix 2).

DISCUSSION

The molluscan, crustacean, and most finfish samples had total mercury levels below the domestic maximum permissible level of 0.5 mg.kg⁻¹. Those fish species that had concentrations equal to or above 0.5 mg.kg⁻¹ were predatory and long-lived species. Carnivorous fish ingest the accumulated mercury of their prey items, and the higher a species is in the food chain, the higher its

* Now Chemical Residues, MAFTech.

mercury concentrations tend to be (Working Group on Mercury in Fish 1980). Mercury has a long biological half-life in organisms, which leads to its concentration over time (Brooks and Rumsey 1974), and longer-lived fish species generally have higher mean mercury concentrations than shorter-lived species. Older fish of the same species have higher mercury levels, and levels in individuals tend to increase with fish length (van den Broek *et al.* 1981). The variability of mercury levels at any length may thus reflect the error associated with determining mercury levels, differences in individual growth rates, and the variability of mercury levels encountered in the environment, particularly if the uptake of mercury is rapid (Walker 1976).

Nineteen fish species had mean area mercury levels above the New Zealand maximum permissible level (Table 2). Consideration should be given to the small sample sizes of some of these species, particularly mako shark (*Isurus oxyrinchus*), seal shark (*Dalatias licha*), and Owston's spiny dogfish (*Centroscymnus owstonii*), where only one sample was analysed.

All the finfish and crustacean species had concentrations of cadmium, copper, lead, and zinc below the New Zealand maximum permissible levels. High zinc and cadmium levels were found in the Bluff oyster (*Tiostrea lutaria*); however, there is no maximum permissible level set for cadmium and zinc concentrations in shellfish. Cadmium, copper, and zinc levels in arrow squid (*Nototodarus sloanii*) and giant squid (*Architeuthis* sp.) digestive gland and gonad tissue exceeded the maximum permissible levels. Very high levels of these heavy metals in the digestive gland have also been observed in *Nototodarus gouldi* (Finger and Smith 1987). The maximum permissible level for selenium was exceeded in giant squid digestive gland tissue. The most commonly consumed part of squid, the mantle, had lower than permissible levels of cadmium, copper, and zinc in all regions except the west coast of the South Island, where permissible cadmium levels were exceeded in arrow squid.

Fish accumulate heavy metals other than mercury less than molluscs, and in New Zealand several studies have shown that mean levels are below the statutory permissible levels (Brooks and Rumsey 1973, Tracey and van den Broek 1987). Shellfish, particularly filter feeders, accumulate certain heavy metals, e.g., cadmium levels above 3 mg.kg^{-1} (Nielsen 1975) and zinc levels above 1000 mg.kg^{-1} (Thrower and Eustace 1973) have been found in oysters. Lead concentrations were below the limits set in the Food Regulations 1984 in all species.

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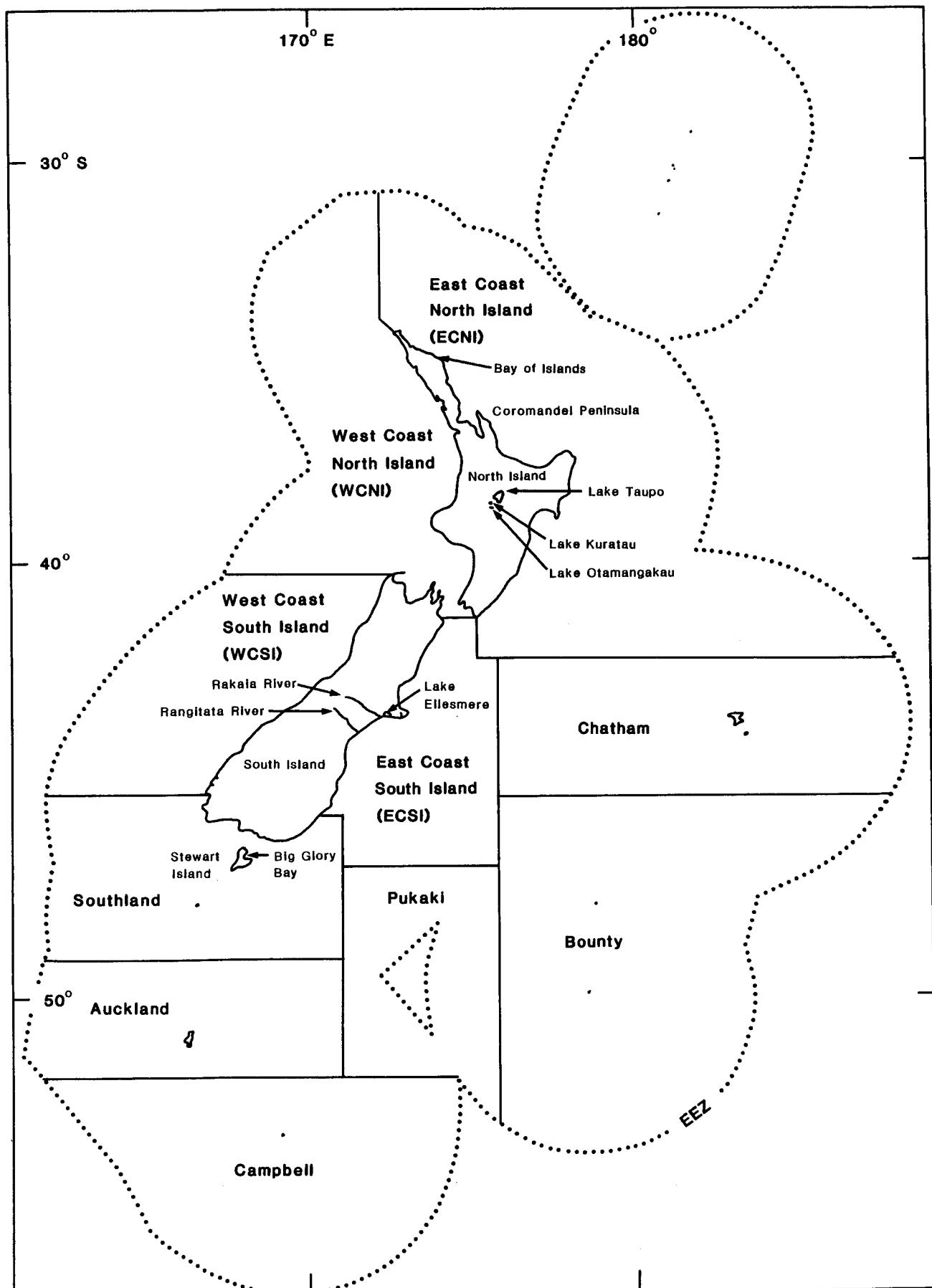


Figure 1: Areas by which marine samples were grouped and freshwater sampling sites.

Table 1a: Mercury concentrations in teleost muscle samples

Code	Species	Area*	Length (cm)				Weight (kg)				Mercury ($\text{mg} \cdot \text{kg}^{-1}$)			
			n†	\bar{x}	s.e.	Range	n	\bar{x}	s.e.	Range	n	\bar{x}	s.e.	Range
ANC	Anchovy <i>Engraulis australis</i>	WCNI									20	0.04	0.01	0.01-0.16
BAR	Barracouta <i>Thrysites atun</i>	Chattham ECSI WCNI Factory Total	24 50 36 57 167	70.2 0.8 66.7 2.0 73.4	0.8 66-89 44-96 1.3 51-92	62-78 50 20 57 127	2.06 0.20 0.48-3.30 0.09 0.48-3.60	0.07 0.20 0.66-3.45 0.06 0.48-3.60	1.40-3.60 50 36 57 167	0.12 0.09 0.08 0.08 0.09	0.01 0.01 0.01 0.01 0.00	0.05-0.25 0.04-0.26 0.01-0.48 0.01-0.29 0.01-0.48		
BAS	Bass groper <i>Polyprion moeneo</i>	Campbell	4	105.5	11.4	72-120	10	7.82	2.05	2.72-19.96	10	0.40	0.07	0.14-0.68
BCO	Blue cod <i>Parapercis colias</i>	ECNI ECSI WCNI Factory Total	21 1 8 19 49	24.2 52.0 33.8 26.6 28.5	0.3 2.0 2.0 1.0 0.9	22-28 1 8 25-39 22-52	21 1 8 19 49	0.31 2.50 0.69 0.63 0.54	0.22-0.49 1 0.15 0.06 0.06 0.06	0.25-1.50 1 8 0.38-1.50 0.22-2.50 49	21 1 8 19 49	0.08 0.28 0.21 0.05 0.09	0.01 0.01 0.01 0.01 0.01	0.04-0.15 0.07-0.49 0.02-0.08 0.02-0.49
BEL	Black flounder <i>Rhomboptera retiaria</i>	L. Ellesmere	6	20.2	2.7	16-33	6	0.70	0.06	0.47-0.80	6	0.03	0.01	0.01-0.06
BNS	Bluenose <i>Hyperoglyphe antarctica</i>	Campbell Chattham ECNI WCSI Total	4 24 78§ 5 26 78§ 59	64.8 52.1 0.9 38-76 71-82 2.5 51-94 0.9 38-76 1.7 47-94	4.1 0.8 0.9 78 5 69.3 56.1 0.9 38-76 5 9.14 0 0 78 5 9.14 5 9.14 1.7 47-94	54-72 47-58 38-76 71-82 51-94 38-76 47-94 5 9.14 0.9 38-76 1.3 17-41 37 0.9 78 5 9.14 1.06 7.10-12.10	0.22 4.35 1.06 5 0 0.41 0.63 5 9.14 1.06 1.06 0.63 0.05 0.05 0.05 1.06 7.10-12.10	1.10-9.80 1.10-9.80 7.10-12.10 8.10-12.10 1.10-9.80 7.10-12.10 7.10-12.10 7.10-12.10 7.10-12.10 7.10-12.10 7.10-12.10 7.10-12.10 7.10-12.10 7.10-12.10 7.10-12.10 7.10-12.10 7.10-12.10	10 24 83 26 47 143	0.79 0.04 0.37 0.47 0.36	0.16 0.01 0.02 0.08 0.03	0.04-1.29 Tr-0.12 0.04-0.90 Tr-1.80 Tr-1.80		
BOE	Black oreo <i>Allocyttus</i> sp.	Chattham Factory Total	17 20 37	34.9 20.4 27.1	0.6 0.4 1.3	31-41 17-24 17-41	17 20 37	0.89 0.41 0.63	0.06 0.02 0.05	0.60-1.65 0.30-0.57 0.30-1.65	17 20 37	0.17 0.31 0.24	0.03 0.02 0.02	0.05-0.44 0.20-0.47 0.05-0.47
BRI	Brill <i>Colistium guntheri</i>	Factory	30	39.5	0.7	30-46	30	1.10	0.60	0.42-1.72	50	0.06	0.01	0.01-0.22
BTR	Brown trout <i>Salmo trutta</i>	L. Ellesmere	6	36.5	5.8	19-53	6	0.84	0.28	0.10-1.80	6	0.19	0.05	0.03-0.32

* See Figure 1.

† n is number of specimens in the sample, \bar{x} is mean, s.e. is standard error, in this and ensuing tables.

‡ Partial length and weight measurements.

Table 1a: Mercury concentrations in teleost muscle samples (continued)

Code	Species	Area	Length (cm)			Weight (kg)			Mercury ($\text{mg} \cdot \text{kg}^{-1}$)					
			n	\bar{x}	s.e.	n	\bar{x}	s.e.	Range	n	\bar{x}	s.e.		
BYX	<u>Alfonso no Beryx splendens</u>	ECSI Factory Total	10 12 22	34.6 45.7 40.6	1.8 0.5 1.5	30-48 43-49 30-49	10 12 22	0.76 2.33 1.62	0.14 0.08 0.19	0.40-1.85 1.87-2.80 0.40-2.80	10 22 32	0.28 0.93 0.73	0.07 0.07 0.07	0.14-0.89 0.40-1.69 0.14-1.69
CON	<u>Conger eel</u> <u>Conger sp.</u>	Unknown	11	129.3	6.2	89-150	11	7.17	1.13	1.48-11.80	11	0.24	0.03	0.03-0.36
EEL	<u>Marine eel*</u>	Chatham									1	0.14		
EMA	<u>Blue mackerel</u> <u>Scomber australasicus</u>	WCNI	59	45.8	0.7	33-54	59	1.27	0.07	0.37-2.17	59	0.18	0.01	0.05-0.43
ESO	<u>N.Z. sole</u> <u>Peltorhamphus</u> <u>novaeseelandiae</u>	Factory	11	34.2	1.8	26-41	11	0.50	0.08	0.22-0.85	13	0.05	0.01	0.02-0.10
GUR	<u>Gurnard</u> <u>Chelidonichthys kumu</u>	ECSI ECNI Total	10 30 40	37.4 36.0 36.4	1.4 0.8 0.7	31-42 28-44 28-44	20 20 20	0.39 0.04 0.39	0.04 0.12-0.65 0.12-0.65	10 30 40	0.16 0.15 0.15	0.02 0.02 0.02	0.07-0.30 0.05-0.52 0.05-0.52	
HAK	<u>Hake</u> <u>Merluccius australis</u>	Auckland Campbell Chatham ECSI Pukaki Southland WCSI Total	9 3 14 71 3 33 53 186	102.3 79.3 77.6 87.2 76.0 95.8 84.6 87.7	2.0 17.8 3.7 1.9 10.6 2.3 1.9 1.2	91-107 44-101 55-104 59-120 63-97 71-120 41-115 41-120	2 2 2 4.15 31 33	1.35 2.80-5.50 3.75 0.27 0.26	9 3 14 72 33 53 187	0.36 0.52 0.19 0.02 0.22 0.28 0.26	0.05 0.52 0.03 0.04-0.43 0.03 0.03 0.02	0.24-0.71 0.25-0.78 0.04-0.43 0.03 0.03 0.08-0.81 0.10-1.22 0.03-1.22		
HAP	<u>Hapuku</u> <u>Polyprion oxygeneios</u>	Campbell Chatham ECSI WCNI WCSI Factory Unknown Total	10 24 4† 10 14 20† 1† 17† 41† 59	84.6 83.0 42.2 63.1 101.9 69.3 91.0 55.5 60.9 84.5	7.7 1.8 5.7 3.3 2.9 1.6 1.6 2.1 1.9 2.3	25-117 65-98 34-59 52-86 81-125 52-80 3.63 19.29 19.29 19.29	10 42 10 14 14 20 1.02 1.02 1.02 1.02	9.09 2.40 4 10 19.29 8.76 0.71 13.00-25.00 3.00-14.00	1.52 1.04 2.40 3.63 19.29 8.76 0.71 13.00-25.00 3.00-14.00	10 24 14 14 34 1 17 9 109	0.41 0.27 0.08 0.08 0.52 1 0.28 0.18 0.33	0.07 0.03 0.02 0.02 0.05 0.24 0.05 0.05 0.03	0.13-0.76 0.09-0.69 0.03-0.25 0.06-1.20	

* Species unknown.

† Partial length and weight measurements.

§ Weight of gutted fish.

Table 1a: Mercury concentrations in teleost muscle samples (continued)

Code	Species	Area	Length (cm)				Weight (kg)				Mercury ($\text{mg} \cdot \text{kg}^{-1}$)			
			n	\bar{x}	s.e.	Range	n	\bar{x}	s.e.	Range	n	\bar{x}	s.e.	
HOK	<u><i>Macruronus novaezealandiae</i></u>	Auckland Campbell ECNI ECSI WCSI Total	9 23 20 124 41 217	71.2 80.3 69.9 70.2 82.4 73.6	1.3 2.4 3.3 1.2 1.6 0.9	64-76 65-100 55-106 41-100 61-103 41-106	20 8 1.01 0.12 0.12 0.12	1.06 0.50-2.90 0.60-1.50	0.16 0.18 0.09 0.18 0.18 0.18	9 23 20 124 41 217	0.07 0.16 0.11 0.09 0.18 0.12	0.01 0.02 0.03 0.01 0.02 0.01	0.03-0.12 0.06-0.27 0.03-0.58 0.01-0.69 0.04-0.42 0.01-0.69	
JAV	<u><i>Javelin fish</i></u> <u><i>Lepidorhynchus denticulatus</i></u>	ECNI	20	53.6	1.7	37-62	20	0.57	0.04	0.25-0.90	20	0.16	0.01	0.10-0.25
JDO	<u><i>John dory</i></u> <u><i>Zeus faber</i></u>	ECNI WCNI Total	10 30 40	31.1 38.3 36.5	1.6 1.7 1.4	26-42 21-52 21-52	20 20 20	1.60 1.58 0.16	0.16 0.31-2.60 0.31-2.60	10 30 40	0.13 0.16 0.15	0.05 0.05 0.04	0.02-0.56 0.02-1.32 0.02-1.32	
JMA	<u><i>Jack mackerel</i></u> <u><i>Trachurus declivis</i></u>	Southland WCNI Total	1 43 44	34.0 32.1 32.1	1.0 1.0 0.9	22-49 22-49 22-49	19 20 20	0.48 0.52 0.52	0.09 0.15-1.30 0.15-1.30	1 43 44	0.21 0.13 0.13	0.01 0.01 0.01	0.03-0.34 0.03-0.34 0.03-0.34	
KAH	<u><i>Kahawai</i></u> <u><i>Arripis trutta</i></u>	ECNI	10	47.2	1.5	38-51					10	0.35	0.05	0.07-0.62
KIN	<u><i>Kingfish</i></u> <u><i>Seriola latifrons</i></u>	ECNI	12	65.1	5.9	48-125	12	6.90	3.10	1.60-40.00	12	0.30	0.07	0.07-0.74
LDO	<u><i>Lookdown dory</i></u> <u><i>Cynoscion traversi</i></u>	ECSI WCSI Total	2 24 26	42.5 39.4 39.7	6.5 1.5 1.4	36-49 24-51 24-51	2 2 2	1.57 0.72 0.72	0.72 0.85-2.30 0.85-2.30	2 24 26	0.28 0.43 0.42	0.11 0.03 0.03	0.17-0.39 0.17-0.73 0.17-0.73	
LEA	<u><i>Leatherjacket</i></u> <u><i>Navodon scaber</i></u>	ECNI WCNI Total	20 20 40	23.6 25.6 24.6	0.3 0.0 0.3	22-26 23-29 22-29	20 20 20	0.27 0.01 0.27	0.01 0.20-0.36 0.20-0.36	20 20 40	0.06 0.06 0.06	0.00 0.00 0.00	0.03-0.11 0.03-0.08 0.03-0.11	
LFE	<u><i>Long-finned eel</i></u> <u><i>Anguilla dieffenbachii</i></u>	L. Ellesmere									24	0.07	0.01	0.03-0.25
LIN	<u><i>Ling</i></u> <u><i>Genypterus blacodes</i></u>	Pukaki Southland WCSI ECSI Campbell Auckland Factory Unknown Total	73 28 33 222 178 31 20* 5 20* 570	75.0 88.6 105.8 86.8 85.8 82.5 73.2 89.4 73.2 86.0	2.4 3.1 3.5 1.4 1.5 3.4 2.6 3.1 2.6 0.8	34-118 54-119 69-148 31-153 39-133 33-116 51-93 81-99 51-93 31-153	73 18 176 3.60 0.21 20 3.31 5 20 272	0.26 3.74 0.58 0.50-11.37 0.26-19.40 1.08-5.65 4.08 0.77 3.31 0.14-19.40)	0.14-10.30 0.58 0.58 0.50-11.37 0.26-19.40 1.08-5.65 2.04-6.80 1.08-5.65 0.31 3.36	73 34 222 178 31 20 5 592	0.39 0.64 0.73 0.31 0.52 0.94 0.80 0.13 0.47	0.04 0.09 0.07 0.02 0.03 0.10 0.80 0.13 0.02	0.02-1.45 0.05-1.92 0.09-1.70 0.03-2.44 0.03-1.35 0.03-1.91 0.04-2.02 0.12-0.55 0.02-2.40	

* Partial length and weight measurements.

Table 1a: Mercury concentrations in teleost muscle samples (continued)

Code	Species	Area	Length (cm)				Weight (kg)							
			n	\bar{x}	s.e.	Range	n	\bar{x}	s.e.	Range				
OPE	Orange perch <u>Lepidoperca pulchella</u>	Chatham	12	29.8	1.2	25-37				12	0.07	0.01	0.02-0.17	
ORH	Orange roughy <u>Hoplostethus atlanticus</u>	Chatham ECNI ECSI WCNI	329 20 56 314 119* 119* 719 50*	33.3 27.1 26.7 25.9 25.7 29.4 27.6 37.5	0.3 1.6 0.8 0.4 0.3 0.3 0.3 0.5	17-44 19-38 16-41 3-40 19-32 19-32 3-44 33-42	297 20 56 314 120 120 687 50	1.25 0.74 0.81 0.78 0.66 0.66 0.98 0.67	0.03 0.12 0.08 0.03 0.01 0.01 0.02 0.19	0.23-2.80 0.24-1.74 0.19-2.70 0.003-2.20 0.40-1.00 0.40-1.00 0.003-2.80 0.42-1.00	392 20 56 314 151 151 933 70	0.37 0.23 0.14 0.40 0.52 0.52 0.39 0.45	0.01 0.04 0.01 0.02 0.01 0.01 0.01 0.02	0.01-1.08 0.05-0.64 0.04-0.43
PAR	Parore <u>Girella tricuspidata</u>	Factory Factory												
PIL	Pilchard <u>Sardinops neopilchardus</u>	WCNI												
RCO	Red cod <u>Pseudophycis bachus</u>	Auckland Campbell Chatham ECSI WCSI Total	16 9 18 20 1 64	47.2 42.9 48.9 43.6 69.0 46.3	1.5 2.7 1.4 2.0 1.0 1.0	39-60 28-53 40-59 30-63 28-69 28-69								
RIB	Ribaldo <u>Mora moro</u>	Campbell ECNI WCSI Total	20 20 40	42.9 57.3 50.1	2.4 1.6 1.8	25-63 44-67 25-67	20 4 24	1.07 0.40 1.35	0.16 0.40 0.20	0.25-2.90 1.90-3.50 0.25-3.50	10 20 21	0.47 0.41 0.58	0.11 0.05 0.04	0.02-0.26 0.02-0.14 0.00-0.08
RTR	Rainbow trout <u>Salmo gairdneri</u>	L. Kuratau L. Otamangakau L. Taupo Total	5 1 1 6	44.6 61.5 61.5 47.3	4.8 0.7 0.7 4.8	37-63 37-55 37-90 37-63	5 10 0.60 15	1.16 0.25 0.25 0.78	0.38 0.65-2.60 0.07-2.60 0.07-2.60	5 11 20 36	0.06 0.03 0.09 0.07	0.02 0.01 0.01 0.01	0.04-0.12 0.01-0.09 0.06-0.15 0.01-0.15	
SAM	Quinnat salmon <u>Oncorhynchus tshawytscha</u>	Rakaia R. Rangitata R. Southlands Total	30 4 41 75	73.9 75.0 44.6 57.9	2.5 2.1 0.7 2.0	38-90 70-80 37-55 37-90	30 4 41 75	5.48 5.51 1.34 3.22	0.39 0.53 0.05 0.29	0.93-8.58 4.37-6.84 0.52-2.17 0.62-8.58	31 4 41 76	0.05 0.04 0.36 0.22	0.00 0.00 0.01 0.02	0.01-0.07 0.03-0.05 0.28-0.45 0.03-0.45
SBW	Southern blue whiting <u>Micromesistius australis</u>	Campbell Pukaki Total	133 82 215	44.5 40.8 43.1	0.3 0.4 0.3	34-52 35-48 34-52	54 54 54	0.64 0.64 0.64	0.02 0.28-1.01 0.28-1.01	39 84 23	0.18 0.11 0.15	0.01 0.01 0.01	0.03-0.38 0.03-0.29 0.03-0.38	

* Partial length and weight measurements.

† Subcutaneous layer samples.

§ Farmed salmon from Big Glory Bay, Stewart Island.

Table 1a: Mercury concentrations in teleost muscle samples (continued)

Code	Species	Area	Length (cm)			Weight (kg)			Mercury ($\text{mg} \cdot \text{kg}^{-1}$)					
			\bar{n}	\bar{x}	s.e.	\bar{n}	\bar{x}	s.e.	Range	\bar{n}	\bar{x}			
SFE	Short-finned eel <i>Anguilla australis</i>	L. Ellesmere	54	46.8	1.1	29-70	54	0.25	0.23	0.05-0.90	54	0.11	0.01	0.03-0.36
SKI	Gemfish <i>Rexea solandri</i>	ECNI Southland	50	57.4	1.2	42-73	30	1.21	0.18	0.52-6.20	20	0.39	0.02	0.23-0.58
		WCNI	6	68.7	3.4	56-82					10	0.16	0.02	0.09-0.29
		WCSI				42-82	30	1.21	0.18	0.52-6.20	6	0.27	0.28	0.14-0.41
		Total	56	58.6	1.2					86	0.26	0.07	0.13-0.56	
										0.29	0.01		0.09-0.58	
SKJ	Skiblack <i>Katsuwonus pelamis</i>	ECNI	90	54.5	0.9	41-72	90	3.73	0.21	0.60-7.60	90	0.17	0.01	0.06-0.34
SNA	Snapper <i>Chrysophrys auratus</i>	ECNI WCNI	31	32.2	1.0	23-43	20	1.17	0.11	0.65-1.65	31	0.29	0.04	0.02-0.75
		Total	29	45.3	2.7	25-78	29	2.79	0.42	0.48-9.20	29	0.35	0.05	0.03-1.11
			60	38.6	1.6	23-78	40	2.34	0.32	0.48-9.20	60	0.32	0.03	0.02-1.11
SPE	Sea perch <i>Helicolenus</i> sp.	Chatham ECNI ECSI	14	33.8	1.2	27-42	20	0.91	0.12	0.05-1.85	14	0.10	0.01	0.05-0.17
		WCSI	20	39.1	1.2	30-48	30	0.70	0.05	0.30-1.60	20	0.29	0.03	0.10-0.60
		Total	30	29.7	0.9	21-42					30	0.08	0.01	0.01-0.32
			6	31.5	4.1	19-46					6	0.36	0.09	0.15-0.70
			70	33.4	0.8	19-48	50	0.78	0.06	0.05-1.85	70	0.17	0.02	0.01-0.70
SPR	Sprat <i>Sprattus antipodum</i>	WCNI								20	0.02	0.01	0.00-0.06	
SSI	Silverside <i>Argentina elongata</i>	Campbell WCNI	12	25.8	0.4	22-27				12	0.10	0.01	0.05-0.16	
		Total	12	25.8	0.4	22-27				20	0.03	0.01	0.01-0.09	
SSO	Smooth oreo <i>Pseudocottus maculatus</i>	Chatham Factory	13	32.6	0.6	28-35	13	0.64	0.04	0.40-0.88	13	0.24	0.03	0.03-0.38
		Total	20	25.7	1.0	18-35	20	0.79	0.07	0.27-1.53	20	0.19	0.02	0.08-0.38
			33	28.4	0.9	18-35	33	0.73	0.05	0.27-1.53	33	0.21	0.02	0.03-0.38
STA	Stargazer <i>Kathetostoma giganteum</i>	Chatham ECSI WCSI	25	64.5	1.7	46-78	16	5.80	0.50	3.10-8.71	25	0.18	0.02	0.03-0.31
		Factory	31	50.4	2.3	35-73	31	2.74	0.36	0.68-7.40	31	0.12	0.02	0.03-0.58
		Total	19	64.2	2.0	50-75					19	0.31	0.04	0.09-0.61
			14*	38.7	2.3	26-57	29	0.86	0.13	0.16-3.75	57	0.09	0.02	0.02-0.68
			14*	38.7	2.3	26-57	29	0.86	0.13	0.16-3.75	132	0.15	0.01	0.02-0.68
			75	58.6	1.4	35-78	47	3.77	0.36	0.68-8.71				
STM	Striped marlin <i>Tetrapturus audax</i>	ECNI	34	200.4	2.3	158-222				34	0.98	0.05	0.15-1.44	

* Partial length and weight measurements.

Table 1a: Mercury concentrations in teleost muscle samples (continued)

Code	Species	Area	Length (cm)				Weight (kg)				Mercury (mg.kg^{-1})										
			n	\bar{x}	s.e.	Range	n	\bar{x}	s.e.	Range	n	\bar{x}	s.e.	Range							
STN	<i>Thunnus maccoyii</i>	WCNI	4*	136.8	2.5	133-144	6	1.60	0.33	0.85-3.13	SWA	<i>Seriola punctata</i>	Auckland Campbell Chatham ECSI Southland WCSI Total	2	183.0	6.0	177-189	6	1.38	0.27	0.82-2.57
			4*	136.8	2.5	133-144								2	183.0	6.0	177-189				
			2	183.0	6.0	177-189								10	43.9	1.1	39-49				
														34	37.0	0.3	32-40				
TAR	<i>Tarakihi</i> <i>Nemadactylus macropterus</i>	Chatham	31	45.4	0.5	41-52	35	0.06	0.01	0.03-0.19	TRE	<i>Trevally</i> <i>Caranx georgianus</i>	ECNI WCNI Total	28	40.4	1.6	27-56	31	0.03	0.00	BdI-0.08
		ECSI	36	46.8	0.7	37-53	29	0.04	0.01	Tr-0.14				36	1.86	0.08	0.90-2.50				
		Southland	139	42.6	0.5	27-56	36	0.07	0.00	0.03-0.12				36	0.90-2.50	0.05	0.00-0.22				
		WCSI												139							
WAR	<i>Common warehou</i> <i>Seriola brama</i>	Chatham	31	42.2	0.6	37-50	31	0.18	0.02	0.05-0.39	WHI	<i>Whitebait</i> <i>Galaxias</i> spp.	WCNI Unknown Total	10	33.4	0.9	28-37	10	0.16	0.03	0.05-0.32
		ECNI	30	36.4	0.9	27-48	20	1.07	0.08	0.44-2.00				30	0.13	0.02	0.03-0.33				
		WCNI	71	38.5	0.6	27-50	20	1.07	0.08	0.44-2.00				71	0.16	0.01	0.03-0.39				
		Total																			
WHA	<i>White warehou</i> <i>Seriola caerulea</i>	WCNI	26	42.7	1.1	32-53	16	1.32	0.14	0.60-2.60	WHA	<i>White warehou</i> <i>Seriola caerulea</i>	Auckland Campbell Southland Total	4	42.5	1.7	42-50	4	1.75	0.19	1.35-2.25
		Unknown	4	46.5	1.7	42-50	20	1.41	0.12	0.60-2.60				4	0.60-2.60	0.27	0.04				
		Total	30	43.2	1.0	32-53	20	1.41	0.12	0.60-2.60				30	0.60-2.60	0.27	0.04				
														19	52.0	2.7	42-97				
WHI	<i>Whitebait</i> <i>Galaxias</i> spp.	Campbell									WHA	<i>White warehou</i> <i>Seriola caerulea</i>	WCNI Unknown Total	9	0.02	0.00	0.01-0.03				
		WCSI																			
WHA	<i>White warehou</i> <i>Seriola caerulea</i>	Auckland	8	53.5	1.6	44-59	13	0.02	0.00	0.01-0.05	WHA	<i>White warehou</i> <i>Seriola caerulea</i>	Auckland Campbell Southland Total	21	56.7	0.6	51-61	23	0.10	0.01	0.04-0.19
		Campbell	21	55.8	0.7	44-61	21	0.18	0.02	0.09-0.47				29	55.8	0.7	44-61	57	0.11	0.01	0.01-0.47
		Southland																			
		Total																			

* Length of tailed fish.

Table 1b: Mercury concentrations in muscle tissue from cartilaginous fish

Code	Species	Area	Length (cm)			Weight (kg)			Mercury ($\text{mg} \cdot \text{kg}^{-1}$)					
			n	\bar{x}	s.e.	n	\bar{x}	s.e.	Range	\bar{x}	s.e.			
BSH	Seal shark <u>Datatasa licha</u>	ECNI	1	145						1	4.99			
CYO	Owston's spiny dogfish <u>Centroscymnus owstonii</u>	ECNI	1	84						1	2.14			
ELE	Elephant fish <u>Callorhynchus milii</u>	ECSI Southland Factory Total	12 2 20* 14	71.1 57.0 35.4 69.1	2.7 4.0 2.2 2.7	57-89 53-61 25-53 53-89	1 20 1 20	3.7 1.18 3.7 1.18	0.22 0.34-2.90 0.22 0.34-2.90	12 2 20	0.13 0.06 0.05 0.01	0.03 0.01 0.05-0.06 0.01-0.10		
ETL	Lucifer dogfish <u>Etmopterus lucifer</u>	Campbell	1	38						1	0.28			
GSH	Ghost shark <u>Hydrolagus novaeseelandiae</u>	ECSI Campbell Total	21 21 42	96.9 73.0 84.9	2.6 1.4 2.4	61-114 63-94 61-114				21 21 42	0.39 0.50 0.45	0.02 0.03 0.02		
GSP	Pale ghost shark <u>Hydrolagus</u> sp.	Auckland ECSI Total	5 22 27	74.8 51.4 55.7	2.6 1.3 2.1	70-84 38-61 38-84	5 22 27	2.63 0.97 1.27	0.35 0.07 0.15	12 5 22	0.23 0.42 0.08	0.42 0.15 0.01		
MAK	Mako shark <u>Isurus oxyrinchus</u>	Campbell	1	150						1	2.37			
NSD	Northern spiny dogfish <u>Squalus blainvilliei</u>	WCSI	4	86.8	3.0	81-95	4	3.95	0.67	2.90-5.90	4	1.96	0.42	1.21-3.00
SCH	School shark <u>Galeorhinus galeus</u>	ECNI ECSI WCNI	10 8 39	149.1 74.6 107.7	2.7 2.1 4.5	129-161 67-82 67-150	8 25 25	2.33 5.72 1.05	1.50-3.40 1.48-20.00 1.58	10 8 64	3.04 0.21 0.90	0.30 0.09 0.71	1.60-4.60 0.08-0.80 0.07-3.00	
	Total		25*	42.5	2.1	28-75	25	1.58	0.26 0.50-7.20	82	1.09	0.12	0.07-4.60	

* Partial length and weight measurements.

Table 1b: Mercury concentrations in muscle tissues from cartilaginous fish (continued)

Code	Species	Area	Length (cm)				Weight (kg)				Mercury ($\text{mg} \cdot \text{kg}^{-1}$)		
			n	\bar{x}	s.e.	Range	n	\bar{x}	s.e.	Range	n	\bar{x}	s.e.
SKA	<u>Mixed skate</u> <u>Raja</u> spp.	ECSI	39*	0.74	0.04	0.40-1.26	39	0.28	0.02	0.05-0.56	3	0.13	0.07
		Southland	3†	58.7	14.7	42-88	3	5.13	3.44	1.40-12.00	3	0.15	0.03
		WCNI	7†	49.1	2.7	37-58	1	50.00			7	1.59	0.03
		ECNI									1		
		WCSI									7	1.26	0.21
		Factory									123	0.26	0.03
SND	<u>Shovelnose spiny dogfish</u> <u>Centroscyllium calceum</u>	Total	10†	52.0	4.5	37-88	122*	0.84	0.04	0.11-2.15	7	0.79-2.19	0.01-2.49
							161*	0.82	0.03	0.11-2.15	80	0.29	0.03
							16.35	11.48		1.40-50.00			
											6	2.19	0.19
SPD	<u>Spiny dogfish</u> <u>Squalus acanthias</u>	ECNI	15	74.5	3.8	57-105	49	2.10	0.17	0.75-5.70	15	0.24	0.07
		Campbell	95	78.8	1.2	54-115	25	2.86	0.21	1.40-4.80	100	0.28	0.03
		ECSI	21	80.8	2.1	67-99	40	1.48	0.16	0.44-4.00	25	0.55	0.08
		WCSI					40	1.48	0.16	0.44-4.00	40	0.27	0.16
		Factory	40§	80.5	1.9	66-120	74	2.05	0.11	0.44-5.70	180	0.31	0.02
		Total	40§	80.5	1.9	66-120							
SPO	<u>Rig</u> <u>Mustelus lenticulatus</u>	Total	131	78.6	1.0	54-115							
		ECSI	14	87.1	4.5	51-115					14	0.44	0.09
		ECNI	28	89.6	1.6	79-111					28	0.34	0.03
		WCNI	17	73.1	3.1	48-94	11	1.84	0.22	0.50-2.80	17	0.32	0.06
		Factory	60§	38.5	1.4	19-65	60	0.72	0.08	0.13-3.20	60	0.29	0.04
		Unknown	7	82.6	11.5	48-144					7	0.66	0.25
		Total	60§	38.5	1.4	19-65	60	0.72	0.08	0.13-3.20	126	0.34	0.03
			66	84.1	2.0	48-144	11	1.84	0.22	0.50-2.80			

* Wing weight.

† Wing width.

§ Partial length and weight measurements.

Table 1c: Mercury concentrations in mollusc tissues

Code	Species	Area	Tissue	Length (cm)			Weight (kg)			Mercury ($\text{mg} \cdot \text{kg}^{-1}$)							
				n	\bar{x}	s.e.	n	\bar{x}	s.e.	n	\bar{x}	s.e.					
ASQ	Arrow squid <i>Nototodarussloani</i>	Auckland	Mantle	20	30.9	1.1	21-42			21	0.08	0.01	0.01-0.13				
		Southland	Mantle	13	23.2	1				13	0.04	0.01	0.01-0.08				
		Chatham	Mantle	28	21.9	0.5	15-27			30	0.01	0.00	Tr-0.04				
		Total	Mantle	61	25.1	0.7	15-42			64	0.04	0.00	Tr-0.13				
GSQ	Giant squid <i>Architeuthis</i> sp.	ECNI	Mantle							1	0.07						
			Tentacle							1	0.09						
			Gonad							1	0.06						
			Digestive gland							1	0.07						
			Mantle							1	0.07						
			Tentacle							1	0.08						
			Gonad							1	0.06						
			Mantle							2	0.07	0.00	0.07-0.07				
			Tentacle							2	0.09	0.00	0.08-0.09				
			Gonad							2	0.06	0.00	0.06-0.06				
MSB	Blue mussel <i>Mytilus edulis aoteanus</i>	WCNI	Digestive gland							1	0.07						
			Muscle							12	0.011	0.001	0.007-0.014				
			Muscle							12	0.02	0.00	0.01-0.03				
		MSG	WCNI	Muscle						12	0.019	0.001	0.014-0.025				
										12	0.03	0.01	0.01-0.06				
		OYS	Southland	Homogenised whole	30	6.5	0.2	4.7-9.2	30*	0.837	0.017	0.702-1.111	30	0.01	0.00	Bd1-0.03	
		POY	ECNI	Homogenised† whole						34	0.958	0.041	0.709-1.817	34	0.02	0.00	Bd1-0.03
		SCA	Unknown	Gonad						5*	2.58	0.17	2.00-2.90	5	0.01	0.00	Tr-0.01
				Muscle						10*	14.86	0.57	12.50-17.90	10	0.01	0.00	Tr-0.01
				Muscle and gonad sample						9*	18.08	0.67	14.60-20.70	10	0.01	0.00	Tr-0.01

* Weight in grams.

† Three homogenised oysters per sample.

Table 1d: Mercury concentrations in crustacean muscle samples

Code	Species	Area	Length (cm)				Weight (kg)				Mercury ($\text{mg} \cdot \text{kg}^{-1}$)			
			n	\bar{x}	s.e.	Range	n	\bar{x}	s.e.	Range				
CRA	Rock lobster <i>Jasus edwardsii</i>	ECSI	20	8.9	0.1	7.7-9.6	20	0.34	0.01	0.23-0.40	20	0.26	0.02	0.11-0.41
		Southland	20	8.9	0.1	7.7-9.6	20	0.34	0.01	0.23-0.40	19	0.10	0.01	0.01-0.17
		Total									39	0.18	0.02	0.01-0.41
PAD	Paddle crab <i>Ovalipes catharus</i>	WCSI	20	9.2	0.1	8.5-9.6	20	0.16	0.01	0.11-0.19	20	0.11	0.01	0.02-0.22

Table 2: Fish with mean mercury levels ($\text{mg} \cdot \text{kg}^{-1}$) above the domestic permissible level of $0.5 \text{ mg} \cdot \text{kg}^{-1}$

Species	Area	n	Mercury level
Seal shark (<u>Dalatias licha</u>)	ECNI	1	4.99
School shark (<u>Galeorhinus galeus</u>)	ECNI	10	3.04
Mako shark (<u>Isurus oxyrinchus</u>)	Campbell	1	2.37
Shovelnose spiny dogfish (<u>Deania calcea</u>)	ECNI	6	2.19
Owston's spiny dogfish (<u>Centroscymnus owstonii</u>)	ECNI	1	2.14
Northern spiny dogfish (<u>Squalus blainvillei</u>)	WCSI	4	1.96
Southern bluefin tuna (<u>Thunnus maccoyi</u>)	WCNI	6	1.60*
Mixed skate (<u>Raja</u> spp.)	ECNI	1	1.59
Southern bluefin tuna (<u>Thunnus maccoyi</u>)	WCNI	6	1.38†
Mixed skate (<u>Raja</u> spp.)	WCSI	7	1.26
Striped marlin (<u>Tetrapturus audax</u>)	ECNI	34	0.98
Ling (<u>Genypterus blacodes</u>)	Auckland	31	0.94
Alfonsino (<u>Beryx splendens</u>)	Factory	12	0.93
School shark (<u>Galeorhinus galeus</u>)	WCNI	64	0.90
Ling (<u>Genypterus blacodes</u>)	Factory	20	0.80
Bluenose (<u>Hyperoglyphe antarctica</u>)	Campbell	4	0.79
Ling (<u>Genypterus blacodes</u>)	WCSI	34	0.73
Rig (<u>Mustelus lenticulatus</u>)	Unknown	7	0.66
Ling (<u>Genypterus blacodes</u>)	Southland	29	0.64
Ribaldo (<u>Mora moro</u>)	WCSI	21	0.58
Spiny dogfish (<u>Squalus acanthias</u>)	WCSI	25	0.55
Hake (<u>Merluccius australis</u>)	Campbell	3	0.52
Hapuku (<u>Polyprion oxygeneios</u>)	WCNI	34	0.52
Ling (<u>Genypterus blacodes</u>)	Campbell	178	0.52
Orange roughy (<u>Hoplostethus atlanticus</u>)	Factory	151	0.52
Ghost shark (<u>Hydrolagus novaezelandiae</u>)	Campbell	21	0.50

* Tail flesh.

† Belly flesh.

Table 3a: Cadmium concentrations in teleost muscle samples

Code	Species	Area	Length (cm)				Weight (kg)				Cadmium ($\text{mg} \cdot \text{kg}^{-1}$)			
			\underline{n}	\bar{x}	s.e.	Range	\underline{n}	\bar{x}	s.e.	Range	\underline{n}	\bar{x}		
BAR	Barracouta <u>Thysites atun</u>	ECSI	2	78.0	0.0	78-78	2	2.10	0.00	2.10-2.10	2	0.02	0.00	0.02-0.02
BCO	Blue cod <u>Parapercis colias</u>	WCNI	1	41.0		1	1.50				1	0.01		
BNS	Bluenose <u>Hyperoglyphe antarctica</u>	ECNI	3	79.3	2.7	74-82 57-67	3	10.17	1.55 1.95	7.10-12.10 4.50-8.40	5	0.03	0.00	0.02-0.04
BOE	Black oreo <u>Aliocytus</u> sp.	ECSI	5	28.4	1.8	23-34	5	0.55	0.11	0.294-0.938	5	0.03	0.01	0.02-0.06
BYX	Alfonso's <u>Beryx splendens</u>	ECSI WCNI Total	5 5 10	36.6 24.2 30.4	3.0 1.0 2.5	31-48 22-28 22-48	5 5 10	0.90 0.25 0.58	0.24 0.06 0.16	0.50-1.85 0.15-0.50 0.15-1.85	5	0.01	0.00	0.01-0.01 0.02-0.05 0.01-0.05
ESO	N.Z. sole <u>Peltorhamphus novaezeelandiae</u>	ECSI	5	27.4	1.3	25-32	5	0.12	0.04	0.05-0.25	5	0.05	0.01	0.02-0.09
21	Gurnard <u>Chelidonichthys kumu</u>	ECSI ECNI Total	5 6 11	33.4 41.3 37.7	3.4 0.9 2.0	26-45 38-44 26-45	5 6 11	0.44 0.55 0.50	0.19 0.02 0.08	0.10-1.15 0.50-0.65 0.10-1.15	5	0.04	0.01	0.02-0.07 Tr-0.01 Tr-0.07
	Hoki <u>Macruronus novaehollandiae</u>	ECSI	5	55.6	1.6	51-60	5	0.40	0.04	0.30-0.50	5	0.01	0.00	0.01-0.01
	Jack mackerel <u>Trachurus declivis</u>	WCNI	2	46.5	2.5	44-49	2	1.25	0.05	1.20-1.30	2	0.02	0.00	0.02-0.02
LFE	Long-finned eel <u>Anguilla dieffenbachii</u>	L. Ellesmere									5	0.03	0.01	0.01-0.07
LIN	Ling <u>Genypterus blacodes</u>	ECSI Campbell Total	6 30 36	68.5 95.3 90.8	3.2 1.8 2.3	56-77 60-108 56-108	6 30 36	1.55 3.86 3.48	0.24 0.24 0.25	0.75-2.25 0.75-6.50 0.75-6.50	6	0.02	0.01	BdI-0.04 BdI-0.05 BdI-0.05
ORH	Orange roughy <u>Hoplostethus atlanticus</u>	Chatham ECSI WCNI Total	5 6 37 48	22.2 37.0 31.4 31.1	0.4 1.6 1.1 1.0	21-23 31-41 15-39 15-41	5 6 37 48	0.36 1.91 1.17 1.18	0.01 0.24 0.08 0.09	0.32-0.40 0.94-2.70 0.15-1.87 0.15-2.70	37 6 37 80	0.01 0.01 0.02 0.01	0.00 0.00 0.00 0.00	0.00-0.03 0.01-0.01 0.00-0.13 0.00-0.13
PAR	Parore <u>Girella tricuspidata</u>	Factory	10	38.3	1.0	34-42	10	1.30	0.09	0.90-1.70	10	0.01	0.00	0.01-0.02

* Partial length and weight measurements.

Table 3a: Cadmium concentrations in teleost muscle samples (continued)

Code	Species	Area	Length (cm)				Weight (kg)				Cadmium ($\text{mg} \cdot \text{kg}^{-1}$)			
			n	\bar{x}	s.e.	Range	n	\bar{x}	s.e.	Range	n	\bar{x}	s.e.	Range
RCO	Red cod <u>Pseudophycis bachus</u>	ECSI	6	52.3	3.6	39-63	6	1.48	0.30	0.50-2.60	6	0.02	0.00	0.01-0.03
RIB	Ribaldo <u>Mura moro</u>	ECNI	8	50.8	2.8	37-63	8	1.64	0.27	0.45-2.90	8	0.01	0.00	0.01-0.01
RTR	Rainbow trout <u>Salmo gairdneri</u>	L. Kuratau L. Otanangakau L. Taupo Total	5 1 1 6	44.6 61.5 47.3	4.8 2.60	37-63 1.40	5 1 6	1.16 0.38	0.65-2.60	5 1 5	0.01 0.01 0.01	0.00 0.01	0.01-0.01	
SAM	Quinnat salmon <u>Oncorhynchus tshawytscha</u>	Rakai R. Rangitata R. Southland* Total	7 2 20 29	72.0 73.0 44.7 53.2	5.7 3.0 0.9 2.8	48-87 70-76 39-53 39-87	7 2 20 29	0.95 0.41 0.07 0.40	1.60-8.07 5.00-5.82 0.97-2.07 0.97-8.07	8 2 20 30	0.01 0.04 0.01 0.01	0.00 0.02 0.00 0.00	0.01-0.02 0.02-0.05 Bd1-0.02 0.00-0.05	
SBW	Southern blue whiting <u>Micromesistius australis</u>	Campbell	6	48.5	0.6	47-51	6	0.72	0.04	0.60-0.87	6	0.03	0.00	0.02-0.04
SFL	Sand flounder <u>Rhomboleia plebeja</u>	ECSI	5	28.2	0.7	26-30	5	0.22	0.03	0.15-0.30	5	0.03	0.00	0.02-0.04
SKJ	Skipjack <u>Katsuwonus pelamis</u>	ECNI	30	56.5	1.6	45-71	30	4.00	0.37	0.60-7.50	30	0.02	0.00	0.01-0.04
SPE	Sea perch <u>Helicolenus</u> sp.	ECSI	5	32.6	1.2	30-36	5	0.71	0.11	0.50-1.10	5	0.03	0.01	0.01-0.06
SSO	Smooth oreo <u>Pseudocytthus maculatus</u>	ECSI	5	27.4	4.2	17-37	5	0.67	0.22	0.149-1.163	5	0.03	0.02	0.01-0.09
STA	Stargazer <u>Kathetostoma giganteum</u>	ECSI	5	65.8	2.2	60-73	5	5.24	0.67	3.90-7.40	5	0.03	0.01	0.01-0.04
SMA	Silver warehou <u>Seriolaella punctata</u>	ECSI WCNI Total	4 6 10	47.0 51.2 49.5	1.6 0.5 0.9	43-50 50-53 43-53	4 6 10	2.14 2.40 2.29	1.70-2.50 2.20-2.50 1.70-2.50	4 6 10	0.03 0.00 0.01	0.01 0.00 0.01	0.02-0.06 Tr-0.02 0.00-0.06	
TRE	Trevally <u>Caranx georgianus</u>	WCNI	4	38.0	0.4	37-39	4	1.20	0.04	1.12-1.30	4	0.01	0.00	0.01-0.01
WIT	Witch <u>Atractoscion scapha</u>	ECSI	1	35.0			1	0.50			1	0.03		

* Farmed salmon from Big Glory Bay, Stewart Island.

Table 3b: Cadmium concentrations in muscle tissue from cartilaginous fish

Code	Species	Area	Length (cm)			Weight (kg)			Cadmium (mg kg^{-1})		
			n	\bar{x}	s.e.	n	\bar{x}	s.e.	n	\bar{x}	s.e.
ELE	Elephant fish <u><i>Callorhynchus milii</i></u>	ECSI	1	81		1	3.7		1	0.01	
MAK	Mako shark <u><i>Squatnus oxyrinchus</i></u>	Campbell	1	150					1	0.11	
NSD	Northern spiny dogfish <u><i>Squalus blainvilliei</i></u>	WCSI	4	86.8	3.0	81-95	4	3.00	0.67	2.9-5.9	4
RSK	Rough skate <u><i>Raja nasuta</i></u>	ECSI	3	69.3	3.0	65-75	3	2.60	0.38	2.0-3.3	3
SCH	School shark <u><i>Galeorhinus galeus</i></u>	ECSI WCNI Total	7 1 8	83.6 147 91.5	4.6 8.9	67-103 67-147	7 1 8	3.19 1.70 4.91	0.48 1.78	1.5-5.2 1.5-17.0	7 1 8
SKA	Mixed skate <u><i>Raja</i> spp.</u>	WCNI Factory Total	7* 7*	49.1 49.1	2.7 2.7	37-58 37-58	29† 29†	0.26 0.26	0.03 0.03	0.01-2.49 0.01-2.49	7 29 36
SPD	Spiny dogfish <u><i>Squalus acanthias</i></u>	WCSI	4	85.3	4.3	74-95	7	3.13	0.24	2.0-3.9	7
SPO	Rig <u><i>Mustelus lenticulatus</i></u>	ECSI ECNI Total	5 9 14	97.0 90.3 92.7	2.8 2.8 2.2	87-103 84-106 84-106	5 5 5	3.68 0.30	0.30	2.7-4.5	5 9 14

* Wing width.

† Wing weight.

Table 3c: Cadmium concentrations in mollusc tissues

Code Species	Area	Tissue	Length (cm)				Weight (kg)				Cadmium ($\text{mg} \cdot \text{kg}^{-1}$)			
			n	\bar{x}	s.e.	Range	n	\bar{x}	s.e.	Range	n	\bar{x}	s.e.	Range
ASQ Arrow Squid <i>Nototodarvis sloani</i>	ECSI	Mantle	20	27.4	0.9	21-37	20	0.571	0.060	0.230-1.139	20	0.06	0.01	0.02-0.13
		Digestive gland	10	25.9	0.5	24-28	10	0.491	0.033	0.331-0.619	10	56.00	9.00	31.00-132.00
		Gonad	5	26.6	0.7	24-28	5	0.538	0.045	0.373-0.619	5	0.16	0.06	0.05-0.39
		Mantle	30	22.7	0.3	20-27	30	0.274	0.016	0.140-0.452	30	0.04	0.01	0.01-0.15
		Mantle	83	22.8	0.6	12-36	83	0.449	0.036	0.065-1.422	83	0.13	0.02	0.00-1.27
	WCNI	Mantle	42	29.9	0.5	23-37	42	0.654	0.030	0.320-1.062	42	0.05	0.01	0.00-0.28
		Digestive gland	10	30.7	0.9	26-35	10	0.762	0.064	0.397-1.062	10	31.40	2.98	18.00-48.00
		Gonad	5	31.2	1.7	26-35	5	0.790	0.115	0.397-1.062	5	0.13	0.05	0.02-0.33
		Mantle	40	24.3	0.8	17-34	40	0.400	0.036	0.155-0.942	40	1.76	0.36	0.04-7.54
		Digestive gland	10	19.8	0.3	17-21	10	0.218	0.012	0.155-0.269	10	146.20	11.60	113.00-242.00
WCNI Total	WCNI	Gonad	5	19.4	0.5	17.5-20.5	5	0.203	0.017	0.155-0.249	5	0.45	0.11	0.25-0.88
		Mantle	48	22.1	0.9	9-35	48	0.399	0.037	0.038-1.106	48	0.23	0.05	0.01-2.24
		Mantle	263	24.4	0.4	9-37	263	0.454	0.017	0.038-1.422	263	0.37	0.07	Bdl-7.54
		Digestive gland	30	24.5	0.9	17-35	30	0.491	0.047	0.155-1.062	30	78.10	10.30	18.00-242.00
		Gonad	15	25.7	1.4	17.5-35	15	0.510	0.075	0.155-1.062	15	0.25	0.06	0.02-0.88
GSQ Giant squid <i>Architeuthis</i> sp.	ECNI	Mantle									1	0.07		
		Tentacle									1	0.06		
		Gonad									1	0.06		
		Digestive gland									1	8.60		
		Mantle									1	0.05		
OYS Bluff oyster <i>Tiostrea lutaria</i>	OYS	Tentacle									1	0.04		
		Gonad									2	0.07	0.02	0.05-0.09
		Mantle									1	0.04	0.01	0.04-0.06
		Tentacle									2	0.05	0.01	0.04-0.06
		Gonad									1	8.60		
PAU Paua <i>Haliotis iris</i>	PAU	Digestive gland												
		Southland Muscle	30	6.5	0.2	4.7-9.2	30*	0.837	0.017	0.702-1.111	30	4.92	0.34	2.01-9.42
		Total	ECNI	Muscle							20	0.03	0.00	0.01-0.08
		WCNI	Muscle								25	0.03	0.00	0.02-0.07
		Total	Muscle								45	0.02	0.00	0.01-0.08

* Weight in grams.

Table 3d: Cadmium concentrations in crustacean muscle samples

Code	Species	Area	Length (cm)				Weight (kg)				Cadmium ($\text{mg} \cdot \text{kg}^{-1}$)			
			n	\bar{x}	s.e.	Range	n	\bar{x}	s.e.	Range	n	\bar{x}	s.e.	
CRA	<u>Rock lobster <i>Jasus edwardsii</i></u>	ECSI	10	8.9	0.2	7.7-9.6	10	0.338	0.015	0.236-0.393	10	0.15	0.10	Bd1-0.98
		Southland	10	8.9	0.2	7.7-9.6	10	0.338	0.015	0.236-0.393	10	0.50	0.21	Bd1-2.10
		Total									20	0.32	0.12	Bd1-2.10
PAD	<u>Paddle crab <i>Ovalipes catharus</i></u>	WCSI	10	9.1	0.1	8.5-9.5	10	0.149	0.010	0.111-0.176	10	0.07	0.04	0.02-0.33

Table 4a: Copper concentrations in teleost muscle samples

Code	Species	Area	Length (cm)				Weight (kg)				Copper ($\text{mg} \cdot \text{kg}^{-1}$)			
			n	\bar{x}	s.e.	Range	n	\bar{x}	s.e.	Range				
BAR	Barbacouta <u>Thyrsites atun</u>	ECSI	2	78.0	0.0	78-78	2	2.10	0.00	2.1-2.1	2	0.34	0.02	0.32-0.35
BCO	Blue cod <u>Parapercis colias</u>	WCNI	1	41			1	1.50			1	0.16		
BNS	Bluenose <u>Hyperoglyphe antarctica</u>	ECNI	3	79.3	2.7	74-82	3	10.17	1.55	7.10-12.10	5	0.39	0.11	0.03-0.60
BOE	Black oreo <u>Allocyttus sp.</u>	ECSI	5	28.4	1.8	23-34	5	0.55	0.11	0.294-0.938	5	0.30	0.02	0.20-0.30
BYX	Alfonsoino <u>Beryx splendens</u>	ECSI WCNI Total	5 5 10	36.6 24.2 30.4	3.0 1.0 2.5	31-48 22-28 22-48	5 5 10	0.90 0.25 0.58	0.24 0.06 0.16	0.50-1.85 0.15-0.50 0.15-1.85	5 5 10	0.46 0.54 0.50	0.06 0.02 0.03	0.26-0.63 0.50-0.60 0.26-0.63
ES0	N.Z. sole <u>Peltorhamphus novaezeelandiae</u>	ECSI	5	27.4	1.3	25-32	5	0.12	0.04	0.05-0.25	5	0.54	0.05	0.40-0.70
GUR	Gurnard <u>Chelidonichthys kumu</u>	ECSI ECNI Total	5 6 11	33.4 41.3 37.7	3.4 0.9 2.0	26-45 38-44 26-45	5 6 11	0.44 0.55 0.50	0.19 0.02 0.08	0.10-1.15 0.50-0.65 0.10-1.15	5 6 11	0.34 0.25 0.29	0.04 0.04 0.03	0.30-0.50 0.15-0.42 0.15-0.50
	Hoki <u>Macruronus novaezealandiae</u>	ECSI	5	55.6	1.6	51-60	5	0.40	0.04	0.30-0.50	5	0.38	0.04	0.30-0.50
	Jack mackerel <u>Trachurus declivis</u>	WCNI	2	46.5	2.5	44-49	2	1.25	0.05	1.20-1.30	2	0.47	0.03	0.44-0.50
LFE	Long-finned eel <u>Anguilla dieffenbachii</u>	L. Ellesmere									5	0.35	0.12	0.19-0.83
LIN	Ling <u>Genypterus blacodes</u>	ECSI Campbell Total	6 30 36	68.5 95.3 90.8	3.2 1.8 2.3	56-77 60-108 56-108	6 30 36	1.55 3.86 3.48	0.24 0.24 0.25	0.75-2.25 0.75-6.50 0.75-6.50	6 30 36	0.44 0.96 0.87	0.11 0.26 0.22	0.30-1.00 0.14-7.34 0.14-7.34
ORH	Orange roughy <u>Hoplostethus atlanticus</u>	Chattham ECSI WCNI Total	5 6 37 48	22.2 37.0 31.4 31.1	0.4 1.6 1.1 1.0	21-23 31-41 15-39 15-41	5 6 37 48	0.36 1.91 0.24 1.17	0.01 0.24 0.94-2.70 0.08	0.32-0.40 0.94-2.70 0.15-1.87 0.09	37 6 37 80	2.00 0.14 0.25 1.05	0.79 0.02 0.06 0.38	0.00-26.32 0.09-0.19 0.06-2.20 0.00-26.32
PAR	Parore <u>Girella tricuspidata</u>	Factory	10	38.3	1.0	34-42	10	1.30	0.09	0.90-1.70	10	0.51	0.05	0.30-0.90

* Partial length and weight measurements.

Table 4a: Copper concentrations in teleost muscle samples (continued)

Code	Species	Area	Length (cm)				Weight (kg)				Copper (mg.kg ⁻¹)			
			n	\bar{x}	s.e.	Range	n	\bar{x}	s.e.	Range				
RCO	Red cod <i>Pseudophycis batus</i>	ECSI	6	52.3	3.6	39-63	6	1.48	0.30	0.50-2.60	6	0.40	0.06	0.20-0.50
RIB	Ribaldo <i>Mora moro</i>	ECNI	8	50.8	2.8	37-63	8	1.64	0.27	0.45-2.90	8	0.22	0.05	0.10-0.52
RTR	Rainbow trout <i>Salmo gairdneri</i>	L. Kuratau L. Otanangakau L. Taupo Total	5	44.6	4.8	37-63	5	1.16	0.38	0.65-2.60	5	0.39	0.01	0.37-0.41
SAM	Quinnat salmon <i>Oncorhynchus tshawytscha</i>	Rakai R. Rangitata R. Southland* Total	7	72.0	5.7	48-87	7	5.09	0.95	1.60-8.07	8	0.46	0.04	0.30-0.60
SBW	Southern blue whiting <i>Micromesistius australis</i>	Campbell	6	48.5	0.6	47-51	6	0.72	0.04	0.60-0.87	6	0.27	0.03	0.20-0.39
SFL	Sand flounder <i>Rhomboptera plebeia</i>	ECSI	5	28.2	0.7	26-30	5	0.22	0.03	0.15-0.30	5	0.50	0.05	0.50-0.70
SKJ	Skipjack <i>Katsuwonus pelamis</i>	ECNI	30	56.5	1.6	45-71	30	4.00	0.37	0.60-7.50	30	0.54	0.03	0.36-0.99
SPE	Sea perch <i>Helicolenus sp.</i>	ECSI	5	32.6	1.2	30-36	5	0.71	0.11	0.50-1.10	5	0.34	0.02	0.30-0.40
SSO	Smooth oreo <i>Pseudocytthus maculatus</i>	ECSI	5	27.4	4.2	17-37	5	0.67	0.22	0.149-1.163	5	0.28	0.02	0.20-0.30
STA	Stargazer <i>Kathetostoma giganteum</i>	ECSI	5	65.8	2.2	60-73	5	5.24	0.67	3.90-7.40	5	0.46	0.07	0.30-0.70
SWA	Silver warehou <i>Seriola punctata</i>	ECSI WCSI Total	4	47.0	1.6	43-50	4	2.14	0.21	1.70-2.50	4	0.53	0.08	0.40-0.70
TRE	Trevally <i>Caranx georgianus</i>	WCNI	10	49.5	0.9	43-53	10	2.29	0.09	1.70-2.50	10	0.34	0.06	0.15-0.70
WIT	Witch <i>Arnoglossus scripta</i>	ECSI	4	38.0	0.4	37-39	4	1.20	0.04	1.12-1.30	4	0.46	0.07	0.30-0.61
			1	35.0			1	0.50			1	0.40		

* Farmed salmon from Big Glory Bay, Stewart Island.

Table 4b: Copper concentrations in muscle tissue from cartilaginous fish

Code	Species	Area	Length (cm)				Weight (kg)				Copper (mg.kg ⁻¹)			
			n	\bar{x}	s.e.	Range	n	\bar{x}	s.e.	Range	n	\bar{x}	s.e.	
ELE	Elephant fish <i>Callorhynchus mili</i>	ECSI	1	81			1	3.70			1	0.17		
MAK	Mako shark <i>Isurus oxyrinchus</i>	Campbell	1	150							1	0.99		
NSD	Northern spiny dogfish <i>Squalus blainvilliei</i>	WCSI	4	86.8	3.0	81-95	4	3.00	0.67	2.9-5.9	4	0.43	0.13	0.20-0.80
RSK	Rough skate <i>Raja nasuta</i>	ECSI	3	69.3	3.0	65-75	3	2.60	0.38	2.0-3.3	3	0.50	0.00	0.50-0.50
SCH	School shark <i>Galeorhinus galeus</i>	ECSI WCNI Total	7 1 8	83.6 147 91.5	4.6 8.9	67-103 67-147	7 1 8	3.19 17.0 4.91	0.48 1.78	1.5-5.2 1.5-17.0	7 1 8	0.34 0.15 0.32	0.04 0.04 0.04	0.19-0.50 0.15-0.50
SKA	Mixed skate <i>Raja</i> spp.	WCNI Factory Total	7* 7*	49.1 49.1	2.7 2.7	37-58 37-58	29† 29†	0.26 0.26	0.03 0.03	0.01-2.49 0.01-2.49	7 29 36	0.18 0.30 0.28	0.01 0.01 0.01	0.12-0.23 0.22-0.55 0.12-0.55
SPD	Spiny dogfish <i>Squalus acanthias</i>	WCSI	4	85.3	4.3	74-95	7	3.13	0.24	2.0-3.9	7	0.47	0.08	0.30-0.80
SP0	Rig <i>Mustelus lenticulatus</i>	ECSI ECNI Total	5 9 14	97.0 90.3 92.7	2.8 2.8 2.2	87-103 85-106 84-106	5 5 5	3.68 0.30	0.30	2.7-4.5	5 9 14	0.39 0.23 0.29	0.05 0.05 0.04	0.24-0.50 0.03-0.40 0.03-0.50

* Wing width.
 † Wing weight.

Table 4c: Copper concentrations in mollusc tissues

Code	Species	Area	Tissue	Length (cm)				Weight (kg)				Copper (mg.kg ⁻¹)		
				n	\bar{x}	s.e.	Range	n	\bar{x}	s.e.	Range	n	\bar{x}	s.e.
ASQ	Arrow squid <i>Nototodarus stoani</i>	Auckland	Mantle	20	27.4	0.9	21-37	20	0.571	0.06	0.230-1.139	20	1.99	0.18
			Digestive gland	10	25.9	0.5	24-28	10	0.491	0.033	0.331-0.619	10	262.00	59.00
		ECNI	Gonad	5	26.6	0.7	24-28	5	0.538	0.045	0.373-0.619	5	23.10	11.70
			Mantle	30	22.7	0.3	20-27	30	0.274	0.016	0.140-0.452	30	2.66	0.21
			Mantle	83	22.8	0.6	12-36	83	0.449	0.036	0.065-1.422	83	3.11	0.28
			Digestive gland	42	29.9	0.5	23-37	42	0.654	0.030	0.320-1.062	42	2.90	0.12
			Gonad	10	30.7	0.9	26-35	10	0.762	0.064	0.397-1.062	10	634.00	55.00
		WCSI	Mantle	5	31.2	1.7	26-35	5	0.790	0.115	0.397-1.062	5	11.50	4.70
			Digestive gland	39	24.2	0.8	17.5-34	39	0.398	0.037	0.155-0.942	39	6.42	1.08
			Gonad	10	19.8	0.3	17-21	10	0.218	0.012	0.155-0.269	10	365.30	28.50
			Mantle	5	19.4	0.5	17.5-20.5	5	0.203	0.017	0.155-0.249	5	46.40	15.10
			Digestive gland	48	22.1	0.9	9-35	48	0.399	0.037	0.038-1.106	48	2.38	0.14
WCNI	Total	ECNI	Gonad	262	24.4	0.4	9-37	262	0.454	0.017	0.038-1.422	262	3.30	0.20
			Mantle	30	24.5	0.9	17.35	30	0.491	0.047	0.155-1.062	30	421.00	40.00
			Digestive gland	15	25.7	1.4	17.5-35	15	0.510	0.075	0.155-1.062	15	27.00	7.20
			Gonad	1	25.7	0.5	17-21	1	0.218	0.012	0.155-0.269	1	28.50	204.00
			Mantle	1	25.7	0.5	17-21	1	0.218	0.012	0.155-0.269	1	28.50	204.00
		WCNI	Tentacle	1	25.7	0.5	17-21	1	0.218	0.012	0.155-0.269	1	28.50	204.00
			Gonad	1	25.7	0.5	17-21	1	0.218	0.012	0.155-0.269	1	28.50	204.00
			Digestive gland	1	25.7	0.5	17-21	1	0.218	0.012	0.155-0.269	1	28.50	204.00
			Mantle	1	25.7	0.5	17-21	1	0.218	0.012	0.155-0.269	1	28.50	204.00
			Tentacle	1	25.7	0.5	17-21	1	0.218	0.012	0.155-0.269	1	28.50	204.00
GSQ	Giant squid <i>Architeuthis</i> sp.	ECNI	Gonad	1	25.7	0.5	17-21	1	0.218	0.012	0.155-0.269	1	28.50	204.00
			Digestive gland	1	25.7	0.5	17-21	1	0.218	0.012	0.155-0.269	1	28.50	204.00
			Mantle	1	25.7	0.5	17-21	1	0.218	0.012	0.155-0.269	1	28.50	204.00
			Tentacle	1	25.7	0.5	17-21	1	0.218	0.012	0.155-0.269	1	28.50	204.00
OYS	Bluff oyster <i>Tiostrea lutaria</i>	Southland	Muscle	30	6.5	0.2	4.7-9.2	30*	0.837	0.017	0.702-1.111	30	5.35	0.29
			Muscle	20	7.06	0.57	3.80-15.70	25	5.37	0.23	3.60-7.40	45	6.12	0.31
			Muscle	20	7.06	0.57	3.80-15.70	25	5.37	0.23	3.60-7.40	45	6.12	0.31
			Muscle	20	7.06	0.57	3.80-15.70	25	5.37	0.23	3.60-7.40	45	6.12	0.31
PAU	Paua <i>Haliotis iris</i>	ECNI	Muscle	1	0.80	0.20	0.08-0.80	1	0.80	0.20	0.08-0.80	1	0.80	0.20
			Muscle	1	0.80	0.20	0.08-0.80	1	0.80	0.20	0.08-0.80	1	0.80	0.20
			Muscle	1	0.80	0.20	0.08-0.80	1	0.80	0.20	0.08-0.80	1	0.80	0.20

* Weight in grams.

Table 4d: Copper concentrations in crustacean muscle samples

Code	Species	Area	Length (cm)					Weight (kg)					Copper ($\text{mg} \cdot \text{kg}^{-1}$)		
			<u>n</u>	\bar{x}	s.e.	Range		<u>n</u>	\bar{x}	s.e.	Range		<u>n</u>	\bar{x}	s.e.
CRA	Rock lobster <u>Jasus edwardsii</u>	ECSI	10	8.9	0.2	7.7-9.6	10	0.338	0.015	0.236-0.393	10	3.75	0.45	2.50-7.00	
		Southland	10	8.9	0.2	7.7-9.6	10	0.338	0.015	0.236-0.393	10	9.42	0.87	6.30-16.10	
		Total	10	8.9	0.2	7.7-9.6	10	0.338	0.015	0.236-0.393	20	6.58	0.81	2.50-16.10	
PAD	Paddle crab <u>Ovalipes catharus</u>	WCSI	10	9.1	0.1	8.5-9.5	10	0.149	0.010	0.111-0.176	10	3.34	0.40	1.80-5.50	

Table 5a: Zinc concentrations in teleost muscle samples

Code	Species	Area	Length (cm)			Weight (kg)			Zinc ($\text{mg} \cdot \text{kg}^{-1}$)					
			n	\bar{x}	s.e.	n	\bar{x}	s.e.	Range	n	\bar{x}	s.e.	Range	
BAR	Barracouta <u>Thyrsites atun</u>	ECSI	2	78.0	0.0	78-78	2	2.10	0.00	2.10-2.10	2	3.85	0.05	3.8-3.9
BCO	Blue cod <u>Parapercis colias</u>	WCNI	1	41			1	1.50			1	2.50		
BNS	Bluenose <u>Hyperoglyphe antarctica</u>	ECNI	3	79.3	2.7	74-82	3	10.17	1.55	7.10-12.10 (4.50-8.40)	5	3.56	0.19	3.0-3.9
BOF	Black oreo <u>Allocyttus sp.</u>	ECSI	2*	62.0	5.0	57-67	2	6.45	1.95	4.50-8.40	5	3.56	0.19	3.0-3.9
BYX	Alfonsino <u>Beryx splendens</u>	ECSI WCNI Total	5 10 10	28.4 30.4 25.5	1.8 2.0 2.2-2.8	23-34	5	0.55	0.11	0.294-0.938	5	2.90	0.32	2.4-4.1
ESO	N.Z. sole <u>Peltorhamphus novaezealandiae</u>	ECSI	5	27.4	1.3	25-32	5	0.12	0.04	0.05-0.25	5	6.04	0.58	5.1-8.3
GUR	Gurnard <u>Chelidonichthys kumu</u>	ECSI ECNI Total	5 6 11	33.4 41.3 37.7	3.4 0.9 2.0	26-45	5	0.44	0.19	0.10-1.15	5	3.26	0.19	2.9-3.9
HOK	Hoki <u>Macruronus novaezealandiae</u>	ECSI	5	55.6	1.6	51-60	5	0.40	0.04	0.30-0.50	5	3.42	0.31	2.5-4.5
JMA	Jack mackerel <u>Trachurus declivis</u>	WCNI	2	46.5	2.5	44-49	2	1.25	0.05	1.20-1.30	2	16.0	0.30	15.7-16.3
LFE	Long-finned eel <u>Anguilla dieffenbachii</u>	L. Ellesmere									5	15.7	1.35	11.0-19.0
LIN	Ling <u>Genypterus blacodes</u>	ECSI Campbell Total	6 30 36	68.5 95.3 90.8	3.2 1.8 2.3	56-77 60-108 56-108	6	1.55	0.24	0.75-2.25	6	3.85	0.28	2.7-4.5
ORH	Orange roughy <u>Hoplostethus atlanticus</u>	Chatham ECSI WCNI Total	5 6 37 48	22.2 37.0 31.4 31.1	0.4 1.6 1.1 1.0	21-23 31-41 15-39 15-41	5	0.36	0.01	0.32-0.40	37	2.92	0.19	1.4-7.4
PAR	Parore <u>Girella tricuspidata</u>	Factory	10	38.3	1.0	34-42	10	1.30	0.09	0.90-1.70	10	11.25	1.89	6.9-27.5

* Partial length and weight measurements.

Table 5a: Zinc concentrations in teleost muscle samples (continued)

Code	Species	Area	Length (cm)				Weight (kg)				Zinc ($\text{mg} \cdot \text{kg}^{-1}$)		
			n	\bar{x}	s.e.	Range	n	\bar{x}	s.e.	Range	\bar{n}	\bar{x}	s.e.
RCO	Red cod <i>Pseudophycis batus</i>	ECSI	6	52.3	3.6	39-63	6	1.48	0.30	0.50-2.60	6	3.87	0.43
RIB	Ribaldo <i>Mura moro</i>	ECNI	8	50.8	2.8	37-63	8	1.64	0.27	0.45-2.90	8	2.88	0.20
RTR	Rainbow trout <i>Salmo gairdneri</i>	L. Kuratau L. Otamangakau L. Taupo Total	5 1 1 6	44.6 61.5 73.0 47.3	4.8 2.60 3.0 4.8	37-63 1 70-76 37-63	5 1 2 6	1.16 0.38 5.41 1.40	0.38 0.65-2.60 0.41 0.95	0.65-2.60 1 2.00-5.82 0.97-2.07	5 1 5 11	4.98 3.70 4.45 4.90	0.18 0.24 0.05 0.18
SAM	Quinnat salmon <i>Oncorhynchus tshawytscha</i>	Rakaja R. Rangitata R. Southland* Total	7 2 20 29	72.0 73.0 44.7 53.2	5.7 3.0 0.9 2.8	48-87 70-76 39-53 39-87	7 2 20 29	5.09 5.41 1.38 2.55	0.95 0.41 0.07 0.40	1.60-8.07 5.00-5.82 0.97-2.07 0.97-8.07	8 2 20 30	4.30 4.45 2.98 3.42	0.17 0.05 0.07 0.13
SBW	Southern blue whiting <i>Micromesistius australis</i>	Campbell	6	48.5	0.6	47-51	6	0.72	0.04	0.60-0.87	6	4.52	0.34
SFL	Sand flounder <i>Rhomboleia plebeia</i>	ECSI	5	28.2	0.7	26-30	5	0.22	0.03	0.15-0.30	5	6.34	0.23
SKJ	Skipjack <i>Katsuwonus pelamis</i>	ECNI	30	56.5	1.6	45-71	30	4.00	0.37	0.60-7.50	30	5.80	0.54
SPE	Sea perch <i>Helicolenus</i> sp.	ECSI	5	32.6	1.2	30-36	5	0.71	0.11	0.50-1.10	5	3.48	0.10
SSO	Smooth oreo <i>Pseudocytthus maculatus</i>	ECSI	5	27.4	4.2	17-37	5	0.67	0.22	0.149-1.163	5	2.58	0.17
STA	Stargazer <i>Kathetostoma giganteum</i>	ECSI	5	65.8	2.2	60-73	5	5.24	0.67	3.90-7.40	5	6.68	0.77
SWA	Silver warehou <i>Seriola punctata</i>	ECSI WCNI Total	4 6 10	47.0 51.2 49.5	1.6 0.5 0.9	43-50 50-53 43-53	4 6 10	2.14 2.40 2.29	0.21 0.05 0.09	1.70-2.50 2.20-2.50 1.70-2.50	4 6 10	3.35 2.23 2.68	0.19 0.18 0.22
TRE	Trevally <i>Caranx georgianus</i>	WCNI	4	38.0	0.4	37-39	4	1.20	0.04	1.12-1.30	4	9.92	0.87
WIT	Witch <i>Arnoglossus scapha</i>	ECSI	1	35.0			1	0.50			1	5.40	

* Farmed salmon from Big Glory Bay, Stewart Island.

Table 5b: Zinc concentrations in muscle tissue from cartilaginous fish

Code	Species	Area	Length (cm)			Weight (kg)			Zinc ($\text{mg} \cdot \text{kg}^{-1}$)		
			n	\bar{x}	s.e.	n	\bar{x}	s.e.	n	\bar{x}	s.e.
ELE	Elephant fish <i>Callorhinus milii</i>	ECSI	1	81		1	3.7		1	3.1	
MAK	Mako shark <i>Isurus oxyrinchus</i>	Campbell	1	150					1	3.7	
NSD	Northern spiny dogfish <i>Squalus blainvilliei</i>	WCSI	4	86.8	3.0	81-95	4	3.00	0.67	2.9-5.9	4
RSK	Rough skate <i>Raja nasuta</i>	ECSI	3	69.3	3.0	65-75	3	2.60	0.38	2.0-3.3	3
SCH	School shark <i>Galeorhinus galeus</i>	ECSI WCNI Total	7 1 8	83.6 147 91.5	4.6 8.9	67-103 67-147	7 1 8	3.19 17.0 4.91	0.48 1.78	1.5-5.2 1.5-17.0	7 1 8
SKA	Mixed skate <i>Raja</i> spp.	WCNI Factory Total	7*	49.1	2.7	37-58	28†	1.16	0.08	0.04-1.9	7 28 35
SPD	Spiny dogfish <i>Squalus acanthias</i>	WCSI	4	85.3	4.3	74-95	7	3.13	0.24	2.0-3.9	7
SPO	Rig <i>Mustelus lenticulatus</i>	ECSI ECNI Total	5 9 14	97.0 90.3 92.7	2.8 2.8 2.2	87-103 85-106 84-106	5 5 5	3.68 0.30	0.30	2.7-4.5	5 9 14
										3.40 2.70 2.94	0.18 0.09 0.13
										3.0-4.0 2.4-3.2 2.4-4.0	

* Wing width.

† Wing weight.

Table 5c: Zinc concentrations in mollusc tissues

Code	Species	Area	Tissue	Length (cm)				Weight (kg)				Zinc ($\text{mg} \cdot \text{kg}^{-1}$)			
				n	\bar{x}	s.e.	Range	n	\bar{x}	s.e.	Range	n	\bar{x}	s.e.	Range
ASQ	Arrow squid <i>Nototodarvis sloani</i>	Auckland	Mantle	20	27.4	0.9	21-37	20	0.571	0.060	0.230-1.139	20	11.12	0.16	10.0-13.1
			Digestive gland	10	25.9	0.5	24-28	10	0.491	0.033	0.331-0.619	10	47.10	3.60	31.0-70.0
			Gonad	5	26.6	0.7	24-28	5	0.538	0.045	0.373-0.619	5	22.32	1.59	17.5-26.3
			Mantle	30	22.7	0.3	20-27	30	0.274	0.016	0.140-0.452	30	12.98	0.18	10.2-14.7
			Mantle	83	22.8	0.6	12-36	83	0.449	0.036	0.065-1.422	83	14.41	0.29	6.3-30.5
			Mantle	42	29.9	0.5	23-37	42	0.654	0.030	0.320-1.062	42	11.93	0.33	1.9-16.0
			Digestive gland	10	30.7	0.9	26-35	10	0.762	0.064	0.397-1.062	10	107.10	6.90	75.0-133.0
			Gonad	5	31.2	1.7	26-35	5	0.790	0.115	0.397-1.062	5	19.94	3.21	11.6-25.8
			Mantle	39	24.2	0.8	17.5-34	39	0.398	0.037	0.155-0.942	39	15.94	0.73	11.3-26.0
			Digestive gland	10	19.8	0.3	11.7-21	10	0.218	0.012	0.155-0.269	10	203.90	15.00	146.0-272.0
WCSI			Gonad	5	19.4	0.5	17.5-20.5	5	0.203	0.017	0.155-0.249	5	22.96	1.53	18.5-26.9
			Mantle	48	22.1	0.9	9-35	48	0.399	0.037	0.038-1.106	48	13.08	0.21	10.8-17.5
			Mantle	262	24.4	0.4	9-37	262	0.454	0.017	0.038-1.422	262	13.55	0.18	11.9-30.5
			Digestive gland	30	24.5	0.9	17.5-35	30	0.491	0.047	0.155-1.062	30	119.40	13.20	31.0-272.0
			Gonad	15	25.7	1.4	17.5-35	15	0.510	0.075	0.155-1.062	15	21.74	1.25	11.6-26.9
GSQ	Giant squid <i>Architeuthis</i> sp.	ECNI	Mantle									1	12.9		
			Tentacle									1	13.9		
			Gonad									1	11.2		
			Digestive gland									1	23.1		
			Mantle									1	11.7		
WCNI			Tentacle									1	9.7		
			Gonad									1	12.8		
			Mantle									2	12.3	0.6	11.7-12.9
			Tentacle									2	11.8	2.1	9.7-13.9
			Gonad									2	12.0	0.8	11.2-12.8
OYS	Bluff oyster <i>Tiostrea lutaria</i>	Southland	Digestive gland									1	23.1		
			Muscle									1	21.74	4.1	28.0-111.0
			Muscle									30	62.2		
			Muscle									20	20.26	0.51	14.9-24.1
			Muscle									25	16.36	0.40	12.8-22.3
PAU	Paua <i>Haliotis iris</i>	ECNI	Total									45	18.10	0.43	12.8-24.1

* Weight in grams.

Table 5d: Zinc concentrations in crustacean muscle samples

Code	Species	Area	Length (cm)			Weight (kg)			Zinc ($\text{mg} \cdot \text{kg}^{-1}$)					
			n	\bar{x}	s.e.	n	\bar{x}	s.e.	n	\bar{x}	s.e.			
CRA	Rock lobster <i>Jasus edwardsii</i>	ECSI	10	8.9	0.2	7.7-9.6	10	0.338	0.015	0.236-0.393	10	15.26	0.55	13.6-18.8
		Southland	10	8.9	0.2	7.7-9.6	10	0.338	0.015	0.236-0.393	10	16.47	0.82	13.7-20.9
		Total									20	15.86	0.50	13.6-20.9
PAD	Paddle crab <i>Ovalipes catharus</i>	WCSI	10	9.1	0.1	8.5-9.5	10	0.149	0.010	0.111-0.176	10	31.46	2.19	20.6-40.9

Table 6a: Lead concentrations in teleost muscle samples

Code	Species	Area	Length (cm)				Weight (kg)				\bar{x}	s.e.	Range	Lead ($\text{mg} \cdot \text{kg}^{-1}$)
			n	\bar{x}	s.e.	Range	n	\bar{x}	s.e.	Range				
BAR	Barracouta <u>Thysites atun</u>	ECSI	2	78.0	0.0	78-78	2	2.10	0.00	2.1- 2.1	2	0.12	0.02	0.10-0.14
BCO	Blue cod <u>Parapercis colias</u>	WCNI	1	41			1	1.5			1	0.06		
BNS	Bluenose <u>Hyperoglyphe antarctica</u>	ECNI	3	79.3	2.7	74-82	3	10.17	1.55	7.1-12.1 4.5-8.4	5	0.04	0.02	0.00-0.10
BOE	Black oreo <u>Aliocyttus</u> sp.	ECSI	5	28.4	1.8	23-34	5	0.55	0.11	0.294-0.938	5	0.06	0.02	0.02-0.13
BYX	Alfonsoino <u>Beryx splendens</u>	ECSI WCNI Total	5 10	36.6 24.2 30.4	3.0 1.0 2.5	31-48 22-28 22-48	5 5 10	0.90 0.25 0.58	0.24 0.06 0.16	0.50-1.85 0.15-0.50 0.15-1.85	5	0.09 0.07 0.08	0.01 0.06 0.03	0.07-0.12 Bdi-0.32 Bdi-0.32
ES0	N.Z. sole <u>Peltorhamphus novaezeelandiae</u>	ECSI	5	27.4	1.3	25-32	5	0.12	0.04	0.05-0.25	5	0.02	0.01	Bdi-0.04
36	Gurnard <u>Chelidonichthys kumu</u>	ECSI ECNI Total	5 6 11	33.4 41.3 37.7	3.4 0.9 2.0	26-45 38-44 26-45	5 6 11	0.44 0.55 0.50	0.19 0.02 0.08	0.10-1.15 0.50-0.65 0.10-1.15	5	0.01 6 11	0.01 0.10 0.06	Bdi-0.03 0.06-0.12 Bdi-0.12
HOK	Hoki <u>Macruronus novaehollandiae</u>	ECSI	5	55.6	1.6	51-60	5	0.40	0.04	0.30-0.50	5	0.01	0.00	Bdi-0.03
JMA	Jack mackerel <u>Trachurus declivis</u>	WCNI	2	46.5	2.5	44-49	2	1.25	0.05	1.20-1.30	2	0.04	0.00	0.04-0.04
LFE	Long-finned eel <u>Anguilla dieffenbachii</u>	L. Ellesmere									5	0.13	0.03	0.06-0.20
LIN	Ling <u>Genypterus blacodes</u>	ECSI Campbell Total	6 30 36	68.5 95.3 90.8	3.2 1.8 2.3	56-77 60-108 56-108	6 30 36	1.55 3.86 3.48	0.24 0.24 0.25	0.75-2.25 0.75-6.50 0.75-6.50	6	0.15 30 36	0.11 0.18 0.17	Bdi-0.64 Bdi-0.65 Bdi-0.65
ORH	Orange roughy <u>Hoplostethus atlanticus</u>	Chatham ECSI WCNI Total	5 6 37 48	22.2 37.0 31.4 31.1	0.4 1.6 1.1 1.0	21-23 31-41 15-39 15-41	5 6 37 48	0.36 1.91 1.17 1.18	0.01 0.24 0.08 0.09	0.32-0.40 0.94-2.70 0.15-1.87 0.15-2.70	37	0.15 6 37 80	0.02 0.16 0.02 0.09	Bdi-0.50 0.09-0.24 Bdi-0.18 Bdi-0.50
PAR	Parore <u>Girella tricuspidata</u>	Factory	10	38.3	1.0	34-42	10	1.30	0.09	0.90-1.70	10	0.00	0.00	Bdi- Bdi

* Partial length and weight measurements.

Table 6a: Lead concentrations in teleost muscle samples (continued)

Code	Species	Area	Length (cm)				Weight (kg)				Lead ($\text{mg} \cdot \text{kg}^{-1}$)			
			n	\bar{x}	s.e.	Range	n	\bar{x}	s.e.	Range	n	\bar{x}	s.e.	Range
RCO	Red cod <i>Pseudophycis bairdii</i>	ECSI	6	52.3	3.6	39-63	6	1.48	0.30	0.50-2.60	6	0.06	0.03	Bd1-0.18
RIB	Ribaldo <i>Mora moro</i>	ECNI	8	50.8	2.8	37-63	8	1.64	0.27	0.45-2.90	8	0.07	0.01	0.04-0.13
RTR	Rainbow trout <i>Salmo gairdneri</i>	L. Kuratau L. Otamangakau L. Taupo Total	5 1 1 6	44.6 61.5 61.5 47.3	4.8 2.8 2.8 4.8	37-63 37-63 37-63 37-63	5 1 1 6	1.16 2.60 2.60 1.40	0.38 0.95 0.95 0.95	0.65-2.60 0.65-2.60 0.65-2.60 0.65-2.60	5 5 5 11	0.20 0.10 0.09 0.14	0.08 0.04 0.04 0.04	0.08-0.51 0.00-0.24 0.00-0.50
SAM	Quinnat salmon <i>Oncorhynchus tshawytscha</i>	Rakaia R. Rangitata R. Southland* Total	7 2 20 29	72.0 73.0 44.7 53.2	5.7 3.0 0.9 2.8	48-87 70-76 39-53 39-87	7 2 20 29	5.09 5.41 1.38 2.55	0.95 0.41 0.07 0.40	1.60-8.07 5.00-5.82 0.97-2.07 0.97-8.07	8 2 20 30	0.02 0.06 0.01 0.01	0.01 0.00 0.00 0.00	Bd1-0.07 0.06-0.06 Bd1-0.07 Bd1-0.07
SBW	Southern blue whiting <i>Micromesistius australis</i>	Campbell	6	48.5	0.6	47-51	6	0.72	0.04	0.60-0.86	6	0.14	0.03	0.04-0.23
SFL	Sand flounder <i>Rhomboptera plebeia</i>	ECSI	5	28.2	0.7	26-30	5	0.22	0.03	0.15-0.30	5	0.00	0.00	Bd1-0.01
SKJ	Skipjack <i>Katsuwonus pelamis</i>	ECNI	30	56.5	1.6	45-71	30	4.00	0.37	0.60-7.50	30	0.06	0.01	0.02-0.11
SPE	Sea perch <i>Helicolenus</i> sp.	ECSI	5	32.6	1.2	30-36	5	0.71	0.11	0.50-1.10	5	0.02	0.01	Bd1-0.05
SSO	Smooth oreo <i>Pseudocyttus maculatus</i>	ECSI	5	27.4	4.2	17-37	5	0.67	0.22	0.149-1.163	5	0.01	0.01	Bd1-0.03
STA	Stargazer <i>Kathetostoma giganteum</i>	ECSI	5	65.8	2.2	60-73	5	5.24	0.67	3.90-7.40	5	0.02	0.01	Bd1-0.04
SWA	Silver warehou <i>Seriola punctata</i>	ECSI WCNI Total	4 6 10	47.0 51.2 49.5	1.6 0.5 0.9	43-50 50-53 43-53	4 6 10	2.14 2.40 2.29	0.21 0.05 0.09	1.70-2.50 2.20-2.50 1.70-2.50	4 6 10	0.02 0.10 0.07	0.01 0.00 0.01	Bd1-0.04 0.10-0.10 0.00-0.10
TRE	Trevally <i>Caramboides georgianus</i>	WCNI	4	38.0	0.4	37-39	4	1.20	0.04	1.12-1.30	4	0.14	0.06	0.07-0.33
WIT	Witch <i>Arnoglossus scapha</i>	ECSI	1	35.0			1	0.50			1	0.02		

* Farmed salmon from Big Glory Bay, Stewart Island.

Table 6b: Lead concentrations in muscle tissue from cartilaginous fish

Code	Species	Area	Length (cm)				Weight (kg)				Lead ($\text{mg} \cdot \text{kg}^{-1}$)		
			n	\bar{x}	s.e.	Range	n	\bar{x}	s.e.	Range	n	\bar{x}	s.e.
ELE	Elephant fish <i>Callorhynchus mili</i>	ECSI	1	81		1	3.70				1	1.05	
MAK	Mako shark <i>Isurus oxyrinchus</i>	Campbell	1	150							1	0.18	
NSD	Northern spiny dogfish <i>Squalus blainvilliei</i>	WCSI	4	86.8	3.0	81-95	4	3.00	0.67	2.9-5.9	4	0.00	0.00
RSK	Rough skate <i>Raja nasuta</i>	ECSI	3	69.3	3.0	65-75	3	2.60	0.38	2.0-3.3	3	0.01	0.01
SCH	School shark <i>Galeorhinus galeus</i>	ECSI WCNI Total	7 1 8	83.6 147 91.5	4.6 8.9	67-103 67-147	7 1 8	3.19 17.0 4.91	0.48 1.78	1.5-5.2 1.5-17.0	7 1 8	0.07 0.11 0.07	0.03 Bd1-0.25 0.00-0.25
SKA	Mixed skate <i>Raja</i> spp.	WCNI Factory Total	7* 7*	49.1 49.1	2.7	37-58	29† 29†	0.26 0.26	0.03 0.03	0.01-2.49 0.01-2.49	7 29 36	0.16 0.07 0.09	0.03 0.11 0.01
SPD	Spiny dogfish <i>Squalius acanthias</i>	WCSI	4	85.3	4.3	74-95	7	3.13	0.24	2.0-3.9	7	0.18	0.09
SP0	Rig <i>Mustelus lenticulatus</i>	ECSI ECNI Total	5 9 14	97.0 90.3 92.7	2.8 2.8 2.2	87-103 84-106 84-106	5	3.68	0.30	2.7-4.5	5 9 14	0.14 0.07 0.10	0.08 0.02 0.03

* Wing width.
 † Wing weight.

Table 6c: Lead concentrations in mollusc tissues

Code	Species	Area	Tissue	Length (cm)				Weight (kg)				Lead ($\text{mg} \cdot \text{kg}^{-1}$)			
				n	\bar{x}	s.e.	Range	n	\bar{x}	s.e.	Range	n	\bar{x}	s.e.	Range
ASQ	<u>Arrow squid</u> <i>Nototodaruis sloanii</i>	Auckland	Mantle	20	27.4	0.9	21-37	20	0.571	0.060	0.230-1.139	20	0.02	0.01	BdI-0.11
		Digestive gland	10	25.9	0.5	24-28	10	0.491	0.033	0.331-0.619	10	0.06	0.04	BdI-0.44	
		Gonad	5	26.6	0.7	24-28	5	0.538	0.045	0.373-0.619	5	0.04	0.02	BdI-0.09	
		Mantle	30	22.7	0.3	20-27	30	0.274	0.016	0.140-0.452	30	0.03	0.01	BdI-0.09	
		Mantle	83	22.8	0.6	12-36	83	0.449	0.036	0.065-1.422	83	0.03	0.01	BdI-0.40	
		Mantle	42	29.9	0.5	23-37	42	0.654	0.030	0.320-1.062	42	0.03	0.00	BdI-0.12	
		Digestive gland	10	30.7	0.9	26-35	10	0.762	0.064	0.397-1.062	10	0.05	0.03	BdI-0.22	
		Gonad	5	31.2	1.7	26-35	5	0.790	0.115	0.397-1.062	5	0.03	0.01	BdI-0.06	
		Mantle	39	24.2	0.8	17.5-34	39	0.398	0.037	0.155-0.942	40	0.04	0.02	BdI-0.50	
		Digestive gland	10	19.8	0.3	17-21	10	0.218	0.012	0.155-0.269	10	0.07	0.03	BdI-0.29	
WCSI	<u>WCSI</u>	Gonad	5	19.4	0.5	17.5-20.5	5	0.203	0.017	0.155-0.249	5	0.15	0.06	0.03-0.28	
		Mantle	48	22.1	0.9	9-35	48	0.399	0.037	0.038-1.106	48	0.02	0.00	BdI-0.90	
		Total	263	24.4	0.4	9-37	263	0.454	0.017	0.038-1.422	263	0.03	0.00	BdI-0.50	
		Digestive gland	30	24.5	0.9	17-35	30	0.491	0.047	0.155-1.062	30	0.06	0.02	BdI-0.44	
		Gonad	15	25.7	1.4	17.5-35	15	0.510	0.075	0.155-1.062	15	0.07	0.02	BdI-0.28	
GSQ	<u>Giant squid</u> <i>Architeuthis</i> sp.	ECNI	Mantle	1	BdI			1	BdI			1	BdI		
		Tentacle	1	BdI				1	BdI			1	BdI		
		Gonad	1	BdI				1	BdI			1	BdI		
		Digestive gland	1	BdI				1	BdI			1	BdI		
		Mantle	1	BdI				1	BdI			1	BdI		
OVS	<u>OVS</u>	WCNI	Tentacle	1	BdI			1	BdI			1	BdI		
		Gonad	1	BdI				1	BdI			1	BdI		
		Mantle	1	BdI				2	BdI			2	BdI		
		Tentacle	1	BdI				2	BdI			2	BdI		
		Gonad	1	BdI				1	BdI			1	BdI		
PAU	<u>PAU</u>	Total	Digestive gland	1	BdI			1	BdI			1	BdI		
		Southern	Muscle	30	6.5	0.2	4.7-9.2	30*	0.837	0.017	0.702-1.111	30	0.01	0.01	BdI-0.20
		Tiostrea lutaria										20	0.10	0.04	0.00-0.75
		Paua	ECNI									25	0.05	0.01	0.00-0.12
		Haliotis iris	WCNI									45	0.07	0.02	0.00-0.75

* Weight in grams.

TABLE 6d: Lead concentrations in crustacean muscle samples

Species Code	Species	Area	Length (cm)						Weight (kg)						Lead (mg.kg ⁻¹) Range
			N	\bar{x}	SE	Range	N	\bar{x}	SE	Range	N	\bar{x}	SE	Range	
CRA	Rock lobster <i>Jasus edwardsii</i>	ECSI	10	8.9	0.2	7.7-9.6	10	0.338	0.015	0.235-0.393	10	0.01	0.01	Bdi-0.04	
		Southland	10	8.9	0.2	7.7-9.6	10	0.338	0.015	0.236-0.393	10	0.01	0.00	Bdi-0.04	
		Total									20	0.01	0.00	Bdi-0.04	
PAD	Paddle crab <i>Ovalipes catharus</i>	WCSI	10	9.1	0.1	8.5-9.5	10	0.149	0.010	0.111-0.176	10	0.00	0.00	Bdi-0.02	

TABLE 7: Selenium levels in tissues from the giant squid *Architeuthis* sp.

Area	Tissue	Selenium (mg.kg ⁻¹)			
		N	\bar{x}	s.e.	
ECNI	Mantle	1	0.12		
	Tentacle	1	0.18		
	Gonad	1	0.62		
	Digestive gland	1	2.52		
WCNI	Mantle	1	0.22		
	Tentacle	1	0.14		
	Gonad	1	1.14		
	Digestive gland	1	2.52		
Total	Mantle	2	0.17	0.05	0.12-0.22
	Tentacle	2	0.16	0.02	0.14-0.18
	Gonad	2	0.88	0.26	0.62-1.14
	Digestive gland	1	2.52		

Table 8a: Organochlorine levels ($\text{mg} \cdot \text{kg}^{-1}$) in teleost muscle samples

Code	Species	Area	Length (cm)	Weight (kg)	HCB	Lindane	DDE	DDD	DDT	Total DDT	PCBs
BAR	Barracouta <u><i>Thyrsites atun</i></u> ($n = 1$)	WCNI	\bar{x} s.e. Range	83	3.3	0.00	0.00	0.02	0.00	0.02	0.00
BEL	Black flounder <u><i>Rhomboptera reticaria</i></u> ($n = 6$)	L. Ellesmere	\bar{x} s.e. Range	20.2 2.7 16.0-33.0	0.70 0.06 0.47-0.80	0.00 0.00 0.00-0.00	0.00 0.00 0.00-0.00	0.01 0.01 Tr-0.05	Tr 0.00 Tr-Tr	Tr 0.00 Tr-Tr	0.00 0.00-0.00
BTR	Brown trout <u><i>Salmo trutta</i></u> ($n = 6$)	L. Ellesmere	\bar{x} s.e. Range	36.5 5.8 19.0-53.0	0.84 0.28 0.10-1.80	0.00 0.00 0.00-0.00	0.00 0.00 0.00-0.00	0.05 0.01 0.02-0.08	0.00 0.00 0.00-0.00	0.04 0.01 0.02-0.08	0.00 0.01 0.00-0.00
GUR	Gurnard <u><i>Chelidonichthys kumu</i></u> ($n = 6$)	ECNI	\bar{x} s.e. Range	41.3 0.9 38.0-44.0	0.55 0.02 0.50-0.65	0.00 0.00 0.00-0.00	0.00 0.00 0.00-0.00	0.05 0.01 0.00-0.00	0.00 0.00 0.00-0.00	0.04 0.01 0.02-0.08	0.00 0.01 0.00-0.00
JDO	John dory <u><i>Zeus faber</i></u> ($n = 2$)	WCNI	\bar{x} s.e. Range	51.0 1.0 50.0-52.0	2.53 0.08 2.45-2.60	0.00 0.00 0.00-0.00	0.00 0.00 0.00-0.00	0.00 0.00 0.00-0.00	0.00 0.00 0.00-0.00	0.00 0.00 0.00-0.00	0.00 0.00 0.00-0.00
KIN	Kingfish <u><i>Seriola lajana</i></u> ($n = 1$)	ECNI	\bar{x} s.e. Range	125	40.0	0.00	0.00	0.00	0.00	0.00	0.00
LDO	Lookdown dory <u><i>Cynoscion traversi</i></u> ($n = 1$)	ECSI	\bar{x} s.e. Range	49	2.3	0.00	0.00	0.00	0.00	0.00	0.00
LFE	Long-finned eel <u><i>Anguilla dieffenbachii</i></u> ($n = 24$)	L. Ellesmere	\bar{x} s.e. Range			0.00 0.00 0.00-0.00	0.00 0.00 0.00-0.00	0.01 0.00 0.00-0.05	0.00 0.00 Tr-0.02	Tr 0.00 Tr-Tr	0.01 0.00 Tr-0.07
LIN	Ling <u><i>Genypterus blacodes</i></u> ($n = 11$)	Campbell	\bar{x} s.e. Range			3.19 0.52	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00

Table 8a: Organochlorine levels_o (mg.kg⁻¹) in teleost muscle samples (continued)

Code	Species	Area	Length (cm)	Weight (kg)	HCB	Lindane	DDE	DDD	DDT	Total DDT	PCBs
ORH	Orange roughy <i>Hoplostethus atlanticus</i> (<u>n</u> = 25)	Chatham	\bar{X} S.e. Range	Tr 0.00 Tr-Tr	Tr 0.00 Tr-Tr	Tr 0.00 Tr-Tr	Tr 0.00 Tr-Tr	Tr 0.00 Tr-Tr	Tr 0.00 Tr-Tr	Tr 0.00 Tr-Tr	
RIB	Ribaldo <i>Mora moro</i> (<u>n</u> = 5)	ECNI	\bar{X} S.e. Range	54.4 3.0 47.0-63.0	1.95 0.32 0.00-0.00	0.00 0.00 0.00-0.00	0.00 0.00 0.00-0.00	0.00 0.00 0.00-0.00	0.00 0.00 0.00-0.00	0.00 0.00 0.00-0.00	
RTR	Rainbow trout <i>Salmo gairdneri</i> (<u>n</u> = 5)	L. Kuratau	\bar{X} S.e. Range	44.6 4.8 37.5-63.0	1.16 0.38 0.65-2.60	0.00 0.00 0.00-0.00	0.00 0.00 0.00-0.00	0.59 0.30 0.08-1.77	Tr 0.00 Tr-Tr	0.6 0.31 0.11-1.81	
(n = 1)											
(n = 6)											
L. Taupo											
\bar{X} S.e. Range											
47.8 4.7 37.5-63.0											
(n = 6)											
Total											
\bar{X} S.e. Range											
47.8 4.7 37.5-63.0											
SBW											
Southern blue whiting <i>Micromesistius australis</i> (<u>n</u> = 7)											
\bar{X} S.e. Range											
44.1 1.2 39.0-48.0											

Table 8b: Organochlorine levels (mg.kg^{-1}) in muscle tissue from cartilaginous fish

Code	Species	Area		Length (cm)	Weight (kg)	HCB	Lindane	DDE	DDD	DDT	Total DDT	PCBs
ELE	Elephant fish <u><i>Californichthys milii</i></u> ($n = 1$)	ECSI	\bar{x} s.e. Range	81.0	3.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SCH	School shark <u><i>Galeorhinus galeus</i></u> ($n = 4$)	WCNI	\bar{x} s.e. Range	135.5 8.6 110.0-147.0	12.50 2.06 0.00-0.00	0.00 0.00 0.00-0.00	0.00 0.00 0.00-0.00	Tr 0.00 Tr-Tr	0.00 0.00 0.00-0.00	0.00 0.00 0.00-0.00	Tr 0.00 Tr-Tr	0.00 0.00
SKA	Mixed skate <u><i>Raja</i></u> spp. ($n = 20$)	Factory	\bar{x} s.e. Range	1.09* 0.10 0.40-1.90	0.00 0.00 0.00-0.00	0.00 0.00 0.00-0.00	Tr 0.00 Tr-Tr	0.00 0.00 0.00-0.00	0.00 0.00 0.00-0.00	Tr 0.00 Tr-Tr	0.00 0.00	
SPO	Rig <u><i>Mustelus lenticulatus</i></u> ($n = 2$)	WCNI	\bar{x} s.e. Range	87.5 1.5 86.0-89.0	2.75 0.05 2.70-2.80	0.00 0.00 0.00-0.00	0.00 0.00 0.00-0.00	0.00 0.00 0.00-0.00	0.00 0.00 0.00-0.00	0.00 0.00 0.00-0.00	0.00 0.00 0.00-0.00	

* Wing weight.

APPENDIX 1: New Zealand heavy metal maximum permissible levels for "fish and fish products", including crustaceans and molluscs (New Zealand Statutory Regulations 1984/262)

Heavy metal	Concentration (ppm)
Mercury	0.5
Cadmium	1.0*
Copper	30.0
Zinc	40.0
Lead	2.0
Selenium	2.0*

* Except shellfish.

APPENDIX 2: Fisheries Research Centre conventions for length measurement

Fork length	Barracouta, bluenose, brown trout, alfonsino, blue mackerel, jack mackerel, kahawai, kingfish, orange perch, parore, ribaldo, rainbow trout, quinnat salmon, southern blue whiting, gemfish, skipjack, snapper, silverside, southern bluefin tuna, silver warehou, tarakihi, trevally, common warehou, white warehou
Total length	bass groper, blue cod, black flounder, black oreo, brill, conger eel, gurnard, hake, hapuku, hoki, javelin fish, John dory, lookdown dory, leatherjacket, long-finned eel, ling, red cod, short-finned eel, sea perch, smooth oreo, stargazer, seal shark, Owston's spiny dogfish, elephant fish, Lucifer dogfish, ghost shark, pale ghost shark, mako shark, northern spiny dogfish, school shark, shovel-nose spiny dogfish, spiny dogfish, rig, witch
Standard length	orange roughy
Rear of eye to fork	striped marlin
Wing width	skate
Mantle length	arrow squid, giant squid
Carapace length	rock lobster
Carapace width	paddle crab
Longest dimension of shell from hinge to shell margin	Bluff oyster