codex alimentarius commission

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

WORLD HEALTH ORGANIZATION

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Agenda Item 14 (b) **CX/FAC 06/38/29**
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JOINT FAO/WHO FOOD STANDARDS PROGRAMME

CODEX COMMITTEE ON FOOD ADDITIVES AND CONTAMINANTS

Thirty-eighth Session

The Hague, the Netherlands, 24 – 28 April 2006

DRAFT MAXIMUM LEVELS FOR CADMIUM

Comments at Step 6 submitted in response to Cl 2005/36-FAC by Australia, Canada, Costa Rica, Japan and South Africa

AUSTRALIA

At its 36th session CCFAC could not reach agreement on the proposed Draft Maximum Level for Molluscs (including cephalopods) of 1.0 mg/kg. The following points were discussed:

- Concerns that the proposed level is not achievable for oysters, scallops and cephalopods when viscera is included due to high natural occurrence of cadmium contamination;
- A proposal to divide the molluscs category (including cephalopods) into three sub-categories, with separate MLs: Marine bi-valve molluscs at 1.0 mg/kg; Scallops without digestive caecum at 1.0 mg/kg; and Cephalopods at 2.0 mg/kg;
- A proposal to either separate out oysters at a proposed level of 3.0 mg/kg, or to remove oysters from the proposed MLs entirely.

Australia is pleased to make the following comments on the development of a Codex Maximum Limit (ML) for cadmium in molluscs:

1. Cadmium is a naturally occurring contaminant often found at low levels in seafood. Low levels of cadmium can be detected in seafood harvested from pristine waters where there is no industrial or agricultural activity in many parts of the world.
2. Australia believes that the current suggestion for setting a ML for cadmium in molluscs is overly complicated given the recent dietary exposure work requested by CCFAC and carried out at the 64nd JECFA meeting held in 2005. The establishment of separate MLs for cadmium for sub-categories of molluscs is, in Australia's opinion, unnecessary. The Codex MLs should apply to the commodity as traded to avoid confusion in international trade.
3. Based on the JECFA evaluation (February 2005) for cadmium for various food groups (leafy vegetables, other vegetables, and molluscs), Australia recommends that the CCFAC discontinue work on the proposed ML for cadmium in molluscs for the following reasons:
    a. JECFA estimated the highest intakes of cadmium at 5 percent or less than 5 percent of the PTWI for these food groups, including molluscs, in all 5 GEMS regional diets;
    b. JECFA's intake estimates for these food groups therefore do not meet criteria laid out in the *CCFAC policy for Exposure Assessment of Contaminants and Toxins in Foods or Food Groups* for setting MLs which was endorsed by the CAC in 2005.

4. As a second option should CCFAC not discontinue MLs for cadmium in molluscs, Australia suggests that, in order to simplify the deliberations on the setting of an ML for cadmium in molluscs, whilst protecting human health, CCFAC should consider establishing a ML of 2-3 mg/kg for molluscs (without viscera), including cephalopods but excluding oysters and gastropods.

CANADA

Canada does not object to the Maximum Level for cadmium in polished rice of 0.4 ppm. An exposure assessment for children aged 6 to 11 years revealed that 0.4 ppm cadmium in polished rice is not expected to pose a health risks to Canadian consumers.

Canada has no objection to the proposed Maximum Level of 1.0 for marine bivalve molluscs (excluding oysters and scallops) and cephalopods (without viscera). However, marine bivalve molluscs and cephalopods do not appear to be significant contributors to the total dietary intake of cadmium. Hence, the need to establish Maximum Levels in the first instance for such foods is questioned.

COSTA RICA

Costa Rica avails itself of the opportunity to express its comments in respect of the draft aforementioned and wishes to point out the following:

In the case of marine bivalve molluscs and cephalopods without viscera there is data from 2002-2003 where the cadmium levels are between 0.5 and 1.5 ppm. However, it is possible that today these levels are higher due to environmental conditions such as for example: the effect of sea currents, increasing environmental pollution, changes in the feeding habits of the species, migrations, sedimentation, without taking into account contaminations during processing. On the basis of the foregoing and despite the fact that the real cadmium levels in these foods are not monitored, an increase in these levels is to be expected, as is stated by among others countries such as Thailand and Chile.

Costa Rica does not have cadmium levels as low as those recommended by the CCFAC of 1.0 ppm and recommends supporting 2.0 ppm as the maximum level in these products.

As regards polished rice, still no studies are available. However, efforts are being made to carry these out.

JAPAN

The Government of Japan strongly supports the advancement of the draft ML for cadmium in polished rice at 0.4 mg/kg to Step 8 for the reasons below:

General aspects

1. The *Risk Analysis Principles Applied by the Codex Committee on Food Additives and Contaminants* adopted at the 28th Codex Alimentarius Commission (CAC) stipulates in paragraph 8 that Codex Committee on Food Additives and Contaminants (CCFAC) shall base its risk management recommendations on risk assessments by the Joint FAO/WHO Expert Committee on Food Additives (JECFA) of naturally occurring toxicants and contaminants in foods. Section 1.4.3 of the General Standard of Contaminants and Toxins in Food (GSCTF) also stipulates that an evaluation by JECFA and subsequent recommendations regarding the acceptable intake and regarding maximum levels in foods shall be the main basis for decisions to be discussed by the CCFAC.

2. Annex I of the GSCTF states, “MLs shall be set as low as reasonably achievable and that providing it is acceptable from the toxicological point of view, MLs shall be set at a level which is (slightly) higher than the normal range of variation in levels in foods that are produced with current adequate technological methods, in order to avoid undue disruptions of food production and trade.”

3. The CCFAC shall base its recommendation on MLs for contaminants on JECFA’s risk assessment and in accordance with the ALARA principle as contained in the GSCTF.

Specific aspects

4. The 27th CAC requested CCFAC to take account of the results of the evaluation by the 64th JECFA. The 64th JECFA concluded that the effect of different MLs on overall intake of cadmium would be very small and noted that the total intake of cadmium was 40-60% of the PTWI of 7 µg/kg bw per week;

therefore, a variation of 1-6% due to the use of the proposed MLs is of no significance in terms of risk to human health (JECFA/64/SC). Based on this assessment, the 37th CCFAC agreed to advance the proposed draft ML in polished rice to Step 5 as it can adequately protect the health of consumers. Both this decision and the subsequent adoption by the 28th CAC of the draft ML for cadmium in polished rice at Step 5 are fully in accordance with the above mentioned principles and we respect these decisions.

5. The government of Japan has taken risk management measures for reducing cadmium-contamination of rice, such as removing the soils identified as polluted, and developing and encouraging the use of such agricultural practices as to decrease cadmium uptake by rice plants. Despite these efforts, the level of 0.2 mg/kg is not yet readily achievable as a result of the naturally high background levels of cadmium due to the geological characteristics of the country (volcanoes, acidic soil, etc.).

6. Available analytical data together with the JECFA evaluations and the ALARA principle justifies the maximum level at 0.4 mg/kg.

SOUTH AFRICA

South Africa is of the opinion that the Cadmium concentration allowed for Molluscan Shellfish should take into account the manner in which the shellfish is generally consumed (either meats only or meats and viscera) as well as the rate at which it is consumed (some products, such as abalone, are too expensive to be able to consume them too frequently). If considered in this manner, lower levels for cadmium (at 1mg/kg) can be set for Molluscan Shellfish which are consumed frequently (such as bivalves), and a higher level of 2mg/kg for Molluscan Shellfish which is not consumed that frequently. The manner in which Molluscan Shellfish is consumed by the majority of the population should also be taken into account for laying down levels i.e. the meats of cephalopods, abalone and scallops are mostly consumed without the viscera, therefore, testing should exclude viscera. In order to ensure fair trade in these products, South Africa proposes the following levels based on reported levels of Cadmium in Molluscan Shellfish:

Molluscan Shellfish group	**Maximum level (mg/kg)**
Cephalopods (excluding viscera)	1mg/kg
Bivalve marine molluscs (excluding oysters and scallops)	1mg/kg
Oysters and scallops and other non-bivalve marine molluscs, e.g. gastropods (excluding viscera)	2mg/kg

Codex Submission – SA Fishing Industry

Cadmium in Marine Gastropods

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MARKET

The world market for marine gastropods and specifically abalone is expanding and with it the capture and production of abalone in countries such as China, Australia, Taiwan, Japan, New Zealand, Mexico, South Africa, Philippines, Korea and Chile[1]. Any regulations that may unnecessarily inhibit trade in these products, will affect industries in all of the aforementioned countries.

Even though there is a growing market, the capture, production and consumption of marine gastropods, in South Africa mainly of the genus *Haliotis* (abalone), is limited. This is because of the cultural significance attached to these products as we as their inherently high value which limits their distribution. To date I have not been able to secure a definitive study on the consumption of abalone in terms of

- per capita consumption by country
- consumption by prime users
- consumption of users or per capita by occasion – e.g. Chinese New Year

Hence defining an anchor point for an ALARA-type setting of limits has been difficult. A recent study by ProChile[2] estimates that the global consumption of abalone is spread throughout the world (as a percentage of harvest) as depicted in the table below.

Table 1: Consumption of Abalone[3]

Country	Percentage	Consumption seasonality/Format
China	29	- At the end of the year, Chinese New Year. - August-February, high season of weddings and annual dinner of companies. - Mostly Fresh (Australia, South Africa, Taiwan), then Frozen (Australia, USA, South Africa, Philippines) and Dry (Japan, South Africa, Philippines) in the interior of the country
Hong Kong	27	- Mostly canned (Mexico, South Africa, Australia, New Zealand)
Japan	25	- Mostly frozen and live
Taiwan	8	- Not available
Singapore	7	- Not available
Others	2	- Not available
Korea	1	- Not available
USA	1	- Not available

[1] "Estudio del Mercado Mundial y definición de ventajas competitivas para Chile del Abalone" Editorial del Norte Ltda. 2004. Autores Quiroz & Asociados con auspicio de CORFO.

[2] *Ibid.*

[3] *Ibid.*

SOURCE OF CADMIUM

Marine gastropods are slow growing with an average time from spawning to reach commercial size being between 3.5 years (cultured) and 5 years or more (capture fishery). During this period the abalone have the opportunity to ingest significant levels of cadmium as algae such as *Macrocystis pyrifera* used for abalone feed have been shown to contain levels of 0.15 – 0.31 mg/kg wet weight[4]. Over and above this source sea water contains trace amounts of Cadmium as monitored by uptake in bivalves[5] to a level of 1 - 14µg/g[6] dry weight bivalves

The data indicate that:

- A prime source of Cadmium in abalone is derived from their natural diet.
- The “High” cadmium levels in mussels reflect the correlation between the presence of high levels of dissolved cadmium in surface waters and upwelling. Whether the trends observed could be due to higher intensity or length of upwelling periods, or anthropogenic inputs has to be investigated.
  - In Saldanha Bay this may be partly attributable to industrial pollution.
  - In other areas the source may be rivers transporting cadmium from weathering rocks or other anthropogenic origins within the catchment area[7].
- • Cadmium concentration seems to be affected by the level of development and industrialisation of the sites. The highest median concentration values are found at harbour sites.
- • The refining of fuel (and the use of lead free fuel) as had a significantly positive effect on the level of Cadmium in the water on the SW coast of South Africa8.

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[4] Samples analyzed in 2005 by ISO17025 accredited lab GCL (Chile) using the protocol AOAC 999.10

[5] The Cape Peninsula Mussel Watch Programme. The species of mussels sampled are *Mytilus galloprovincialis* and *Perna perna* while the metals analysed are cadmium, copper, lead, zinc, iron and manganese. Samples were collected in the April/May and September/October months of every year and analysed for trace metals using Atomic Absorption Spectroscopy.

[6] Appendix 1 – Data from the Cape Peninsula Mussel Watch Programme.

[7] Appendix 2 - Measured cadmium levels in wild and cultivated molluscan shellfish in South Africa

[8] The Cape Peninsula Mussel Watch Programme.

LEVELS OF CADMIUM IN ABALONE

Analysis of the different parts of abalone of two species (samples from South African abalone *H.midae* and Californian Red Abalone from Chile *H.rufescens*) have yielded the following:

Table 2: Levels of Cadmium in different parts of abalone

	Species	Range of Cadmium detected
Whole Abalone[9]	*H.rufescens*[10]	1.5 – 4.0 mg/kg
	H.midae[11,12]	0 – 3.0 mg/kg
Muscle only	*H.rufescens*	0.1 – 0.17 mg/kg
	H.midae	0.2 mg/kg
Viscera	*H.rufescens*	9.1 – 13.7 mg/kg
	H.midae	1.6 mg/kg
Processed Abalone (canned without viscera)	*H.rufescens*	0.1 mg/kg
	H.midae	0.1 – 0.2 mg/kg

Considering the application of ALARA to the levels of cadmium in abalone, one should consider the significance of abalone as a contributor to dietary cadmium intake. Hence we believe that a limit of 1.0mg/kg will limit if not prevent trade in whole abalone and a value of no less than 3.0mg/kg should be considered for the products.

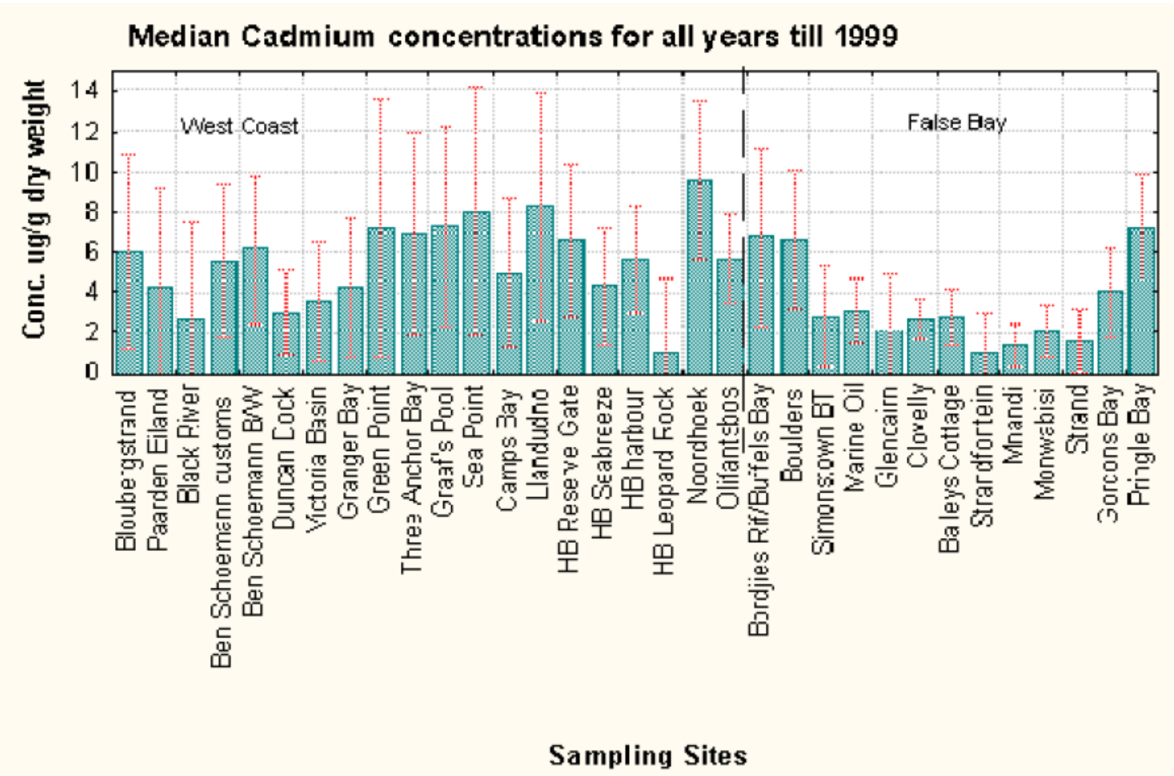
[9] It must be noted that the whole abalone may be used in the preparation of food

[10] Samples analyzed in 2005 by ISO17025 accredited lab GCL (Chile) using the protocol AOAC 999.10

[11] Samples analyzed between 1985 and 2002 by ISO17025 accredited laboratories (South Africa) using the protocol AOAC 999.10

[12] Appendix 2

APPENDIX 1



APPENDIX 2

Measured cadmium levels in wild and cultivated molluscan shellfish in South Africa

Introduction

This refers to CL 2003/13-FAC with specific reference to Part B Paragraph 16, namely the Proposed Draft Maximum Levels for Cadmium [1]: "Proposed Draft Maximum Levels for Cadmium (para. 165 and Appendix XIV). The Committee decided to return proposed draft maximum levels for cadmium in rice, polished (0.2 mg/kg); soy bean, dry (0.2 mg/kg); **molluscs (including cephalopods) (1.0 mg/kg)**; and peanuts (0.2 mg/kg) to Step 3 for circulation, comments and further consideration at its 36th Session."

The current maximum limit (ML) level stipulated in the Foodstuffs, Cosmetics and Disinfectants Act, 1972 (Act No. 54 of 1972) of South Africa is 3 mg/kg, and 2 mg/kg in the proposed amendment to this act.

The concern is that if the ML is set at 1 mg/kg, many of the commercial molluscan shellfish operations in South Africa would not be able to market their product in the EU. This document provides the cadmium concentration in commercial and wild molluscan shellfish in an attempt to show the background cadmium concentrations in various areas along the South African coast. These background levels should be taken into account when determining the regulatory limit.

Status of cadmium levels in molluscan shellfish

Cadmium naturally occurs in trace amounts in the ocean but becomes toxic to living organisms above threshold concentration [2].

Cadmium was analysed for in molluscan shellfish from commercial farms and from wild stock from various areas along the South African coast. The results from these tests are presented below. Data from wild stock in areas that are potentially contaminated due to anthropogenic activities were excluded from the analyses.

Status of cadmium concentrations in shellfish from commercial farms

The cadmium concentrations (wet weight) in abalone, mussels and oysters were statistically analysed using data collected between 1984 until present from commercial farms. Samples were collected from 12 abalone farms, 8 oyster farms and 1 mussel farm that are distributed from Alexander Bay near the Namibian border on the west coast to East London on the east coast (Fig 1). The abalone species farmed with is *Haliotis midae*, the oysters are predominantly *Crassostrea gigas*, though *Striostrea margaritacea* is also utilised to a small extent, and the mussels are predominantly *Mytilus galloprovincialis*, though *Choromytilus meridionalis* and *Perna perna* are also utilized to a small extent.

The abalone farms are all land based utilizing flow through or recirculation technology. Kelp is the predominant feed utilized by the abalone farms, though supplements of artificial feed and other seaweeds such as *Gracilaria* sp and *Ulva* sp is common practice. The oyster farms are predominantly land based, either in dams or raceways to which the water is pumped from the sea. The largest oyster farm however is in Algoa Bay near Port Elizabeth. The mussel farm is situated in Saldanha Bay.

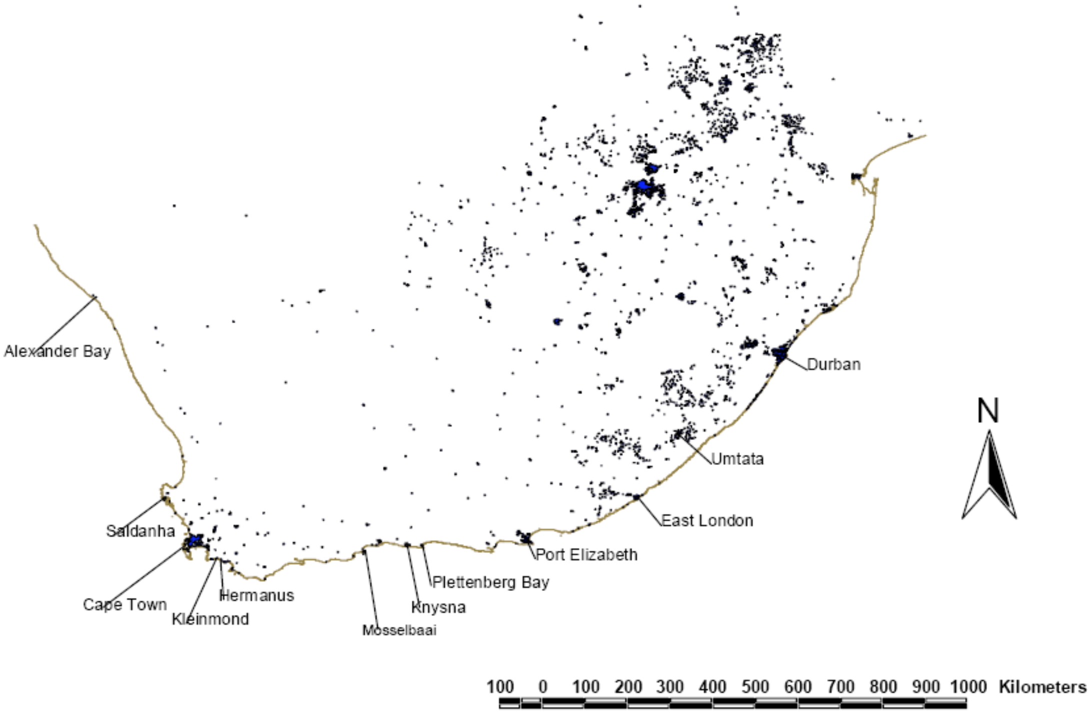


Fig 1: Map of South Africa showing the approximate distribution of the sampling sites

The mean cadmium concentration in abalone from the abalone farms was 1.18 ± 0.85 mg/kg and for the oyster and mussel farms was 0.93 ± 0.79 mg/kg (Table 1). Mussels appear to accumulate higher concentrations of cadmium compared to oysters, with a mean of 1.14 ± 06 mg/kg in the mussels *ca.* 0.85 ± 0.76 mg/kg in the oysters.

Table 1: Concentration of cadmium in abalone and bivalves from commercial farms in South Africa

Species	Mean (mg/kg)	Std Dev (mg/kg)	Range (mg/kg)	% > 1 mg/kg	n
Abalone	1.2	0.8	0.00 - 3.00	57	51
Bivalves	1.0	0.7	0.08 - 2.80	45	33

There is no significant difference in the cadmium concentration between the commercially cultivated abalone and the filter feeders (T-test = 1.01, p = 0.05, n = 84) for the South African coast as a whole.

Considering the above information, 51 % of the abalone samples and 20 % of the mussel and oyster samples tested would exceed the 1 mg/kg limit.

The means and standard deviations were calculated for abalone and bivalves on the west coast, which stretches from Alexander Bay down to Cape Point, for the Hermanus area on the south coast, and the east coast, which stretches from Port Elizabeth to East London (Table 2).

Table 2: The means and standard deviations of cadmium concentrations in molluscan shellfish from commercial farms along the South African coast

Coast	Species	Mean	Std Dev	n
West	Abalone	1.43	0.91	9
	Bivalves	1.22	1.05	25
South	Abalone	1.43	0.75	31
	Bivalves	0.36	0.30	5
East	Abalone	0.29	0.31	11
	Bivalves	0.37	0.30	3

Abalone from the south coast and west coast has significantly greater cadmium concentrations than the east coast with T-test values of 6.98 and 3.61 respectively (p = 0.05). There is no significant difference between in the cadmium concentration between the abalone on the west coast and the south coast (T-test = 0.002, p = 0.05).

The mussels and oysters from the east and south coast have significantly lower cadmium concentrations than the west coast with T-test values of 4.79 and 5.25 respectively (p = 0.05). There is no significant difference between in the cadmium concentration between the bivalves on the east coast and the south coast (T-test = 0.02, p = 0.05).

Status of cadmium levels in the wild

The data for cadmium concentrations in wild molluscan shellfish were derived from data collected as part of the a PhD thesis[3] describing metal concentrations in molluscan shellfish from various areas along the South African coast (Table 1 in Appendix 2) from Saldanha on the west coast to Durban on the east coast (Fig. 1). There are large amounts of data from Saldanha Bay from the Mussel Watch Programme that was excluded due to the probability of anthropogenic contamination. These data are however included in an analyses presented in Table 1 in Appendix 1. A study done by CSIR showed cadmium concentrations of up to 15.74 mg/kg in sediment adjacent to the multi-purpose quay in the bay, possibly as a result of ore dust[4].

The mean and standard deviation of the cadmium concentrations in bivalves from the abovementioned studies along the South African coast is 0.80 ± 0.10 mg/kg. No wild abalone was sampled for cadmium testing. The mussels sampled were predominantly *Perna perna* and *Striostrea margaritacea*. The data for the bivalves, including *Venus verrucosa* and *Solen capensis*, for the various coastal regions are presented in Table 3.

Table 3: The means and standard deviations of cadmium concentrations in wild bivalves from various coastal regions along the South African coast

Coast	Mean	Std Dev	n
West	0.69	0.33	3
South	0.95	0.76	30
East	0.39	0.26	14

Approximately 16% of the wild bivalves sampled would exceed the limit if the regulatory limit was reduced to 1 mg/kg. The cadmium concentration in the mussels versus the oysters for the various coastal regions is presented in Table 4.

Table 4: The means and standard deviations of cadmium concentrations in mussels and oysters from the wild along the South African coast

Coast	Species	Mean	Std Dev	n
West	Mussels	0.31	0	1
	Oysters	0.88	0.01	2
South	Mussels	0.64	0.64	15
	Oysters	1.46	0.73	12
East	Mussels	0.33	0.17	10
	Oysters	0.56	0.39	4

The oysters on the south coast have significantly greater concentrations of cadmium than the mussels on the south coast (T-test = 3.02, p = 0.05). On the east coast there is no significant difference (T-test = 1.16, p = 0.05) between the levels of cadmium in the oysters and mussels. There were not enough samples from the west coast to do any meaningful T-tests.

Discussion

The data for this document has been collated from various sources covering large spatial and temporal scales. The methods used to determine the cadmium concentrations would also be different resulting in varying levels of accuracy. Due to the large amount of data used however, the data should reflect general trends along the South African.

The most recent study by the Mussel Watch programme on the west coast and a number of other studies[5] suggests that there is a high variability along the South African coast and even within a bay. In Saldanha Bay this may be partly attributable to industrial pollution[4]. In other areas the source may be rivers transporting cadmium from weathering rocks[6] or other anthropogenic origins within the catchment area.

The cadmium concentrations appear to be greater on the west and south coast than on the east coast. This may be as a result of upwelling systems bringing cadmium up from deep water systems off the west and south coast[6]. Although the mean cadmium concentrations in the cultivated shellfish appear to be greater that in the wild shellfish, there is no statistical difference. This may be as a result of the high variability in the cadmium concentrations in the various coastal regions.

The abalone industry in South Africa is small compared to international molluscan shellfish producers, producing a little over 500 tons in 2003. It is, however a rapidly growing industry and is currently one of the most important mariculture industries together with the mussel industry creating employment and stimulating the South African economy.

Although the majority of the abalone is exported to the east, South Africa wants to enter the European market. The mussel and oyster farms are also interested in eventually being able to export their products. Thus far the levels of cadmium in molluscan shellfish have been within the regulatory limits of 3 mg/kg set by South African legislation. Should the level now be decreased to 1 mg/kg as proposed by Codex many of the farms would not satisfy EU requirements, effectively creating a trade barrier.

Most foods have an inherently low level of cadmium, with the exception of shellfish, which have been shown to bind cadmium and accumulate it at a significantly higher level[7]. The World Health Organization/Food and Agricultural Organization (WHO/FAO) (WHO, 1989) has determined a maximum tolerable weekly intake of 7 g Cd/kg (about 60 g/person/day for a 60 kg person)[7]. Due to the considerable variation in molluscan shellfish consumption in different areas and among different age groups, this document will not attempt to quantify the consumption and therefore the ML for cadmium. This should be done on a case-by-case basis and may require different regulatory limits for different areas[7]. Such a study should keep in mind that the half-life for cadmium in the human body is between 10 to 30 years[7]. The FDA has however determined that a cadmium concentration of 3 mg/kg (90th percentile) is of concern for the age group of 18 to 44 years[7].

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Appendix 1

Table 1: Breakdown of cadmium concentrations in abalone and the various species of bivalves analysed from wild stock in Saldanha Bay sampled in 1980, 1981, 1990 & 1991.

Species	Mean (mg/kg)	Std Dev (mg/kg)	Median (mg/kg)	Range (mg/kg)	% > 1 mg/kg	n
Haliotis midae	0.38	0.41	0.3	0.11-1.23	14	14
Choromytilus meridionalis	0.45	0.3	0.40	0.04-1.10	1	95
Perna perna	1.22	0.4	1.12	0.75-1.68	67	6
Mactra sp	0.35	0.1	0.37	0.19-0.50	0	7
Mytilus galloprovincialis	4.26	12.2	0.52	0-60.81	26	108
Oysters	0.88	0.1	0.87	0.60-1.17	26	19
White mussels	0.51	0.1	0.56	0.27-0.61	0	9

Appendix 2

Table 1: The medians and standard deviations of cadmium concentrations in wild bivalves at various stations along the South African coast[2].

Species	Station	Date	Mean (mg/kg)	Std Dev (mg/kg)
Crassostrea gigas	Belvedere (1)	1975	0.56	0.13
Crassostrea gigas	Langebaan lagoon	1974	0.87	
Crassostrea gigas	Saldanha Bay	1977	1.1	
Ostrea edulis	Belvedere (1)	1975	0.61	0.13
Striostrea margaritacea	Belvedere (1)	1978	0.49	0.17
Striostrea margaritacea	Featherbed (3)	1978	1.73	0.37
Striostrea margaritacea	Beacon Point (4)	1978	1.34	0.35
Striostrea margaritacea	Castle Rock (5)	1978	2.39	0.48
Striostrea margaritacea	Noetzie (6)	1978	2.49	0.60
Striostrea margaritacea	Fish Bay (11)	1975	1.93	0.24
Striostrea margaritacea	Walker Point West (12)	1975	1.30	0.44
Striostrea margaritacea	Walker Point East (13)	1975	1.61	0.32
Striostrea margaritacea	Cathedral Rock (14)	1975	2.28	0.31
Striostrea margaritacea	Algoa Bay (15)	1977	0.21	0.11
Striostrea margaritacea	Langebaan Lagoon	1974	0.88	
Striostrea margaritacea	Swartkops River	1975	0.26	
Striostrea margaritacea	Bashee Estuary	1975	0.76	
Striostrea margaritacea	Umgababa Estuary	1976	1.01	
Perna perna	Featherbed (3)	1978	0.52	0.18
Perna perna	East Head Rocks (7)	1978	0.61	0.20
Perna perna	Beacon Point (4)	1978	0.30	0.15
Perna perna	Castle Rock (5)	1978	0.86	0.23
Perna perna	Noetzie (6)	1978	1.07	0.29
Perna perna	Leisure Isle (2)	1978	0.93	0.85
Perna perna	Thesen's Jetty (10)	1978	0.12	0.03
Perna perna	Fish Bay (11)	1978	1.02	0.36
Perna perna	Cathedral Rock (14)	1978	0.37	0.13
Perna perna	Walker Point West (12)	1978	0.54	0.24
Perna perna	Umhlanga Rocks	1976	0.27	
Perna perna	Port Elizabeth	1976	0.24	

Species	Station	Date	Mean (mg/kg)	Std Dev (mg/kg)
Perna perna	Port Elizabeth	1976	0.29	
Perna perna	St Croix	1976	0.50	
Perna perna	Kosi Bay	1976	0.18	
Perna perna	Bashee Estuary	1976	0.39	
Choromytilus meridionalis	Featherbed (3)	1978	0.43	0.22
Choromytilus meridionalis	Port Elizabeth	1976	0.65	
Choromytilus meridionalis	Port Elizabeth	1976	0.39	
Choromytilus meridionalis	Saldanha Bay	1976	0.36	
Choromytilus meridionalis	Saldanha Bay	1976	0.16	
Choromytilus meridionalis	Blouberg Strand	1977	0.31	
Artina squamifera	Leisure Isle (2)	1978	2.60	0.60
Venus verrucosa	Leisure Isle (2)	1978	0.55	0.22
Mactra glabrata	Leisure Isle (2)	1978	0.27	
Mactra glabrata	Saldanha Bay	1976	0.19	
Solen carensis	Thesen's Island (9)	1978	0.58	
Solen carensis	Keurbooms River	1978	0.27	0.06
Ostrea atherstonei	Belvedere (1)	1978	0.75	
Donax serra	Fish Bay (11)	1978	0.07	0.02
Donax serra	Buffalo Bay	1978	0.12	
Donax serra	Keurbooms Strand	1978	0.14	0.12
Donax serra	Maitland, P.E.	1978	0.04	
Donax serra	Saldanha Bay	1975	0.09	
Haliotis midae	Saldanha Bay	1980/91	0.41	0.30
Bivalves	Saldanha Bay	1980/91	2.18	8.30

Stations 1 to 10, denoted in brackets, are situated in or in close proximity to Knysna lagoon on the south coast. Stations 11 to 15 are situated near Mossel Bay, Knysna (2 Stations), Plettenberg Bay and Port Elizabeth respectively. Saldanha Bay and Langebaan Lagoon are situated on the west coast near Saldanha, Blouberg strand is just north of Cape Town, Keurbooms Strand and Keurbooms River is just north of Plettenberg Bay, the Swartkops River is north of Port Elizabeth and St Croix Island is further north, Bashee Estuary is south of Umtata in Transkei on the east coast, Umgababa is south of Amanzimtoti in Natal on the east coast, Umhlanga rocks is north of Durban (Fig 1).