Environmental Health

The Journal of the Australian Institute of Environmental Health

...linking the science and practice of Environmental Health

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Call for Papers

The Journal is seeking papers for publication.

Environmental Health is a quarterly, international, peer-reviewed journal designed to publish articles on a range of issues influencing environmental health. The Journal aims to provide a link between the science and practice of environmental health, with a particular emphasis on Australia and the Asia-Pacific Region.

The Journal publishes articles on research and theory, policy reports and analyses, case studies of professional practice initiatives, changes in legislation and regulations and their implications, global influences in environmental health, and book reviews. Special Issues of Conference Proceedings or on themes of particular interest, and review articles will also be published.

The Journal recognises the diversity of issues addressed in the environmental health field, and seeks to provide a forum for scientists and practitioners from a range of disciplines. Environmental Health covers the interaction between the natural, built and social environment and human health, including ecosystem health and sustainable development, the identification, assessment and control of occupational hazards, communicable disease control and prevention, and the general risk assessment and management of environmental health hazards.

Aims

- To provide a link between the science and practice of environmental health, with a particular emphasis on Australia and the Asia-Pacific Region
- To promote the standing and visibility of environmental health
- To provide a forum for discussion and information exchange
- To support and inform critical discussion on environmental health in relation to Australia's diverse society
- To support and inform critical discussion on environmental health in relation to Australia's Aboriginal and Torres Strait Islander communities
- To promote quality improvement and best practice in all areas of environmental health
- To encourage contributions from students

Papers can be published under any of the following content areas:

Guest Editorials

Guest Editorials address topics of current interest. These may include Reports on current research, policy or practice issues, or on Symposia or Conferences. Editorials should be approximately 700 words in length.

Research and Theory

Articles under Research and Theory should be 3000-5000 words in length and can include either quantitative or qualitative research and theoretical articles. Up to six key words should be included. Name/s and affiliation/s of author/s to be included at start of paper and contact details including email address at the end.

Practice, Policy and Law

Articles and reports should be approximately 3000 words in length and can include articles and reports on successful practice interventions, discussion of practice initiatives and applications, and case studies; changes in policy, analyses, and implications; changes in laws and regulations and their implications, and global influences in environmental health. Up to six key words should be included. Name/s and affiliation/s of author/s should be included at start of paper and contact details including email address at the end.

Reports and Reviews

Short reports of topical interest should be approximately 1500 words. Book reviews should be approximately 700 words and Review Articles should not exceed 3000 words in length.

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We are made aware in this issue of a number of constants in environmental health, in that there are two papers on water quality, two on the safety of food, and three on innovative initiatives to improve environmental and population health. There is also a report on ways of incorporating the adoption of the principles of Ecological Sustainable Development into public health education courses around Australia. There is another way of looking at the papers and that is to say that they are all in one way or another about the work of environmental health officers, whether it is in the natural, built or social environment, and about various ways in which environmental hazards and risks can be mitigated.

Recently, the Commonwealth government has released the second independent and comprehensive State of the Environment Report, the State of the Environment 2001 Report, or SoE 2001. The Report is on Australia's environment and heritage prepared by the Australian State of the Environment Committee. The main areas covered are:

- Atmosphere
- Biodiversity
- Coasts and Oceans
- Human Settlements
- Inland waters
- Land
- Natural and Cultural Heritage.

There are also statements by the Minister, by the Chair of the Committee, fact sheets, and details of the theme reports that were used as source material for the Report. For people wishing to access these documents the website is: www.ea.gov.au/soe/2001.

The state of the environment has implications for environmental health and environmental health practitioners, and for population health. Professor Thom (2002), the Chairman of the Committee, said that 'land and water degradation is of critical concern, and that government intervention, particularly regulation, can be effective in protecting and managing Australia's environment'.

In the key findings, there are many areas that have been commented on in this issue of the Journal, and in those in its first full year of publication. A few examples will suffice. The following examples are taken from the key findings (Australian State of the Environment Committee 2001a). Australia has the highest per capita number of hay fever sufferers, and dust and other particulates are a problem in some localities. Many of the warmest years on record have been recorded in the 1980s and 1990s. In relation to land, Indigenous knowledge is being included in policies. The Report argues that while there has been an increase in pesticide use, monitoring in inland waters and groundwaters is not always as frequent as it should be. The Executive Overview emphasises how important it is for ecological sustainable development that without the 'ecosystem services [which] include soil formation, nutrient cycling, clean water supply, pollination and waste assimilation...the world's economy would

grind to a halt' (Australian State of the Environment Committee 2001b, p. 3).

An analysis of the SoE Report and its implications for environmental health and environmental health practitioners is needed so that the relevant connections can be made, as the Report argues in relation to the health of the environment, it is a complex issue and one that involves different levels of government, different countries, and all communities.

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Heather Gardner
Editor

Removal of Heavy Metals from Aqueous Systems Using a Commercial Biological Adsorbent

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A method that has been shown to be effective for removing pollutant heavy metals from water systems is the process of adsorption. Adsorption involves the addition of a particulate colloidal substrate to the aqueous system containing the metal ions, and this can reduce the pH at which the metal ions can be removed from solution compared to precipitation processes. In this study, a commercially available bacterial adsorbent, which consists of pure cultured bacteria on a cereal support, was studied for its potential as a heavy metal adsorbent. The pH-dependent adsorptive properties of Zn(II), Ni(II) and Cr(III), three metals often found in waste water streams, were measured using this adsorbent. As a comparison, the removal profiles were also determined using the cereal support component of the adsorbent alone, without the bacterial component. It was found that both substrates removed these metals from solution more efficiently than precipitation processes, however, it was found that the adsorption efficiency was principally due to the cereal component of the adsorbent rather than the presence of the bacteria. The extent of removal by adsorption onto this substrate was found to be competitive with other substrates used in conventional water treatment processes.

Key words: *Adsorption, Heavy Metals, Adsorbent, Water Purification, Bacteria*

Water systems can contain a variety of toxic metal ions. The presence of these aqueous heavy metals in the natural environment is potentially hazardous to the health of humans, and can cause substantial environmental damage. Three metals, zinc (Zn(II)), nickel (Ni(II)) and chromium (Cr(III)), have been selected for study since these metals are often found in wastewater streams (Sanciolo, Harding & Mainwaring 1992).

Zn(II) and Ni(II) are often found in electroplating and metal working industry effluents (Sanciolo, Harding & Mainwaring 1992). Ni(II) itself is not a cumulative toxin in animals or humans, but acute intoxication can result from exposure to nickel carbonyl (Barceloux 1999b). While initial effects involve the irritation of the respiratory tract, people with severe poisoning develop intense pulmonary and gastrointestinal toxicity. Ni(II) and Ni(II) compounds are also recognised as carcinogens. Zn(II) compounds, while not being as toxic as Ni(II) compounds, can cause irritation and corrosion of the gastrointestinal tract, along with arterial damage if the exposure level is sufficiently high (Barceloux 1999c).

Commercial applications of Cr(III) include tanning, corrosion inhibition, electroplating, glassware cleaning solutions, manufacture of safety matches, and the production of pigments. It has low toxicity to humans since it is poorly absorbed through the gastrointestinal tract, however, it can be oxidised to the hexavalent form (Cr(VI)). Soil contamination can result from Cr(VI) waste slag being used as landfill in residential, public and industrial areas. Cr(VI) is a skin and mucous membrane irritant that can cause allergic contact dermatitis. It is also a pulmonary carcinogen (Barceloux 1999a).

Aqueous heavy metals cannot be broken down into harmless residues, so development of methods designed to concentrate and remove these metals from solution is desirable. It is well documented that heavy metals will form an insoluble metal hydroxide precipitate upon the addition of base, the amount of which depends on the solution characteristics of the metal ion under investigation (Baes & Mesmer 1986). This method, the most commonly applied process for the removal of heavy metals, requires the control of pH for metal ion precipitation, as excess base addition can result in the re-dissolution of the precipitate for some metals. Substantial amounts of base can be required for this process to be successful. This represents a significant process cost, and often results in large volumes of high pH water, which is not desirable in aqueous systems. The amount of base required, and the final pH of the finished product can potentially be lowered if adsorption processes are employed to treat the aqueous heavy metals. If the metals are adsorbed onto the surface of a substrate, they can be efficiently removed from the high volume wastewater by separation processes such as sedimentation or flotation (Sanciolo, Harding & Mainwaring 1992).

Adsorption of heavy metals has been performed using a wide range of experimental conditions and substrates (Agashe & Regalbuto 1997; Crawford, Harding & Mainwaring 1993a, 1993b; Daughney & Fein 1998). Metal oxides, in particular, have been studied extensively for this purpose, with some oxides having been shown to exhibit a greater affinity for some metals over others (Crawford, Harding & Mainwaring 1993a, 1993b). Carbonaceous substrates, such as coal, have also been used, with the resulting high levels of adsorptive properties being attributed to the presence of carboxylate surface functionality (Burns et al. 1999; Mishra & Chaudhury 1994). Other adsorbents that have been investigated for the recovery of heavy metals include humic acids (Ibarra, Osacar & Gavilan 1979) and latex (Harding & Healy 1979, 1985b).

More recently, biological substrates have been shown to be efficient in the adsorption of heavy metals (Daughney & Fein 1998; Gupta, Shrivastava & Jain 2001, Pagnanelli et al. 2001, Volesky 1990). The advantages associated with the use of biological substrates are that they can be produced relatively inexpensively (sometimes as by-products in the food industry), are renewable, often remove metals efficiently, and in some cases, show high selectivity for certain metal types (Volesky 1990). Biological substrates that have been investigated include fungi (Sag, Akcael & Kutsal 2001), algae (Gupta, Shrivastava & Jain 2001), and bacteria (Pagnanelli et al. 2001; Volesky 1990).

Bacteria are common in natural environments such as rivers, lakes, and oceans (Harvey & Young 1980). In these environments, most solid surfaces such as rocks are coated by organic material (Davis 1984; Schlautman & Morgan 1994) containing appreciable amounts of bacterial biomass. The significance of adsorption in regulating the concentration of dissolved metal ions is widely recognised (Harding & Healy 1979), with the adsorption of natural organic material on particles being an important geochemical process in aquatic systems (Lion & Leckie 1981). The binding of metallic ions by microbial cells is considered to be an important contributing factor to the fossilisation of microorganisms (Ferris, Fyfe & Beveridge 1988).

The commercially available bacterial adsorbent (henceforth called the 'adsorbent') used in this study is marketed as an environmental cleaning agent that is suitable for the digestion of greases, oils and food wastes, and as an odour removal substrate, however, its ability as a heavy metal adsorbent is not known. The product consists of pure, cultured bacteria in a dry, inert state on a cereal support component that acts as an inert stabiliser. The support contains thrashed wheat, agriculture grade

mineral nutrients and food grade enzyme supplements. It is known to contain five types of bacteria, three of which are known to be *Bacillus* strains and two unidentified Gram-negative bacteria. The biological agent components are harmless microbes that occur naturally in soils and aqueous streams in Australia.

Wheat flour has been shown to be an efficient adsorbent of lipids due to the presence of surface-active protein groups such as albumin, globulin, glutenin and gliadin (Keller, Orsel & Hamer 1997). It is unclear as to what role, if any, these surface-active groups would play in the removal of aqueous heavy metals from solution if it were to be used for this purpose.

This study reports the pH-dependent adsorptive properties of the adsorbent for three aqueous metals Cr(III), Zn(II) and Ni(II). In addition, the metal binding efficiency of the cereal support component of the adsorbent was also investigated.

Materials and Methods

Reagents

Analytical grade reagents and chemicals were used in all metal adsorption trials. All solutions were prepared using purified water, and all adsorption experiments were performed using a 0.02 M KNO_3 background electrolyte. The metal solutions (prepared from the nitrate salts) and buffer solutions were prepared using this electrolyte solution. Metal solutions were prepared to give a final concentration of 50 ppm with respect to the metal ion after dilution in the reaction vessel. The concentration of 50 ppm was selected, as this was the level often encountered in metal ion-containing waste streams (Sanciolo, Harding & Mainwaring 1992). The pH levels of solutions were measured using an Activon pH meter, calibrated by phosphate and phthalate buffers at pH values of 6.84 and 4.01 respectively. Adjustments to the pH were made using either 0.1 or 1.0 M HNO_3 or KOH solution.

Adsorption experiments were performed in stirred 250 mL batch reactor vessels that were held at a constant temperature of 25°C. Reaction vessels were purged with nitrogen gas for a period of two hours prior to the adsorption experiments. Vessels were sealed with paraffin-coated film containing gas outlet valves that contained 0.22 µm spore collection filters. All pH adjustments, pH measurements and solution sampling were performed through this film using sterile syringes. All glassware was autoclaved at 121°C for 20 minutes prior to use.

Adsorption experiments

Metal ion adsorption experiments were performed according to the method described by Crawford, Harding and Mainwaring (1993a). An initial 80 mL volume of electrolyte was added to the reaction vessel, stirred, and a known mass of substrate added. Nitrogen purging to ensure a CO_2-free environment was then commenced, and continued for a two-hour period. Aliquots of standard metal nitrate solution (Zn(II), Ni(II) or Cr(III)) were added and the pH was adjusted to the desired level. The volume was adjusted to 100 mL using the electrolyte solution, resulting in a final total metal concentration of 50 ppm. The suspension was equilibrated for 50 minutes under agitated conditions, after which time a sample was removed using a sterile syringe, filtered through a 0.22 µm nitrocellulose filter, and acidified using two drops of concentrated analytical grade HNO_3. The samples were then stored in sealed glass vials for further analysis. Atomic absorption spectroscopy was used to determine the metal ion concentration remaining in solution after equilibrium using a Varian SpectrAA-20 atomic absorption spectrometer (AAS). AAS samples were prepared from standard 1000 ppm metal solutions in the background electrolyte.

Results and Discussion

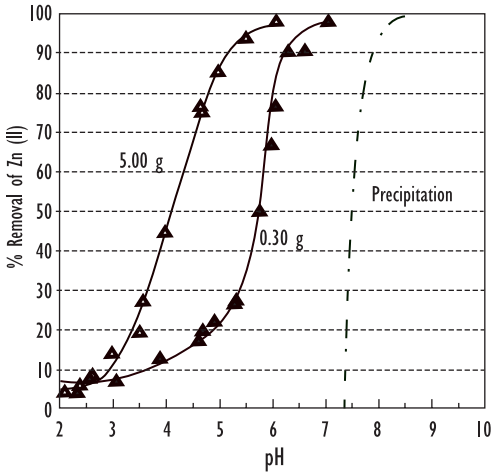
Adsorption onto the adsorbent

The adsorption of 50 ppm Zn(II), Ni(II) and Cr(III) using two different masses of adsorbent (0.30 g and 5.00 g) was measured as a function of pH. The results are given in Figures 1 to 3. For comparison, the hydroxide precipitation profile for each individual metal (50 ppm) is included.

The Zn(II) adsorption results show that greater removal can be achieved using the higher substrate mass, with a reduction in pH at 50% removal of approximately 1.5 units compared to the lower substrate mass results, and approximately 3.5 units compared with direct precipitation. The Zn(II) adsorption using the 5.00 g sample achieved complete Zn(II) removal approximately 1.5 pH units below the pH at which Zn(II) precipitation commenced.

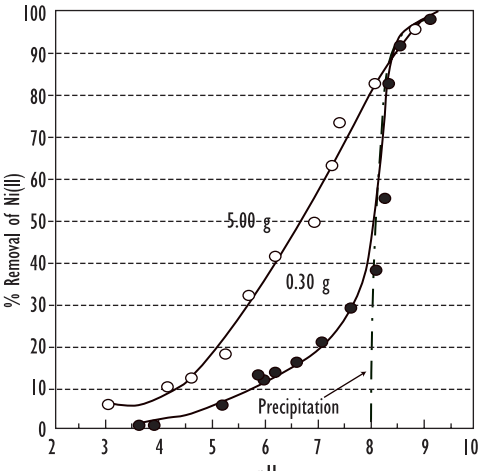
The increased degree of removal at the higher substrate mass can be attributed to an increased available surface area for interaction with aqueous heavy metal ions. Similar effects have been observed for removal of, for example Pb(II) onto goethite (Kooner 1993) and Cd(II) onto iron oxyhydroxide (Benjamin & Leckie 1980).

Figure 1: Removal of Zn(II) by adsorption onto 5.00 g and 0.30 g of adsorbent as a function of pH. The precipitation profile for the metal alone (50 ppm) is included for comparison.



Ni(II) adsorption onto the adsorbent is given as a function of pH in Figure 2. Again, removal of the metal ion from solution could be achieved at a lower pH if a higher substrate mass was used, with a reduction in pH at 50% removal of 1.5 units compared to both the 0.30 g substrate adsorption and direct precipitation results. The reduction in the pH of removal was less pronounced for Ni(II) than was found for Zn(II).

Figure 2: Removal of Ni(II) by adsorption onto 5.00 g and 0.30 g of adsorbent as a function of pH. The precipitation profile for the metal alone (50 ppm) is included for comparison.

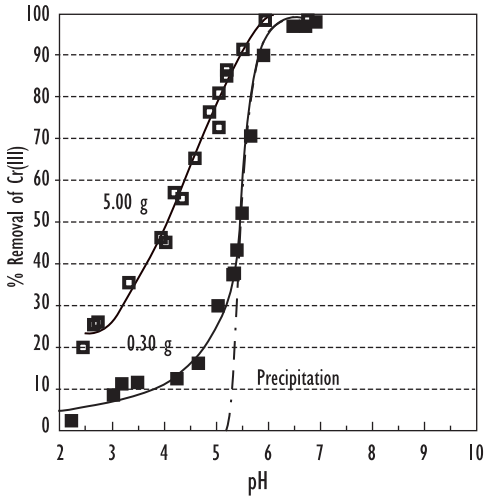


Cr(III) adsorption onto the adsorbent is given as a function of pH (see Figure 3). The Cr(III) could be adsorbed onto the greater mass of substrate at a pH approximately 1.5 units (at 50% removal) lower than that achieved using either the lower substrate mass and direct precipitation. As was observed for the Ni(II) adsorption results, the reduction in the pH of removal was less pronounced for Cr(III) than was obtained for Zn(II). It is noteworthy that the adsorption of Cr(III) onto the higher substrate mass resulted in almost complete removal of the metal at the same pH that precipitation of the Cr(III) would have commenced.

These results indicate that the amount of base required completely to remove Zn(II), Ni(II) and Cr(III) from aqueous solution

would be substantially reduced compared to that required for direct precipitation of the metals if 5.00 g of the adsorbent was present prior to the base addition.

Figure 3: Removal of Ni(II) by adsorption onto 5.00 g and 0.30 g of adsorbent as a function of pH. The precipitation profile for the metal alone (50 ppm) is included for comparison.



Adsorption onto the adsorbent support material

As previously discussed, the adsorbent contained both a biological component and a cereal support medium. To assess the aqueous metal adsorptive capabilities of the support medium alone, a sample was obtained from the supplier that did not have the biological component added, and this was used as a substrate in adsorption experiments. Since it was seen in Figures 1 to 3 that the removal of the aqueous metals was most effective in the presence of the greater mass of adsorbent, all subsequent adsorption trials were performed using 5.00 g of substrate.

The degree of heavy metal removal as a function of pH using the support material is given in Figures 4 to 6. Also included in these graphs for comparison are the adsorption results obtained using 5.00 g adsorbent (that is with the biological material included) and direct precipitation curves.

Figure 4: Removal of Zn(II) by adsorption onto 5.00 g the adsorbent and its support material as a function of pH. The precipitation profile for the metal alone (50 ppm) is included for comparison.

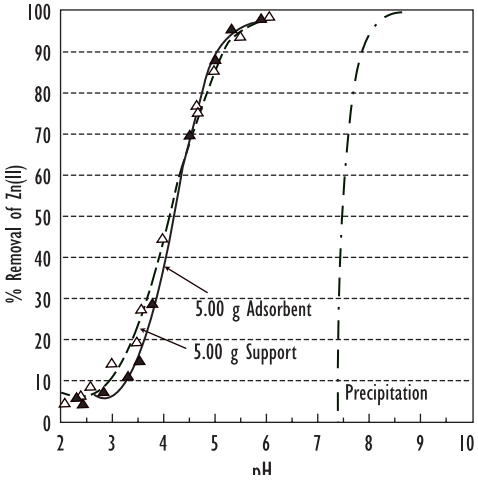
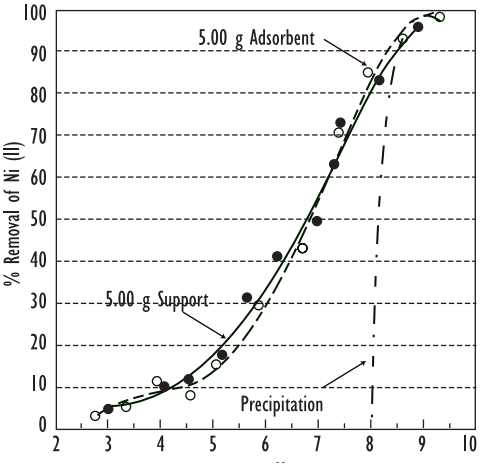
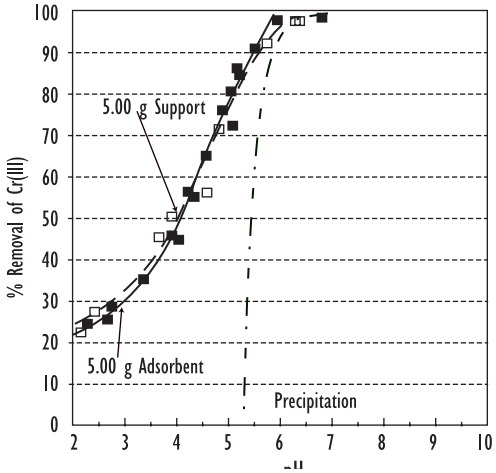


Figure 5: Removal of Ni(II) by adsorption onto 5.00 g the adsorbent and its support material as a function of pH. The precipitation profile for the metal alone (50 ppm) is included for comparison.



It can be seen that there is little difference between the adsorption results obtained using the adsorbent and its support medium for Zn(II), Ni(II) and Cr(III), indicating that a majority of the metal adsorption was likely taking place on the support medium. Wheat and wheat products have been used as adsorption substrates (Keller, Orsel &

Figure 6: Removal of Cr(III) by adsorption onto 5.00 g the adsorbent and its support material as a function of pH. The precipitation profile for the metal alone (50 ppm) is included for comparison.



Hamer 1997), with surface activity being attributed to the surface protein groups. The results given in Figures 4 to 6 are consistent with these observations.

The pH corresponding to the removal of 50% of the heavy metal present is given in Table 1 for the three metals under investigation.

Table 1: Comparison of pH values at 50% removal for the substrate materials used in this study.

	pH at 50% Metal Ion Removal		
Substrate	Zn(II)	Ni(II)	Cr(III)
5.00 g adsorbent	3.8	4.0	6.5
5.00 g adsorbent support material	3.6	4.2	6.6

The adsorbent is prepared by spraying a 44 mL volume of the bacterial component (a liquid suspension of undisclosed concentration) over a mass of 1 kg of the support material. Given these proportions, it would not be surprising that the metal adsorption onto the support material would be in excess of the amount that would take place onto the bacterial component alone. The manufacturer's specifications state that the product contained sufficient nutrient additives to support a tenfold increase in bacterial 'potency' if the solid was pre-incubated in water for 24 hours prior to its use. It is unlikely, however, that even with a tenfold increase in bacterial concentration would appreciably further increase the adsorptive properties displayed by the cereal support component.

Comparison with other substrates

The data obtained in this study show that the adsorption of Zn(II), Ni(II) and Cr(III) onto the substrates studied can be achieved at a lower pH than direct precipitation. The extent of adsorption is dependent on the mass of substrate used, and the metal ion being studied. These adsorption results may be compared to others reported in literature for the removal of the same metals using dissimilar substrates.

Zn(II) adsorption has been reported using substrates such as amorphous iron(III) oxide and amorphous chromium(III) hydroxide (Crawford, Harding & Mainwaring 1993a & 1993b), goethite (Rodda, Johnson & Wells 1993), amorphous iron oxyhydroxide (Benjamin & Leckie 1980), and brown coal (Burns et al. 1999), amongst others. Ni(II) adsorption has been performed the substrates amorphous iron(III) hydroxide, amorphous chromium(III) hydroxide (Crawford, Harding & Mainwaring 1993a,1993b), goethite (Barrow, Gerth & Brümmer 1989) and brown coal (Burns et al. 1999). Cr(III) adsorption has been reported using the substrates silica (Harding & Healy 1979), amorphous iron(III) hydroxide (Crawford, Harding & Mainwaring 1993a, 1993b), amorphous iron oxyhydroxide (Benjamin & Leckie 1980) and brown coal (Burns et al. 1999).

The data obtained by Crawford, Harding and Mainwaring (1993a) and Burns et al. (1999) have been selected for comparison to the results obtained in this study because of the similar experimental conditions used to obtain the results (metal ion concentration, electrolyte concentration, temperature, reaction time).

Table 2 shows results for the pH at 50% metal ion removal for 0.30 g and 5.00 g of the adsorbent and literature values for brown coal (from Burns et al. 1999), amorphous iron(III) hydroxide, and amorphous chromium(III) hydroxide (Crawford, Harding & Mainwaring 1993a).

Table 2: Comparison of the pH values (at 50% removal) for the substrates used with literature values for brown coal, HFO and HCO.

	pH at 50% removal		
Substrate	Zn(II)	Ni(II)	Cr(III)
5.00 g brown coal	3.5	3.5	2.8
5.00 g adsorbent	4.0	6.5	3.8
0.22 g hydrous iron(III) oxide	6.5	7.5	4.5
0.30 g adsorbent	5.7	8.0	5.4
0.20 g hydrous chromium(III) oxide	5.8	7.0	-
Precipitation of 50 ppm metal	7.5	8.0	5.4

The removal of Cr(III), Zn(II) and Ni(II) using 5.00 g of the adsorbent achieves metal ion removal at a pH that is slightly less than that obtained using brown coal, but in excess of that obtained using hydrous iron(III) oxide and amorphous chromium(III) oxide substrates. A direct comparison, however, would also require the effect of surface area (and therefore the number of surface sites available for adsorption) to be taken into account, however, the results given in Table 2 provide an indication of the effectiveness of the substrates used in this study.

Conclusion

The commercially available bacterial adsorbent product was found to be an effective substrate for the removal of aqueous Zn(II), Ni(II) and Cr(III) from water systems. Utilisation of this adsorbent in water treatment processes would result in economic and environmental benefits, since the amount of base required to remove the metal ion from solution is decreased compared to that of direct precipitation, which often also has the disadvantage of resulting in large volumes of high pH water that requires disposal. The extent of adsorption was shown to increase as the substrate mass was increased, resulting in a further decrease in the pH of removal. There was little, if any, difference in the adsorption results obtained using the adsorbent and its support medium, indicating that a majority of the metal adsorption took place on the support medium itself. This medium contains a high proportion of thrashed wheat, and it appears that this is an effective adsorbent of heavy metals, perhaps due to the presence of protein groups on the surface of the wheat.

The data obtained was compared to selected literature data. It was seen that the removal of Zn(II), Ni(II) and Cr(III) using 5.00 g of adsorbent achieved metal ion removal at a pH that was slightly less than that obtained using brown coal, but greater than that obtained using hydrous iron(III) oxide and amorphous chromium(III) oxide substrates. The costs associated with production of the substrates traditionally used in water treatment processes (e.g. metal oxides and activated carbons) are greater than those associated with producing the thrashed wheat substrate, and hence this would be an efficient and economic adsorbent for use in water treatment processes.

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Assessment of Stream Invertebrates and Water Quality During Insecticide Spraying of Plague Locusts in the Flinders Ranges, South Australia

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Large populations of the Australian plague locust (Chortoicetes terminifera) *were present in northern South Australia in mid-2000. Approximately 505 000 hectares of land was were sprayed with insecticides (mostly from aircraft) between September and December 2000 to control the locust plague. In response to concerns about the possible environmental impact from widespread spraying of the insecticides fenitrothion and fipronil, the Environment Protection Agency commissioned a study to assess the impact on off-target aquatic ecosystems. Sampling was conducted at nine riverine sites in the Flinders Ranges both before and after spraying. Water samples were analysed for physical and chemical parameters, and tested for the presence of fenitrothion and fipronil and other pesticides. Macroinvertebrate samples were analysed using the statewide AUSRIVAS bioassessment models to determine whether any changes in community assemblages were likely to have been caused by pesticide impacts. Pesticides were not detected in any water samples, and there was insufficient evidence that the macroinvertebrate communities were altered by the locust spraying operation.*

Keywords: *Australian Plague Locust, Insecticide, Fipronil, Fenitrothion, Water Quality, Aquatic Macroinvertebrates, Flinders Ranges*

The Australian Plague Locust

The Australian plague locust, *Chortoicetes terminifera*, is a native insect which is generally harmless and solitary in behaviour. Locust eggs develop according to temperature and moisture. Usually eggs are laid in autumn (March-May), remain dormant over winter and hatch in spring. However, eggs laid in summer under ideal conditions will hatch within 14-16 days, producing several generations of locusts in one season. This generally coincides with a change in locust behaviour to that of a swarming pest insect. Locusts mature in about 4-6 weeks after hatching and once mature they are able to fly and form swarms. Most locust plagues originate in the channel country of Queensland and adjacent areas of South Australia, New South Wales and the Northern Territory. Large locust populations develop following rainfall in these areas. In the last 50 years South Australia has had major plagues in 1955, 1976, 1979, 1992, 1993 and 1997 (Primary Industries and Resources South Australia [PIRSA] 2000).

Swarms can travel up to 20 km a day and migration may occur at night if sufficient green feed is available to allow fat accumulation. Locusts eat a wide range of plants including pasture grasses, cereal crops, berry fruits, grapevines, some ornamentals, tree fruits and nuts and vegetables.

Locust plagues can be controlled chemically when animals are in the nymph and adult stages and large chemical control

campaigns are common in most affected regions of Australia. Treating small masses of nymphs immediately after hatching, when the locusts congregate in dense groups or bands, can effectively control potentially damaging populations. More than one spraying may be needed because eggs can hatch over a period of several weeks.

The 2000 Plague

In 2000, large amounts of rain fell in Queensland early in the year and this was followed by humid weather, providing optimal breeding conditions for locusts. Large populations then moved to the pastoral country and northern agricultural zone of South Australia. Rain in these areas caused further hatching that ultimately resulted in the production of plague numbers of locusts (PIRSA 2000). The arrival of the plague in southern regions of the State was predicted to coincide with critical stages of agricultural crop development. Population assessments and experience with previous outbreaks of plague locusts in South Australia indicated that the areas most likely to be affected included the southern Flinders Ranges and mid north of the State, northern Eyre Peninsula and the Riverland. It was predicted that if left unchecked, the locust plague could infest the wine-growing regions in the Barossa Valley and the southeast and also cause substantial damage in the city of Adelaide (PIRSA 2000).

A South Australian Government program for insecticide spraying was developed. Its aims were to disperse locust numbers and prevent the formation of swarms, thus reducing widespread crop damage and economic loss. This program combined the efforts of the Australian Plague Locust Commission (APLC), PIRSA, Local Government Authorities and landowners.

By 12 December 2000, approximately 505 000 hectares had been sprayed as part of the control program. PIRSA assumed responsibility for the aerial spraying of large targets and set the priorities for surveying and spraying with the aim of killing the maximum number of locusts per day. They used two chemicals - fipronil in pastoral country and fenitrothion in cropping country.

Major Insecticides

Fenitrothion is a broad range, non-systemic organophosphorous insecticide that has been registered for use in Australia for over 30 years. It is regularly used to protect stored grain from insect damage and to control insects in a range of crops and pastures. It kills mostly by direct contact within 2-3 days and has a less effective residual activity than fipronil (PIRSA 2000). Fenitrothion is regarded as having moderate toxicity and principally acts as a cholinesterase inhibitor (PIRSA 2000). It is very highly toxic to aquatic invertebrates, especially crustaceans and insects (Donkin et al. 1997) and the 48-hour and 96-hour EC_{50} (concentration at which 50% of individuals are affected) was 3 parts per billion (ppb) for *Gammarus fasciatus* (US Environmental Protection Agency [USEPA] 1987). Field studies of the off-target effects of fenitrothion spraying on streams have generally indicated an increase in the drift rate of invertebrates which, in some cases, included dead organisms. Most peaks in drift occurred within the first 12 h after treatment, and the effects generally lasted less than 24 h. In the majority of these studies, no decreases in benthic populations of aquatic invertebrates were observed after spraying. In those cases in which short-term reductions in some groups did occur, the effects were transitory (Agriculture Canada 1993). In other studies fenitrothion caused a significant and lasting decline of springtails over a 12 week period, ranging from 4.6 to 14.4% of the pre-spray level (Römbke & Peveling 1996) and its use was banned in Canada in 1997 after it was linked to significantly increased mortality in forest songbirds (Mineau 1999).

Fipronil was released on to the market in 1993 and is a member of the phenyl pyrazole class of pesticides (Rhône-Poulenc 1995). It takes 7–10 days to kill but does possess

strong residual activity. Fipronil is classed as a World Health Organization (WHO) Class II moderately hazardous pesticide (WHO 1998). It is toxic to a wide range of aquatic invertebrates, and is very highly toxic to oysters, shrimps and other Crustacea (Diallo et al. 1998, Lahr et al. 1998). An invertebrate life cycle study of *Daphnia* sp. (Crustacea) showed that fipronil affects the length of daphnids at concentrations greater than 9.8 ppb (USEPA 1996). The spraying of plague locusts with fipronil in South Australia has been by far the largest campaign using this chemical in Australia. The Australian Plague Locust Commission is still conducting tests of its effect on non-target Australian invertebrate and vertebrate fauna (P. Spurgin, pers. comm.).

The application of fenitrothion and fipronil is governed by strict control regimes including the observation of buffer zones around residences and sensitive areas such as waterways and public water supply dams (APLC 2000). Fenitrothion in particular requires large buffer zones as it is inherently prone to spray drift (NRA 1999). For aerial application the buffer zone is defined by the area 1.5 km upwind or 300 m downwind of the sensitive area and for ground application, 100 m upwind and 100 m downwind (Commonwealth of Australia Gazette 2001). Additional restrictions on the use of fipronil included limiting its application to northern pastoral areas of the State and avoiding populated areas (PIRSA 2000).

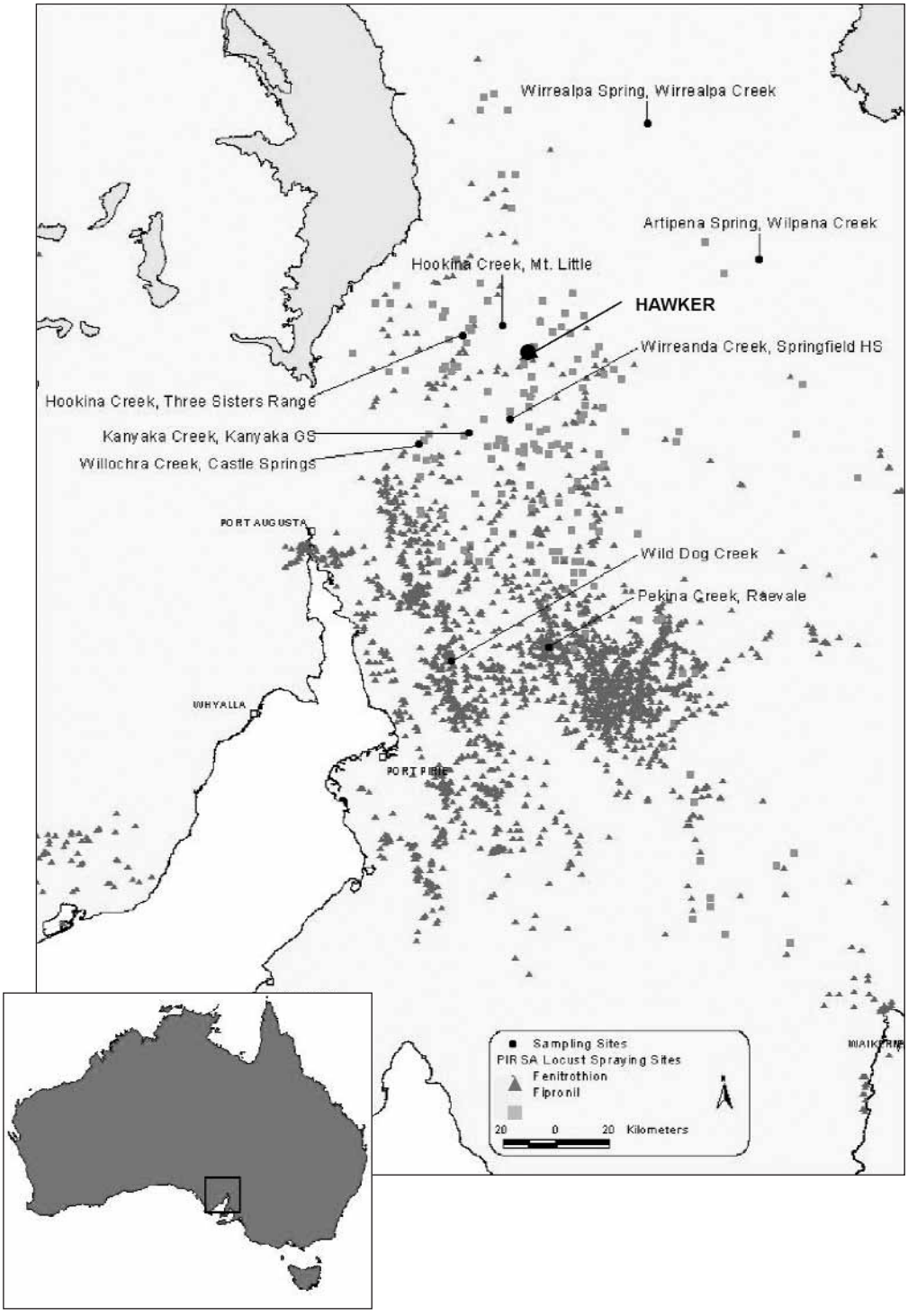
Although buffer zones around waterways help minimise the risk to water supplies and aquatic organisms, off-target applications (which are a possibility when global positioning system equipment is not used) can result in serious damage (Lahr 1997). There is also the possibility of rain washing the insecticides into waterways, where they can have damaging effects on invertebrates (USEPA 1987, Donkin et al. 1997). The most serious effects are generally seen during the periods when pulses of high concentration occur immediately after spraying, when there has been little time for chemical degradation and dilution of insecticides.

Concerns for the environmental impact of the widespread spraying campaign were addressed through cooperative arrangements between PIRSA, the Environment Protection Agency (EPA) and the State Water Monitoring Coordinating Committee. The EPA commissioned this study to address the concerns regarding chemical trespass and off-site environmental impact from the use of fenitrothion and fipronil in the Flinders Ranges. Forming part of the normal migration routes of the Australian plague locust, and situated at the northern limits of areas of intensive agriculture, this landscape has experienced a long history of broad scale insecticide application. This study focused on the Flinders Ranges area as it contains regions of significant environmental value and it was likely to be one of the first areas to be sprayed in 2000, and to require extensive applications of insecticide. The aim of this study was to assess the water quality and invertebrate assemblages of streams within a landscape where the terrestrial ecosystems had received extensive applications of insecticides. The study assessed whether detectable concentrations of either insecticide were present in local waterways following spraying and determined whether the spraying program adversely impacted aquatic organisms in streams of the Flinders Ranges.

Methods

In consultation with PIRSA staff, nine sampling sites were selected for the study (Figure 1). Most sites were located in reaches, which were likely to have a large proportion of their terrestrial catchment sprayed. Where possible, sites were used that had been previously sampled between 1994-1999 as part of a national biological assessment study. The sampling sites differed with respect to the number and density of targets located within their vicinity, and in terms of the insecticide delivered at targets (Figure 1).

Figure 1: Sampling sites and locust spraying sites in 2000



Sampling was conducted using a before/after spraying approach. Spraying first occurred on the 28th September to the west and north of Hawker (PIRSA 2000) and sampling first occurred two weeks later, on the 9th and 10th of October 2000, before large scale spraying had occurred in the catchments of the sites chosen. Sites were sampled again between 28th November and 1st December 2000 after spraying in the area had concluded. From the commencement of sampling, subsequent rainfall first fell between 12-18th October and heavy local rains (50-75 mm) continued into November. This rain produced substantial overland flow, cutting roads in some places (D. Hopkins, PIRSA, pers. comm.).

Sites were sampled using the AUSRIVAS (Australian River Assessment System) protocol (*AUStralian RIVer Assessment System Sampling and Processing Manual 2001*). AUSRIVAS provides a predictive assessment of the biological health of Australian rivers. It comprises standardised techniques for the collection, analysis and reporting of biological data. At present, AUSRIVAS deals only with aquatic macroinvertebrate data but the approach may be applied to other groups of biota. Analyses are conducted using predictive computer models similar to RIVPACS software developed in Britain (Wright et al. 1993). The AUSRIVAS models predict the macroinvertebrate families expected to occur at a site in the absence of significant environmental stress (e.g., pollution, habitat modification) and compare the predictions to those families actually collected at a site.

The sampling strategy involved the selection of sites which were defined as a 100 m reach of each stream, recording physical features and collecting samples to characterise the water quality and macroinvertebrate community of each site. The macroinvertebrates were sampled from both standardised still-water edge habitat and flowing-water riffle habitat (where present) using a 250 µm mesh sweep net over a 10 m area (AUStralian RIVer Assessment System Sampling and Processing Manual 2001). The macroinvertebrates were preserved in the field with 4% formalin. In the laboratory, a minimum of ten percent of each sample was sorted using the technique described by Marchant (1989) and identified. If the total number of individuals in the subsample was less than 200, additional fractions of the sample were examined until the total had been reached. Macroinvertebrates were identified to the lowest possible taxonomic level. While at the sites, samplers were mindful to record any evidence that indicated pesticides may have been present in the water, including the presence of dead or injured invertebrates and any other unusual result (e.g., the capture of very few animals in a sample).

Physico-chemical parameters such as dissolved oxygen, pH and water temperature were recorded from field measurements. Several water samples were collected at each site and stored on ice for subsequent determination of physical and chemical water quality parameters in the laboratory, including the presence of fenitrothion and fipronil (detection limit: 0.5 µg/L). Chemical analyses were carried out using standard methods (APHA 1998).

A number of habitat variables were also recorded at each site to assist with characterising the ecological condition of the Flinders Ranges streams during the sampling program. These included recording stream width, depth at 1 m intervals along a transect, water velocity, the presence of aquatic macrophytes, land use in the area, width and composition of the riparian buffer zone and substrate characteristics.

Results

Pesticides were not detected at any site on either sampling occasion (detection limit: 0.5 µg/L). In addition, the other chemical parameters measured did not change greatly from the first survey to the second (Table 1). Some parameters changed slightly probably due to the changes in weather patterns. For

example, water temperature generally increased, while conductivity generally decreased, presumably due to the input of significant rainwater during this study.

Turbidity increased at all sites, except Kanyaka Ck. This was probably caused by the rainfall washing soil into the streams. Wild Dog Ck, Pekina Ck and Wirreanda Ck had the highest nutrient levels. The higher levels of total phosphorus are related, in part, to the higher turbidities of these sites. Organic nitrogen in aquatic systems is mostly sourced from land runoff while oxides of nitrogen are contributed by both groundwater and runoff. Hookina Ck (west of Three Sisters Range) had the lowest total Kjeldhal nitrogen (TKN) and the highest level of nitrogen oxides at both sampling times, indicating it is subject to nutrient upwellings from groundwater and does not receive much land runoff. Wirreanda Ck had the highest TKN in the pre-spraying sample, and Pekina Ck had the highest in the post-spraying sample. At these sites the nitrogen came either from the animals that water at the site or organic debris, such as leaves, present in the stream. Wirreanda Ck was also relatively fresh compared to most other sites indicating that it obtained most of its water from rainfall rather than the groundwater.

A total of 190 taxa was collected during both surveys, with 49 taxa being the most collected in one sample and 13 being the least. The assemblages collected were fairly typical of aquatic semi-arid environments in Australia, being composed of many species of adult beetle and insect larvae (particularly flies) which are mobile and able to rapidly colonise temporary waters (Boulton & Suter 1986). There were a moderate number of true bugs and caddisflies, which are not

Table 1: Chemical parameters of sites in the Flinders Ranges before (B) and after (A) spraying for locust control. Abbreviations as follows: DO: dissolved oxygen; Tem: temperature; Cond: electrical conductivity; Turb: turbidity; Bicarb: bicarbonate; FiltP: filterable Phosphorus; TotP: total Phosphorus;TKN: total Kjeldhahl Nitrogen; NOX: oxidised Nitrogen.

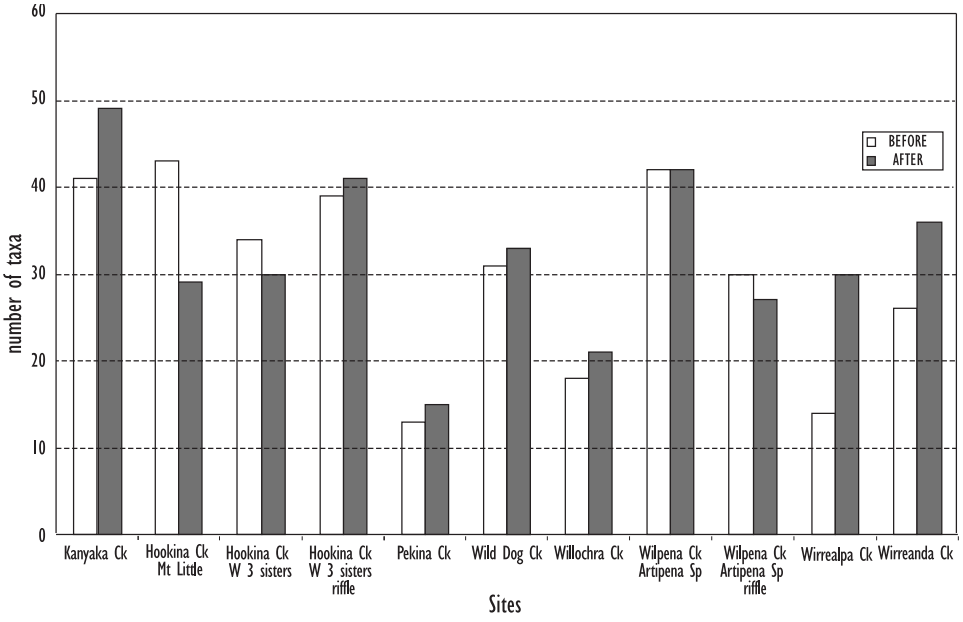
Site	pH	DO	Tem	TDS	Cond	Turb	Bicarb	FiltP	TotP	TKN	NO_x
		mg/L	°C	mg/L	µS/cm	NTU	mg/L	mg/L	mg/L	mg/L	mg/L
Kanyaka Ck B	8.24	9.88	23.8	4700	8370	6.8	358	<0.005	0.044	0.67	0.012
Kanyaka Ck A	8.2	5.8	27.8	4400	7860	5.7	299	<0.005	0.018	0.37	<0.005
Hookina Ck, Mt. Little B	8.06	10.3	25.8	2700	4860	0.85	380	0.007	0.011	0.2	0.006
Hookina Ck, Mt. Little A	8.28	9.04	18.8	3000	5390	9.2	424	<0.005	0.053	1.14	<0.005
Hookina Ck, w. of 3 Sisters B	8.35	8.64	22.1	2200	4000	1.8	397	<0.005	0.007	0.16	0.289
Hookina Ck, w. of 3 Sisters A	8.14	8.98	20.4	2100	3820	5.1	389	<0.005	0.01	0.36	0.331
Wild Dog Creek B	7.33	1.95	15.3	1000	1850	11	329	0.118	0.359	1.6	0.008
Wild Dog Creek A	7.6	5.2	24.4	3800	3720	16	712	0.013	0.21	1.56	<0.005
Pekina Creek B	7.05	5.12	14.4	3300	5800	37	325	<0.005	0.092	1.65	0.008
Pekina Creek A	6.95	0.5	23	730	1320	48	295	0.225	0.812	3.2	0.006
Willochra Creek B	8.91	13.3	14.3	27000	43000	1.4	98	<0.005	0.054	1.9	0.006
Willochra Creek A	9.75	10.7	30.7	19000	31600	5.4	101	<0.005	0.07	1.34	0.006
Wilpena Creek B	8.23	8.78	21	2600	4670	1.7	350	<0.005	0.013	0.24	<0.005
Wilpena Creek A	8.09	6.84	26.2	1500	2620	5.9	303	<0.005	0.044	0.54	0.005
Wirrealpa Creek B	7.75	1.7	18.1	1500	2660	6	447	<0.005	0.026	0.5	0.012
Wirrealpa Creek A	7.5	2.4	28.2	1800	3330	22	430	<0.005	0.058	1.22	0.019
Wirreanda Creek B	8.58	9	23.3	320	585	20	233	<0.005	0.248	2.62	0.008
Wirreanda Creek A	8.94	9.02	25.6	160	283	60	129	<0.005	0.135	1.18	0.007

strong fliers and few snails, as they generally require permanent water sources. No stoneflies were found, as they prefer cooler waters. Crustaceans and aquatic insects are highly sensitive to fenitrothion and fipronil (Diallo et al. 1998, Donkin et al. 1997) and therefore may indicate an impact better than more tolerant species. Few crustaceans were collected either before or after spraying. The amphipod *Austrochiltonia australis* was collected at Wild Dog Ck and Willochra Ck and its abundance decreased at Willochra Ck post-spraying. The yabby *(Cherax destructor)* is not effectively collected by the sampling method used, however, their presence was noted at several sites and a search of their retreats at Hookina Ck, west of Three Sisters Range after post-spraying sampling yielded numerous active individuals in apparent good health. Many insect taxa were collected but their variety and abundance varied between sites and as a group, no impact was observed.

The number of taxa collected at sites was influenced by the habitat quality (water chemistry and physical structure) and the degree of water permanence. The highest numbers of taxa were recorded from Kanyaka, Wilpena and Hookina creeks (Figure 2). These sites all have relatively high habitat complexity and are essentially perennial waterways. At sites where water persists for relatively long times but habitat quality is moderate (Wirrealpa, Wild Dog and Wirreanda creeks) an intermediate richness was recorded. The lowest richness was recorded from Willochra and Pekina creeks (Figure 2). The former is perennial and has good physical structure, but its salinity is beyond the tolerance of many species and the latter has very simple habitat structure and appears to be ephemeral in nature.

Between surveys, taxonomic richness was broadly similar at most sites (Figure 2). However, at four sites, the second sample contained a considerably different number of taxa. In three of those cases, richness increased (Figure 2). Many of the taxa that were present only in the second samples from Kanyaka and Wirrealpa creeks were dragonflies and mayflies; groups whose populations develop later in the year. At Wirreanda Creek, species of corixid water boatmen and hydrophilid beetles appeared

Figure 2: Number of macroinvertebrate taxa per 10% sub sample collected in streams of the Flinders Ranges, SA.

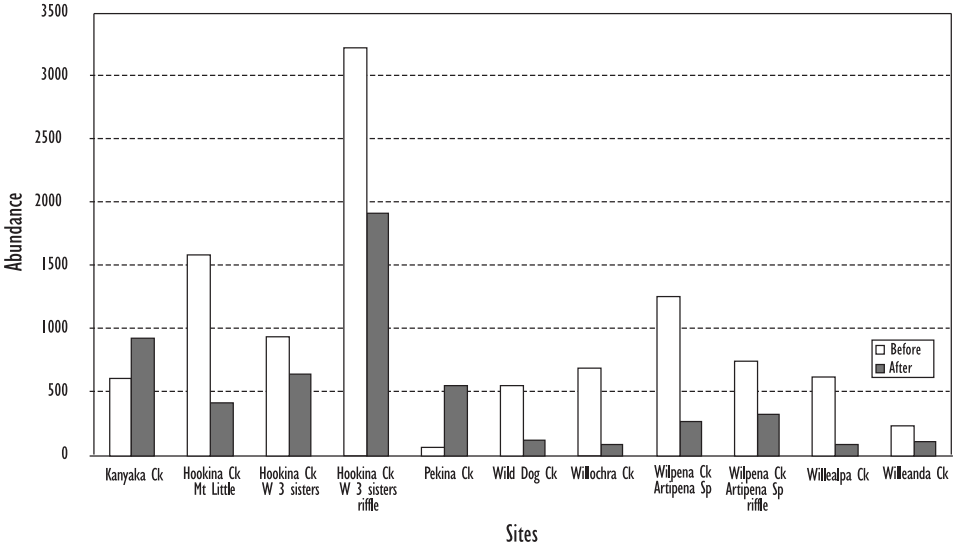


to have colonised between sampling occasions. As a consequence of the rainfall that occurred during this time, the pool in Wirreanda Creek had increased in size and the area and types of macroinvertebrate habitat had increased. These changes, in addition to the open position of the site within a broad plain, may have attracted flying beetles and true bug adults, thus increasing the taxonmic richness in the post spraying sample (Figure 2). Changes in site attributes are likely to account for the lower richness of the Hookina Creek, Mount Little sample post spraying (Figure 2). A reduction in groundwater supply following the first visit resulted in the site being relocated to a reach approximately 300 m upstream that had a very different substratum.

In terms of the abundance of individuals, pre-spraying samples generally contained higher numbers of invertebrates than those collected post-spraying (Figure 3). The groups that showed the greatest decrease in abundance were all benthic invertebrates, namely Oligochaeta, Tanypodinae chironomids and Chironomini chironomids. The most obvious decline occurred in the chironomini populations. However, it is quite likely these changes were due to habitat changes (e.g. the scouring away of benthic organic material caused by increased flow following rainfall) rather than as a result of insecticide spraying. For example, abundance declined in Wirrealpa Ck and Wilpena Ck (Figure 2), however no spraying was conducted near these sites (Figure 1) and while Pekina Ck and Wild Dog were both in an area that was heavily sprayed, they showed opposite patterns in invertebrate abundance (Figure 2). In addition, the decline in abundance was not mirrored by the taxa richness results or the AUSRIVAS results and no pesticides were found in the stream. It is therefore likely that the abundance results are due to the high degree of variability in the streams in the Flinders Ranges, site disturbances and even differences between the operators collecting the samples.

The AUSRIVAS models use statistical methods to calculate an O/E ratio for each sample. This expresses the similarity of the

Figure 3: Number of macroinvertebrate individuals per 10% subsample from streams of the Flinders Ranges, South Australia. Where more than 10% of a sample was examined, values have been scaled accordingly.



number of families that were actually collected or observed (O) to the number of families expected (E) to occur (based on the site's similarity to the reference sites used to construct the model). To summarise the O/E values, they are divided into bands. Band ratings include X (higher than expected number of invertebrate families), A (equivalent to reference condition), B (lower than expected number of invertebrate families) and so on to C and D. Five sites were classified as band A on both occasions (Table 2). The post-spraying samples from Wirrealpa and Wirreanda creeks showed an improved band rating, moving from B to A (Table 2) which mirrors the pattern seen in the taxonomic richness results (Figure 2). Many more expected families were present in the post-spraying sample from Willochra Creek than pre-spraying, but the assemblage still differed significantly to that of reference sites (Table 2). The number of families at Pekina Creek was depressed in both samples (Table 2). There was no obvious trend across sites that indicated any impact had occurred between sampling times and no implication that insecticide runoff had reduced taxon richness at any site.

Table 2: AUSRIVAS Spring Edge model bands of the health of edge habitat at sites sampled in the Flinders Ranges

Site	O/E	Band
Kanyaka Ck		
Before	0.93	A
After	1.06	A
Hookina Ck Mt Little		
Before	1.06	A
After	0.88	A
Hookina Ck 3 sisters		
Before	0.94	A
After	0.87	A
Wild Dog Ck		
Before	0.94	A
After	0.94	A
Wilpena Ck		
Before	1.06	A
After	1.06	A
Wirrealpa Ck		
Before	0.5	B
After	0.87	A
Wirreanda Ck		
Before	0.6	B
After	0.84	A
Pekina Ck		
Before	0.66	B
After	0.53	B
Willochra Ck		
Before	0.43	B
After	0.77	B

None of the riffle habitats fitted the model as extensive areas of flowing water are scarce in the Flinders Ranges so there were no suitable reference sites within the model with which to compare the current sites. However, the riffle samples contained a diverse range of species, including representatives of caddisflies and mayflies - groups that are generally sensitive to pollution.

Discussion

The results of this study provide no conclusive evidence that the ecology of streams in the Flinders Ranges was modified by current locust control operations. Regional patterns in taxonomic richness do, however, appear to be influenced by habitat quality and water permanence. Differences between samples collected before and after the 2000 spraying campaign could be accounted for by the biology of the species present and show no relationship to the density of spraying targets in the vicinity of particular sites (Figure 1).

The streams of the Flinders Ranges represent a disconnected hydrological system, with poor linkages in both space and time between the environments of the catchment and the drainage network. For example, many of the streams are 'groundwater windows' and can be considered independent of conditions occurring at the land surface for much of the time. In this environment, finer scale measurements may be required to determine the pathways of insecticides after

their application to land. Surface runoff is unpredictable and infrequent and it may be episodic and occur rapidly. Collection and analysis of runoff directly from sprayed land, possibly complemented by experimental manipulations, would be useful for clarifying the fate of insecticides, as this is difficult to detect at the scale of stream reach or small catchment. Another method that may be useful is the deployment of passive samplers (Muschal 1999) which concentrate organic contaminants that may: a) be present at concentrations below analytical detection limits; or b) occur infrequently during storm events.

Although no significant impacts were observed in this study, it does not mean that no environmental impact occurred as a result of the broad-scale pesticide spraying program. Fenitrothion is known to have harmful effects on terrestrial invertebrates including honeybees, termites and springtails (Römbke & Peveling 1996). Other work by the APLC has also shown that, as expected, terrestrial invertebrate communities in areas sprayed with pesticides are much less abundant than areas that are not sprayed (Carruthers et al. 1993).

Conclusion

This study found no indication of any significant impacts from the locust control program on the aquatic ecosystems of the nine sites sampled in the Flinders Ranges. There was no conclusive direct or indirect evidence of the transport of fenitrothion or fipronil to the sites studied. The poor hydrologic connectivity between the waterholes of Flinders Ranges streams and their catchments contributes to the difficulty in detecting insecticides in these semi-arid waterways.

Although no pesticides were detected, the work clearly focused attention on the possible off-site impact from this regular spraying program and represents the first detailed environmental impact study from this practice in South Australia, and the first to consider aquatic ecosystems.

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Addressing Cultural Diversity and Food Safety Programs: The Victorian Experience

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Food safety programs have been adopted in Victorian legislation, and have been included in the Australia and New Zealand Food Safety Standards. This study explored the introduction of the food safety program concept amongst Vietnamese food retailers. This paper presents the results of a process evaluation of the "Food Safety Awareness Campaign", implemented amongst Vietnamese food retailers in Melbourne by a group of local government agencies. The evaluation involved the collection of qualitative data from both a group of Vietnamese food proprietors, and a group of environmental health officers who were involved in the program. The evaluation revealed that there was a general understanding of the program, along with its requirements, by the proprietors. This understanding was attributed to the program being conducted in the workplace, general acceptance of the delivery style and the provision of resource materials to facilitate the food safety documentation. A number of areas were identified that impeded the program, particularly the implementation of program tasks by the food proprietors. These included the need for a greater understanding of food hygiene concepts, issues surrounding cultural acceptability, time, costs, benefits, practicality and sustainability of implementing the program. Recommendations for improving the program included; investigating the recruitment of bi-lingual workers, enhancing the program resource materials, the inclusion of food handling staff in the training programs, and the development of strategies surrounding the promotion of benefits of food safety programs for small business.

Key words: *Evaluation, Food Safety Programs, Vietnamese, Qualitative, Training, Food Hygiene*

Education of food proprietors to enhance compliance with Food Act legislation is one of the most common tools used by local government agencies (Office of Regulation Review, 1995). The most appropriate way to educate proprietors, and the suitability of the mechanism selected for program implementation, particularly when dealing with groups from a diverse cultural background, are key questions faced by local government agencies in Victoria. This is particularly important given the cultural diversity of the food sector, and due to the introduction of the legislative requirement for food premises to develop a food safety program.

A number of agencies at the local, state, national and international level have conducted trials involving the training of proprietors in small businesses on the concepts of food safety programs. These trials include The Business of Safe Food (BSF) in Victoria, The Pilot Food Safety Project (PFSP) in New South Wales, Food Safety Project (FSP [ACT]) in the Australian Capital Territory, FoodSafe Handler Training Program (FSIP) in Western Australia, and the Implementation of Food Safety Programs in Small Business (FSPSB) in New Zealand (Allman 1996;

Australia and New Zealand Food Authority [ANZFA] 1998; Centre for Public Health 1997; Small Business Professional Development 1998; Victorian Department of Human Services [DHS] & ANZFA 1996). Typically, the interventions include a basic introduction to food hygiene concepts followed by specific training surrounding identification of food hazards based on Hazard Analysis Critical Control Point (HACCP) principles.

Evaluation of these programs has been mostly informal, however, the key findings suggest that there are a number of issues regarding the training and implementation of food safety programs in small businesses. These issues include ensuring the training is 'hands on', is relevant, involves management commitment and leadership, and addresses cultural difficulties, (particularly those relating to language and literacy). Barriers to success include the lack of support for record keeping, reluctance to change, and the need for a greater understanding of food hygiene concepts together with linking food safety outcomes to 'bottom line' benefits. More positive outcomes were identified as improved relationships with Environmental Health Officers (EHOs) as well as increased consumer confidence, and in some cases perceived increases in hygiene standards (Allman 1996; ANZFA 1998, 1999; Centre for Public Health 1997; Small Business Professional Development 1998; Victorian DHS & ANZFA 1996).

Regardless of the training provided, however, there is still debate regarding the effectiveness of food handler training in achieving increased compliance with legislation and reduction in the incidences of food borne illness. Essentially there has been a call for more evaluation of food hygiene programs. Food hygiene education should examine more closely its operation within the health promotion context in order to achieve sustainable behaviour change among participants, and eventually lead to the reduction of food borne illness.

Traditionally, food hygiene education relies on the knowledge based approach (education and behavioural) through the provision of food hygiene training. It has been described as adopting a 'KAP model' (knowledge, attitudes and practice) where individual behaviours or practice are dependent on knowledge and attitudes (Rennie 1995).

Rennie (1995) suggested that the application of a broader planning model, such as Tones' Health Action Model (HAM), which recognises the influencing factors of skills, knowledge, motivation, environmental support, behavioural intentions, norms, and provides the basis for a more successful approach to food hygiene.

Study Rationale: Evaluation of the Food Safety Awareness Campaign

The research undertook a process evaluation of the 'Food Safety Awareness Campaign' conducted for 12 weeks during 1998 by the Victorian municipalities of Greater Dandenong, Yarra, and Maribyrnong, and the Victorian Department of Human Services. The program was developed in response to outbreaks of food poisoning involving Vietnamese food premises in Melbourne during 1997. The aim of the program was to raise the awareness of food safety among the Vietnamese food retailers and introduce the new legislative requirements of the Food Act 1984. The objectives of the campaign were to trial a method of training 150 food proprietors, who were predominantly Vietnamese, on:

- the changes to the legislation; and
- the implementation of a component of food safety programs, documentation, based on identified potential food risks in their food premises.

The program involved:

- pre-evaluation of the premises by the EHO to ascertain current practices and level of awareness in food hygiene

- an onsite consultation with a project officer (qualified EHO) for 2-3 hours to introduce the food proprietor to the changes to the Food Act 1984 and provide training in the implementation of a program based on food handling practices essential to food safety or good manufacturing practices (GMPs). This included training in the monitoring and recording of:

  – deliveries (suppliers' records)

  – temperatures of cooling and heating equipment (temperature control charts)

  – cleaning tasks (cleaning schedule)

  – pest control measures (pest control chart)

  – staff illnesses (illness register).

The program was delivered in English (the project worker was not bilingual) with some proprietors having friends or children present to interpret. Thermometers were made available for proprietors to purchase and a set of documentation and food hygiene support materials, mostly in English, were provided for proprietors to complete on a daily/weekly basis, depending on the nature of the task, for a six-week period. An outcome evaluation by the project worker was also completed. It involved a quantitative measure of whether the documentation was attempted, changed to suit the premises, completed accurately, translated, or recorded in a language other than English.

Method

The key research questions to be explored in this project were:

- What were the proprietor's perceptions and reactions to the Food Safety Awareness Campaign?

- What were the factors that supported and impeded the process?

The focus of the evaluation was a process evaluation (Hawe, Degeling & Hall 1990), based on the principles of the Health Action Model proposed by Tones (1990). This involved examining the areas of program satisfaction, comprehension, cultural acceptability, motivation and ability to implement the program.

Food proprietors

Data was collected through the conducting of structured open-ended, face to face interviews with a sample of 10 Vietnamese proprietors involved in the program (three from each of the respective municipalities).

The structured open-ended interview method was selected due to the limited time the participants could be available. It was also believed, as suggested by Rissel, Russell and Mitchell (1992), that there is anecdotal evidence that Vietnamese people have a reputation for wanting to please, and have difficulty saying 'no' directly, which may be pronounced in personal interviews. In some Asian cultures it is also considered impolite to respond negatively to a series of questions. Consequently, a respondent might inaccurately answer 'yes' to some or all closed-ended questions (Metoyer-Duran1993). The structured open-ended method was therefore selected in an attempt to overcome this problem.

A stratified purposeful sampling strategy was applied in order to select suitable premises (Patton 1990). This involved selecting premises that had been assessed as implementing the program with either

average, above average, or below average competency, as determined by the project worker.

Participants once selected were given the opportunity to be interviewed in either English by the researcher or Vietnamese, by an interpreter. The interview schedule was translated and pre-tested, in both English and Vietnamese, before use (Metoyer-Duran 1993). Responses to interviews with proprietors conducted in Vietnamese were back-translated (Twin 1997). All interviews were analysed using cross interview analysis (Patton 1990). This involved comparing the individual responses of the proprietors to each of the questions posed and developing categories from these responses. The data were then coded, using the method described by Hawe, Degeling and Hall (1990) to enable patterns and themes to be identified.

Project group

Data were also collected by the conducting of a focus group with the project group (project worker and EHOs) to increase the validity of findings through the triangulation of data (Goodwin & Goodwin 1994). The format used was based on the 'group interview' technique proposed by Hawe, Degeling and Hall (1990) for undertaking process evaluations. Seven themes reflecting the key areas covered in the interviews with the proprietors were explored.

The data from the workshop was analysed based on the procedure proposed by Hawe, Degeling and Hall (1990). Categories were developed for each of the negative and positive responses to each of the themes already determined for the focus group. These categories were then coded and analysed for emerging patterns. Feedback and discussion with the project group took place to assist in the analysis.

Results

Proprietor demographics

Demographic information regarding the number of years the proprietor had lived in Australia, age, educational status, food hygiene training completed is represented in Table 1.

All proprietors were born in Vietnam. The most common language spoken in the business was Vietnamese, with some speaking Chinese and English. Eight of the group had no formal training in food hygiene, however, two were currently undertaking a short course in food hygiene in addition to the program.

Proprietor: Summary of results

Most participants perceived the program as being 'good' and to be about 'checking and measuring the temperature of food and keeping records relating to food safety'. Even though most participants indicated that they understood the verbal and written instructions of the campaign, knowledge of key terms such as 'corrective action' were not understood by most participants. For example, when one proprietor was asked what the word 'corrective action' meant, he commented:

> *I do not understand the word corrective because I do not understand a few Vietnamese words. All OK at the moment, if the fridge does not have the right*

Table 1: Demographic information regarding the number of years the proprietor had lived in Australia, age, educational status, food hygiene training completed

Participants n=10	Years Living in Australia		Age			Educational Status			Formal Food Hygiene Training	
	0-10	10-20	25-30	35-45	>55	Yr 10	Yr 12	Tertiary	TAFE	Other
Male (n=7)	1	6	nil	6	1	5	2	2	2	nil
Female(n=3)	nil	3	1	2	nil	nil	1	nil	nil	nil

temperature, meaning the food is not at the right temperature so I have to find the person to fix the fridge.

Most participants indicated that they would have preferred the program (both written and verbal) to be in Vietnamese, with some indicating that this would have been better for staff. Some indicated that having formal training in food hygiene helped them to understand the program; with others indicating that they found the charts simple to fill out with practice and after careful reading.

The most common charts filled out as part of the program were the daily temperature charts, then the suppliers' charts, followed by the cleaning charts. The most common difficulties perceived by participants were time to fill out the charts, the inability of staff to assist in the filling out of charts and the checking and recording of deliveries. The practicalities of the tasks for staff in the restaurants to be able to undertake were also raised as well as the relevance of certain activities.

For example, one proprietor commented:

We need more time. We need to train people. One hour or two hours is not enough time. Need to be able to get confidence to do it and understand it. When are they going to do it? We need more time to understand why does it. Lots of people don't understand English like me. Make one very confused, can't read it. Vegetables come in. They drop it and leave it. No time to check. If they tie up this campaign in the restaurant the country go down very bad. The cost of labour to do this is too much. We only have five-dollar dishes and to do this means more people employed.

And

Big difference in Asian and European food. Is very different. We have lots of fresh products not always in freezer. Nearly have a couple of hundred different ingredients. Ordered nearly every day. Hard to record daily everything when we get from suppliers all the time.

Mixed responses were received in relation to suggestions for improvements. Most felt more time was needed to undertake the tasks, but concerns were raised regarding paying staff to do this. The need to translate components of the program into Vietnamese was most commonly raised. Other suggestions included staff training, consolidation of charts into one book and looking at simpler method for the recording of time and temperatures.

Even though some felt the program reminded them how to improve food hygiene, and that undertaking the tasks would be safer for customers, all participants indicated that they had not changed anything in their food practices as a result of the program, perceiving that they already produce safe food. Some felt that they carried out the activity because the government required them to do so.

Project group: Summary of results

The EHOs commonly thought that there were many positive aspects to the program. This included it being voluntary, delivered at the proprietors' premises and flexible in terms of delivery and content. The provision of a thermometer to each of the premises as well as the use of visual aids was also considered positive. The group thought that it provided the opportunity to enhance the relationship between the proprietors and EHOs and in some cases the attempt in documentation by proprietors took place. Positive impacts on food hygiene were observed in some instances, such as some proprietors showing further interest in food hygiene education by enrolling in another food hygiene course.

However, some negative themes arising from the workshop included concerns regarding the sustainability of the program, cultural issues such as perception of correct storage of food and in some cases language and literacy issues.

One EHO commented:

I'm not sure whether they always understood. When one proprietor was asked to take the temperature of the fridge, he pulled out the fridge magnet he had put in the fridge.

The suitability of the program content, particularly relating to the amount delivered, and the relevance of some components, was raised. Lack of motivation or willingness of some proprietors to participate in the program, and the impact the program had on the resources of the proprietors (principally time available to them) and on the participating councils, were also considered as issues.
One EHO commented:

> *Labor and resource intensive. If this is the level we have to go to, it has huge implications for us and the council.*

The suitability of some of the materials provided during the program, particularly the durability of the charts provided to document the food hygiene activities was raised. Many recommendations were made by the group to improve the program. These centred around the need to develop strategies to encourage more receptiveness to the program and participation in program activities, sustainability of the program including the implementation of the tasks and the overcoming of cultural barriers surrounding language and literacy and food storage. A review of delivery to ensure the content matched the needs of the participants ensuring relevancy of the tasks required was recommended, as well as developing a mechanism to measure impacts successfully.

Discussion

Limitations of the study

Time constraints and the use of standard open-ended questions as a method of qualitative inquiry limited the ability to explore participants' perceptions of certain aspects of the program in greater detail. For example, when answering questions regarding the storage of food, it would have been helpful to more fully explore these perceptions.

Even though the interview was pre-tested, the wording of some open ended questions did not always produce a direct answer to the question which indicated that some interviewees might not have clearly understood the question. Possible bias may also have been introduced when asking participants certain questions regarding knowledge of food hygiene terms. Other sources of information, such as previous training in food hygiene, may also have assisted interviewees in answering these questions.

Meeting program objectives: key outcomes

Based on pre- and post inspection visits carried out by the EHOs during the program, the EHOs considered that, amongst the more willing or interested proprietors in the program, there appeared to be a raised awareness and in some cases, minor improvements in their hygiene practices. The project worker also provided anecdotal evidence regarding positive improvements (Kelton 1998). The EHOs, however, considered that among less willing or less interested proprietors, no changes were observed, including little or no attempt at documentation.

These perceptions need to be viewed with caution due to:

- the pre- and post inspection visits not measuring the degree of change
- limitations associated with anecdotal evidence
- the possibility of improvements in food hygiene being made as a result of other factors rather than the training itself (e.g., visit by an authority).

In addition, the EHOs raised the issue regarding the difficulty of measuring change as a result of the program and the need to develop better indicators to assist in this process. Other studies also have highlighted the difficulty of linking improved food

hygiene to specific food training programs although increased knowledge may be observed (Telbut 1992).

All proprietors indicated that they had not changed anything in their food practices as a result of the program, perceiving that they already produce safe food (although one felt that it reminded him how to improve food handling at his premises and he gave 'tighter' attention to management). Even though this response could be expected, given that the proprietors would be keen to promote their competencies in the area of food safety, it does raise questions regarding the actual impact the program had on food handling practices at these premises and the need to examine aspects of program implementation further.

Participant satisfaction and implementation of program activities

The general response to the program by the proprietors was positive; with most considering that the instructions concerning the program requirements were clear. The EHOs particularly considered that the workplace was a suitable venue for the training session due to its convenience and familiarity to the proprietors and because it enabled the demonstration of concepts in the workplace. In the case of proprietors who have low language and literacy skills, demonstrating the concepts in the workplace has the advantage that it enables the provision of visual stimuli to help explain concepts (Harmer 1991).

The main factor impeding the implementation of activities in the program was the time available for the proprietor to participate in program delivery and concerns by both the EHOs and proprietors regarding interruptions due to the normal course of business. Therefore overcoming the difficulties of the workplace interruptions appeared preferable to isolating the proprietor from the workplace.

Cultural acceptability

Despite the fact that most proprietors reacted positively to the program (and indicated that they were satisfied with the delivery and the provision of materials), most indicated that they would have preferred the written and verbal instructions to be given in Vietnamese. This generally related to the inability of staff (other than the proprietor) to assist in the implementation of the tasks as the information was in English. Some proprietors also felt that the provision of the program in Vietnamese would have assisted them in better understanding the program.

Concerns were also raised by the project worker that using a friend or child to interpret the program may have resulted in inaccurate messages being conveyed, as the translations could not be verified. Professional interpreters, particularly when translating information of this nature, are more desirable in order to avoid unreliable information being conveyed (Kangan TAFE 1999). It is also interesting to note that half of those interviewed requested the assistance of an interpreter for the interview, a further indication that some proprietors may not have understood the verbal and written instructions of the program (which were in English).

Apart from the language and literacy issues surrounding the delivery of the program, the other cultural issues impacting on the program involved the nature of Vietnamese cooking methods. Many proprietors said that they did not store hot food as they cook it and serve it immediately to the customers, with one proprietor stating that it would therefore be difficult for customers to become poisoned in his restaurant. If correct temperature storage is applied to these products while waiting to be cooked or prior to cooking this may be the case, however, risks may still be imposed by other handling techniques such as poor personal hygiene or cross contamination. In these cases it also raises the question of whether the taking of the temperatures of

food is seen as relevant by these proprietors. As mentioned in the discussion of study limitations, it would have been helpful to explore this perception in more detail. The EHOs also expressed concerns regarding this, together with the difficulties that arise due to customer preference for some hazardous foods to be stored outside the correct holding temperature.

The evaluation by the project worker also raised issues surrounding temperature storage, with cases of food poisoning involving Vietnamese foods being attributed to incorrect storage temperatures of food (Commonwealth Department Health and Family Services 1997; Kelton 1998). This perception might also reflect the need for more basic education in this area as well as addressing strategies surrounding customer preference.

Program materials

The most commonly suggested changes to the program materials involved the charts used to document the food safety activities. Even though it was felt that the charts were generally clear and easy to use, it was believed by both the EHOs and proprietors that the charts needed to be consolidated into one book. The EHOs also felt that the durability of these materials needed to be enhanced as well as ensuring access to further copies. The evaluation carried out by the project worker also highlighted the need to review the ease of recording information in charts, such as using "ticks", rather than numbers or words (Kelton 1998).

Food hygiene training

Most proprietors indicated that they understood the program and various activities; however the evaluation raised doubts regarding this. In particular, most proprietors had difficulties with the concept of 'corrective action', with some EHOs also considering this was not fully understood.

Jacob (1992) suggests that one cannot identify a hazard if there is first no possession of the knowledge that a hazard may exist. The ability to identify hazards in food preparation is necessary in order to be able to carry out corrective action and hazard identification and understanding in food preparation are important parts of basic food hygiene education.

Most proprietors in the program had no previous training in food hygiene, suggesting that further basic training in food hygiene may assist with understanding the procedures required in the program. The EHOs also felt more training in hazard identification was necessary. One proprietor, who had previous food hygiene training, indicated that this had helped him understand the program, including terms such as 'corrective action'. Many studies surrounding training in aspects of food safety programs highlight the need for basic food hygiene training as a pre requisite to food safety program concepts. In particular, Burch (1995) suggests that an essential element of the food safety program approach is that both management and food handlers are fully conversant with all aspects of safe food handling.

From a general theory perspective, to have a clear understanding of why one is carrying out a task rather than being told what to do, is also considered more likely to result in the correct undertaking of the activity (West & Pines 1985). The issue of lack of staff training, understanding or commitment was also mentioned as a difficulty in implementing the procedures by proprietors. Even though the intervention only attempted to introduce the proprietors to the concept, this research, as with other projects such as the FSPSB, BSF, and FSP indicates that this area needs to be addressed (Allman 1996; Small Business Professional Development, 1998; Victorian DHS & ANZFA 1996).

Practicality

The practicality of activities in the program, such as the recording of suppliers' details, was commonly raised as a difficulty with implementing the program. Specifically, one proprietor felt that the volume and range of

ingredients purchased in his food premises (over 100) made it difficult to record information on a daily basis. Problems were also encountered with suppliers not wanting to wait while deliveries were checked, being able to take temperature of frozen food and the ability to record and check goods on arrival. Some perceived that checking the supplier's goods was not needed as they thought that the suppliers should guarantee the quality of their goods. Similar problems have been encountered in other food safety program trials involving small business, in particular the FSPSB, which found that premises did not perceive that keeping an up to date list of suppliers was needed (Allman 1996). It appears that education of suppliers regarding the requirements of food businesses to carry out these tasks is also needed to facilitate the new legislative requirement.

Time, cost and benefits

Lack of time, perceived costs and the need for clear benefits were common themes arising from the evaluation. These issues have also emerged in other trials regarding food safety programs in small business and appear to be key areas that need addressing in order to facilitate the new approach to food safety (Centre for Public Health 1997; Small Business Professional Development 1998; Victorian DHS and ANZFA 1996).

In particular the FSIP found that ensuring the low cost of undertaking the programs was an essential incentive for businesses (ANZFA 1998). The BSF highlighted the need to link food safety programs to bottom line benefits as a method of addressing these issues (Victorian DHS and ANZFA 1996).

Providing solutions to these problems is not an easy task, with the promotion of benefits being considered by the EHOs as a key method to address them. The difficulty is that the concept of food safety programs for small businesses is relatively new and the assessment of savings or tangible benefits (apart from ensuring continual registration of the food premises under the Food Act 1984) relating directly to businesses are still evolving. For example the FSIP found that some positive benefits for businesses were experienced, including a perceived rise in food hygiene standards, staff becoming more proactive in preventing food spoilage, and with the monitoring of a fridge temperature in one business resulting in the loss of stock being averted. This also highlighted the necessitation for the establishment of a routine and cultural change amongst staff and management regarding this new approach (ANZFA 1998).

Rennie (1995) suggests that it is necessary to develop considerable confidence and belief in the current or future benefits if the recommended action is more difficult than the current practice, which is applicable to this program given that documentation is additional to proprietors' current practices. The FSIP also found difficulties among some premises in keeping up with documentation with staff unwilling to take on new responsibilities (ANZFA, 1998).

The FSP (ACT) project found that businesses are more willing to subscribe to training if they are convinced of its value and their need for training (Small Business Professional Development 1998). This is also supported by Nutbeam (1998) who cites that program acceptance by the target group is essential to the intervention. O'Connor & Parker (1995) suggests that for effective collaboration in health, conditions such as the recognition of necessity for both parties (the ability to gain something from the process for themselves) needs to be incorporated in the intervention.

Sustainability

Sustainability of the program was raised as a concern by the EHOs. The Health Action Model proposed by Tones, Tilford, & Robinson (1990) suggests that a number of factors need to be addressed in order for programs to result in sustainable change in the workplace.

These factors include the influencing of norms and significant others, providing an

incentive to change (motivational), belief or concerns regarding adverse effects of current practices, the provision of knowledge, relevant skills and workplace facilities such as the provision of equipment to implement the change (Rennie 1995).

The process applied in this program attempts to address some of these issues such as the provision of knowledge through the training session and facilitating change in the workplace through the provision of equipment such as thermometers and food safety charts. However, the research has indicated that improvements in the provision of suitable knowledge and equipment need to be made. Further strategies need to be developed in the area of benefits, support from other workplace personnel (such as staff training), and addressing the issues of time, practicality and costs in order to ensure effective short and long term changes.

The role of local government

The research has provided the opportunity to examine more closely the role of local government in educating food proprietors as a means of seeking compliance with new food safety legislation, and has raised a range of issues. It has highlighted the need for governments to consider the impact of this legislation on the small business community and perhaps the need to employ strategies recognised by the manufacturing sector in managing cultural diversity in order to achieve more sustainable gains (Migliorino, Miltenyi & Robertson 1994). For example, suggestions for improvements or recommendations for further programs of this nature may include the provision of further training and possible language and literacy support for staff at these premises, resulting in the need for considerably more resources to be made available.

The important question is whose responsibility it is to bear the costs of these programs, and if the responsibility is with local government how capable is it of meeting these demands? One EHO showed particular concern regarding the strain on resources of local government in the provision of this type of program and the ability of councils to meet the costs of any additional program requirements.

Conclusion

The study revealed that there was a perception of a general understanding of the program and tasks by the proprietors. A number of program process supported this including conducting the program at the workplace and the general delivery and provision of equipment and materials to proprietors to undertake the documentation. However, the study did identify a number of areas that impeded the program, particularly the implementation of program tasks. This included the need for a greater understanding of food hygiene concepts by the proprietors, and issues surrounding cultural acceptability, time, costs, benefits and practicality.

Even though the program may have raised the awareness of food hygiene issues, and food proprietors made some attempt at documentation, there is room for improvement in the implementation of the program. This includes include investigating the recruitment of bi-lingual workers, enhancing the program materials (in particular, the food safety charts) including food handling staff in the training and the need to develop strategies surrounding the promotion of benefits of this new approach to food safety for small business.

The program processes also appear to be limited in ability to achieve more sustainable outcomes, including changes to food hygiene behaviour without giving some attention to the above areas.

Finally, the study has provided a further indication of the challenges facing both local government and the food industry in achieving compliance with the new food safety legislation, particularly for culturally diverse groups such as Vietnamese food proprietors.

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Hygiene Indicator Profiling in the Objective Evaluation of Health Education in Food Industry Risk Management

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The effectiveness of health education programs in food industry settings is often only assessed in terms of educational outcomes such as changes in knowledge or perceptions of the food handler. The usefulness of such approach is questioned where hazard assessment plans relating to site-specific outcomes are in place and where measurable hygiene change is to be related to specific operational and cleaning procedures. In some cases this has led to marginalisation of health education as a management strategy in HACCP plans and protocols. The present study investigates indicator profiling as a strategy for evaluating the effectiveness of a health education program in securing measurable change in food contact surface hygiene in three selected food industries, to give quantifiable and comparable end-point measures. A conclusion of the study was that hygiene indicator profiling has the potential to yield meaningful results which could facilitate the use of targeted health education as a measurable HACCP 'corrective action', but that such assessment requires an interdisciplinary risk management approach which takes into account the areas of microbiology, health education, risk assessment, epidemiology and environmental health.

Key Words: *Hygiene Indicators, Risk Assessment, HACCP, Health Education, Food Industry.*

The effectiveness of health education as a component of food hygiene interventions is widely accepted in environmental health practice, but health education is often marginalised or omitted as a corrective strategy in terms of hazard analysis critical control point (HACCP) plans or protocols (Codex Alimentarius Commission 1997; Khandke & Mayes 1998; Mitchell 1998; Mortimore 2001; Panisello & Quantick 2001). This may be due, in part, to the traditional method of evaluating the effectiveness of health education in terms of semi-qualitative educational outcomes, such as improvement in knowledge or change in attitude or perceptions of food handlers, while HACCP plans generally require analysis in terms of quantitative hygiene or production outcomes.

In this regard the potential for assessing health education in the food industry requires investigation in terms of objective hazard assessment and the present paper explores an approach involving the use of established hygiene indicators arranged in profiles (see figures 1.1 to 3.3) to facilitate interpretation and comparison at different stages of the educational process.

Microbiological assessment of the hygiene of premises or of food itself using indicators is a well-established practice using standard procedures and methods, although the performance and hence suitability of accepted food indicators under a variety of environmental and ecological conditions is often debated (Anderson, Turner & Lewis 1997; Brown et al. 2000; Ehiri & Morris 1994; Fleet 1999). The risk manager thus

needs to take into account variations in the performance and usefulness of hygiene indicators under workplace conditions, where factors such as microbiological competition, presence of added or developed inhibitors, temperature, pH and the presence of organic material can effect performance. Relevance of indicators also needs to be assessed in terms of qualitative factors such as the nature of information needed for value judgement by management, the type of industrial operations, time of shift worked, composition and stability of staff cohort, known regional disease endemicity, and public tolerance to risk in terms of the food operation under consideration.

The present paper reports on the development of a generic hygiene indicator profile on the basis of some of these factors, and the application of this profile in the monitoring of hygiene change relating to contact-surface cleaning at selected food premises, in response to targeted health education interventions at each. The premises chosen for application of the profile were a meat products processing plant, a bulk catering premises and an industrial-scale bakery/confectionery. The three premises were selected for the study on the basis of their size, relative consistency of processing cycle, and stability of staff complement.

The applied study was carried out in Cape Town, South Africa where environmental health (EH) practitioners are faced with the internationally familiar dilemma of a dramatically increasing incidence of food poisoning notifications in the wake of the demand for increased food production, prolonged storage, transportation of specialist foods over increasing distances, factory staff mobility resulting in attrition of collective food hygiene knowledge and skill, and ironically a consumerism which demands the reduced use of preservative, shorter cooking times and increased food variety resulting in dubious bacteriostasis, heat disinfection, and turnover of some items (Derry 1996; Djuretic 1997; Maurice 1994; Miles, Braxton & Frewer 1999).

The applied study was carried out in three consecutive phases, involving a two-month baseline hygiene assessment phase prior to the health education program, a three-week assessment phase during the education program, and a final one-month assessment phase following the education program. In all 630 hygiene assessment swabs of cleaned surfaces and utensils were taken to assess the results of the program in securing effective equipment and surface sanitation under operational conditions. Hygiene indicator profiles were constructed from the laboratory results for eight microbiological indicators which offered a range of sensitivity as general hygiene indicators and a range of specificity as indicators of pathogens of regional endemic significance.

Material and Methods

Monitoring for the hygiene indicators was carried out at each of the three premises before, during and after the education program, which involved the use of three separate, consecutive tutorials on personal hygiene, factory hygiene and food handling.

The monitoring process

The eight indicators selected for each profile were plate count, coliforms, enterococci, *Escherichia coli*, *Staphylococcus aureus*, *Clostridium perfringens*, Salmonella and Shigella, each of which has a recognised use in general food hygiene monitoring (Lund, Baird-Parker & Gould 2000). Reasons for selection of each indicator as part of the monitoring profile are presented later in the paper. In each of the three phases of the monitoring program a total of 70 swabs of pre-determined surfaces were taken, each swab being tested for all eight indicators.

During each assessment visit swabs were taken from four pre-determined types of food-contact surface including 'fixed surfaces' such as tables or machine plates requiring in situ cleaning, 'removable surfaces' such as large mixing bowls or blades

which would have to be removed to undergo cleaning, 'utensil surfaces' relating to small items of equipment such as knives or cutting boards, and 'personal surfaces' being the hands and fingernails of cleaning staff.

Swabbing was carried out following surface cleaning and wash-down at the end of each production cycle to avoid variations due to the contamination of swabs with extraneous organic matter or inhibitory substances from foodstuffs during the production cycle. The objective of the applied study was thus to focus on changes in the effectiveness of cleaning procedures in response to health education.

During this time there were no major changes in ambient factory air temperature (air conditioned environment), staff composition, line production procedures, management strategy, type of product or type of detergent and disinfectant in use, as potentially confounding variables. While water supply is of a consistently satisfactory quality in Cape Town, being sourced from well-established and controlled upland surface catchments with subsequent settlement, filtration and disinfection, the quality of cleaning water as a potentially confounding variable was monitored in all cases. A longer baseline-monitoring period would have smoothed fluctuations in observations but might have increased the effect of other variables associated with seasonality, production cycles and staff turnover.

Sterile, rectal-type cotton wool swabs supplied by the analytical laboratory were used for dry and wet swabbing of food contact surfaces, in preference to the agar sausage, agar syringe or RODAC methods, which do not easily adapt to collection from a variety of surface configurations and which may collect clusters of cells from socially clean surfaces resulting in potentially conservative counts. Media used in such preparations are also limited in meeting the physiological growth requirements of a range of microorganisms whereas organisms from correctly transported swabs can be cultured on a variety of media in the laboratory (Lund, Baird-Parker & Gould 2000; Baldock 1974)

All swabbing and transportation was carried out in terms of the relevant code of practice (Government of South Africa 1979) under the direct supervision of the chief Food Hygiene Officer who was a registered EH practitioner skilled in monitoring and hazard analysis relating to food premises. Sampling procedure was based on a variant of the total object swab (TOS) technique, using each swab to sample an area of 25 cm^2 for four similar items, giving a total sampled area of 100 cm^2 per swab. This approach is aimed at reducing variation associated with surface swabbing and producing a collective result for surface types in each area, and presents a modification of the site-specific technique suggested in some HACCP plans. Laboratory analysis was carried out in terms of standard laboratory methods (American Public Health Association 1992) by the regional public health reference laboratory.

Data relating to the hygiene profiles for each of the three premises were entered using a spreadsheet application and presented in graphical form to facilitate initial interpretation prior to statistical analysis. Observed changes were analysed for statistical significance at limit $p = 0.05$ using Chi-squared testing for non-parametric data, with Mantel-Haenszel correction where any classes exhibited frequencies of 5 or less. Analytical procedure was validated by a statistician from the Department of Community Health at the University of Cape Town.

Health education

In order to assess health education needs without simultaneously sensitising staff to the pending hygiene assessment, information was gathered in the baseline-sampling phase through interviews with management and staff employed in similar premises and from reports of routine visits by

Environmental Health Officers (EHOs) to the study premises.

It was decided that the education program needed to be sufficiently flexible to meet the needs of specific premises but at the same time based on a central core of educational material to make the program consistent and cost effective. After having investigated the suitability of a number of models a program was developed with a core component of three 12-minute videotaped presentations on personal hygiene, factory hygiene and food handling respectively. These were shown to cleaning staff over three consecutive weeks, each video being prefaced by a 20-minute introductory session, and followed by a tutorial lasting for 30-60 minutes, depending on the level of interest and involvement. These were referred to as 'video-tutorial' sessions. The sessions were held at a suitable venue at each factory to facilitate ease of attendance.

The target audiences were equipment and production-line cleaning staff who in some cases were general production line workers required to clean their section of the plant following a shift. None of the 48 cleaning staff in the three premises had undergone previous formal training in food hygiene although most had received brief practical training relating to cleaning of their specific work stations soon after gaining employment. Home addresses suggested that the majority came from relatively disadvantaged socio-economic areas.

The combined video-tutorial format enabled passive learning during the audiovisual presentation to be reinforced by active learning during the tutorial session using concrete and familiar problems and examples. The universal educational assumption that participants must arrive at tutorials well-prepared was satisfied by regarding the background experience of participants in each industry as adequate stimulus for meaningful discussion. Care was taken to avoid sexist and culturally-insensitive content in video scripting, while colloquial language and regionally relevant behaviour were retained.

There was evidence that participants took ownership of the program in that most staff attended the non-compulsory sessions at each factory and in one case staff attended in their own time when prevented from doing so during shift time by a management decision.

Development of the base indicator profile

A number of criteria was applied in the selection of indicators for the base profile, including the type and level of contamination of surfaces likely to be encountered in the cleaning process, the nature of the production process preceding cleaning, substances and organisms likely to be encountered, regional disease endemicity, local legislation, and type and format of information required for effective risk management.

Some of the properties of the indicators as discussed in standard texts (American Public Health Association 1992; International Commission on Microbiological Specifications for Foods 2000; Lund, Baird-Parker & Gould 2000) are outlined below to clarify their inclusion and relevance in the profiles:

Plate count involves the assessment of total viable aerobic mesophyllic microorganisms produced from a sample on nutrient medium, and was the least specific of the indicators in the profile, ultimately indicating contamination with gross dirt.

Precautionary to using the indicator is a need to take the time lapse between surface cleaning and plating into account as viability of some contributory species may decrease rapidly with time. In this regard more advanced study would need to include an assessment of contributory species and their known tolerance to specific process conditions or substances.

Plate count was included at the left-hand limit of profiles as a benchmark indicator exhibiting high sensitivity to gross contamination, with no relevance to specific disease risk. As South African legislation prescribes a limit of 100 organisms per cm^2 of cleaned surface swabbed (Government of South Africa 1989) and the indicator lacks precision, counts in excess of 100 were simply recorded as 'positive' and the frequency of positives determined and reflected in the profile.

Coliforms include the genera *Escherichia* and *Enterobacter*, of the family Enterobacteriaceae which is widely used to provide an indication of adequacy of cleaning and disinfecting of food contact surfaces.

Coliforms collectively indicate gross contamination, being found in such diverse substances as soil, grain and other plant dust and in animal and human faeces. Although many coliforms are not of faecal origin, the family includes the pathogens Salmonella and Shigella, thus high counts could indicate potential risk for the presence and multiplication of these pathogens which are known to have a fairly high regional endemicity (Cape Town City Health Department 1998). The fact that coliforms are easy to detect because of their numbers, grow under a wide range of pH and temperature conditions, and can include pathogenic species made them a suitable indicator for inclusion.

Escherichia coli are thermotolerant coliforms of human and animal faecal origin that are identified in South Africa in terms of the modified Eijkmann test. As *E coli* is exclusively of faecal origin, and faecal matter in food is aesthetically unacceptable, the presence of any *E coli* on food contact surfaces was regarded as as a positive result.

While large numbers of *E coli* are excreted in faeces, enhancing detection probability, survival time may be relatively short on inorganic surfaces, particularly where antagonistic substances or ecologically competitive species are present, and for this reason the concept of *E coli* as an indicator of recent faecal contamination only was applied.

E coli was thus included as a commonly used indicator well enshrined in food legislation in South Africa and internationally, but with the reservation that counts might decrease considerably with lapse of time between cleaning and swabbing. It should be noted, however, that analytical techniques may be too slow to warrant inclusion in indicator profiles where urgent results are required, such as food poisoning investigations, emphasising the need to seek the advice of a microbiologist in fine-tuning profiles to meet specific monitoring needs.

Enterococci as a group comprises all group D *Streptococci*, including *Streptococcus faecalis* and *Streptococcus faecium* which are natural inhabitants of the gut of humans and animals. The former are most often associated with human faeces and the latter with animal faeces. These organisms may show longer survival time under stress than *E coli*, making comparative performances under a variety of *in situ* environmental conditions worthy of further investigation (International Commission on Microbiological Specifications for Foods 2000).

While these organisms are of faecal origin they are, however, widely distributed in nature by insects, wind and rain, so finding the organism in food or on surfaces exposed to the elements does not necessarily indicate contamination by food handlers. Heavy loads, however, would be suspect. The organism is found in natural association

with some foods including sea foods, processed meats, egg powder, raw and pasteurised milk, and fruit and vegetables, so the type of food industry being assessed must also be taken into account before it is included in a profile. While there is evidence that Enterococci might cause food poisoning after fermenting certain substrates (Franz, Holzapfel & Stiles 1999), epidemiological evidence is currently insufficient to warrant inclusion of the organism as the cause of outbreaks in standard public health texts (American Public Health Association 2001; Australian Institute of Food Science and Technology Inc 1997).

Because of a relatively high resistance to drying, freezing, high temperature, salt concentration, detergents, and disinfectants, and their association with viscous material such as faeces and fingerprints, Enterococci may well survive disinfection or cleaning processes which would destroy or remove less persistent organisms, and for these reasons it was considered eligible for inclusion in the profile.

Staphylococcus aureus usually indicates contamination from the nose and sometimes the mouth or skin of food handlers, transfer to foods and surfaces usually taking place via the hands. Clothing of nasal carriers frequently harbours *S aureus* and the air is very readily contaminated with dust carrying the bacteria from clothing when a person dresses or undresses. About 25% of people are said to be carriers of the organism and dogs, poultry and cows with infected udders can also act as a source of contamination (American Public Health Association 2001).

Once contaminated, poorly cleaned food contact surfaces may act as persistent reservoirs for the organism. While not intrinsically pathogenic the organism grows readily in acid foods to produce a potent, heat stable enterotoxin. Use of this toxin as indicator is usually impractical in terms of cost, time or available equipment. The toxin may, however, persist long after the bacteria have been destroyed by heat, nutrient reduction, pH change, or overgrowth by competitive genera, such as the ubiquitous *Proteus*, and in this regard new monitoring approaches warrant attention (American Public Health Association 1992).

The organism produces a formidable array of enzymes which enable it to survive low-level chemical disinfection with relative ease making it a useful indicator of surface sanitation. Its ability to survive 100 °C for 30 minutes could also make it a useful monitoring indicator for certain heat-based disinfection processes in the food industry (Balaban & Rasooly 2000).

As staphylococcal enterotoxin is frequently implicated as agent in food poisoning outbreaks in South Africa including the organism in the profile was seen to be necessary. Being a pathogen associated with skin lesions, the presence of nasal carriers and poor hand washing, its presence is always undesirable and the detection of any organisms was regarded as a positive result.

Clostridium perfringens is of animal and human faecal origin, the spores being ubiquitous in soil. From this reservoir large quantities of spores become airborne making strains of the organism the most common potential pathogens in the general environment Some strains, notably type A, cause relatively mild food poisoning when the organism, ingested in large quantities, produces toxin while undergoing sporulation in the digestive tract. Outbreaks are probably widespread but go unrecognised as extensive under-reporting may take place (Forsythe & Hayes 1998).

Spores are very heat-resistant, requiring 100 °C for 30 to 60 minutes to result in a log

1 (90%) reduction of populations. Food vehicles are typically uncured meat or meat products including prepared meat dishes (American Public Health Association 2001).

While the spores are ubiquitous, the active organism is nutritionally fastidious requiring high protein foods for germination and growth. This could result in relatively low recovery of organisms from food contact surfaces as compared to recovery from foodstuffs themselves (International Commission on Microbiological Specifications for Foods 2000). Because of the potentially pathogenic nature of the indicator, however, and the fact that one of the premises in the intervention was a meat processing plant, inclusion in the profile was indicated.

Salmonellae, of the family *Enterobacteriaceae*, are of human and animal intestinal origin. Salmonellosis, caused by enteropathogenic types, is most commonly reported foodborne disease in regions where detection and reporting systems are efficacious, such as North America and Europe (American Public Health Association 2001). Notified cases have increased steadily over a ten-year period in both North America and Europe, where poultry and their products are often implicated in food poisoning outbreaks. The causes of the increase, which may be taking place on a global scale, are not known with precision (Unnevehr & Roberts 2002). The authors of the present paper believe that the widespread practice of cannibalistic feeding of herbivorous food-animals, which has played a role in BSE epizoology, may be contributory.

Typhoid and paratyphoid fevers, caused by other species of *Salmonella*, still occur regularly in rural parts of South Africa and the potential risk to the food industry presented by symptomless or convalescent carriers cannot not be disregarded.

The tendency of Salmonellae to decrease with time under certain conditions, including suspension in clean water, should be taken into account when considering the organism for inclusion in a profile. As rapid transport and early attention to analysis could be guaranteed in the present study, *Salmonella* was included as an indicator.

Shigellae, of the family *Enterobacteriaceae*, cause a dysentery referred to as 'shigellosis' and their importance as foodborne organisms is receiving increased attention internationally. Humans are the only reservoir, the carrier state is common after infection, and very few organisms (10-100) are required to establish infection (American Public Health Association 2001). While not notifiable in South Africa, regional endemicity suggests a risk of transmission to food surfaces and for this reason this pathogen was included.

Results

Figures 1.1 to 3.3 show the results of the applied study carried out as a component of risk management in three food industries.

Figures 1.1 to 1.3 show three comparative graphs for mean number of positive swabs at the meat processing plant for the three phases of the study, representing the consecutive periods before, during and after the intervention. Figures 2.1 to 2.3, and 3.1 to 3.3 show similar profiles for the bulk catering premises and the bakery/confectionery respectively.

In each profile the following abbreviations have been used:

Plt ct: plate count
Colif: coliforms
Entci: enterococci
E col: Escherichia coli
S au: Staphylococcus aureus
C per: Clostridium perfringens
Salm: Salmonella
Shig: Shigella

Figure 1.1: Hygiene indicator profile for meat products processing plant: before health education intervention

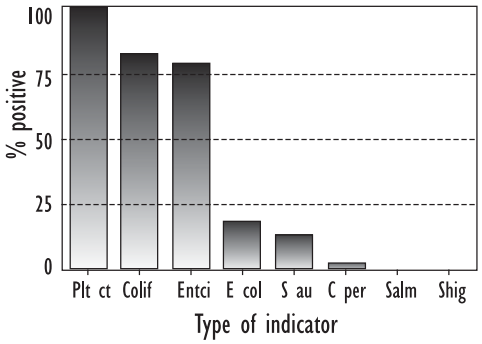


Figure 2.1: Hygiene indicator profile for bulk caterer: before health education intervention

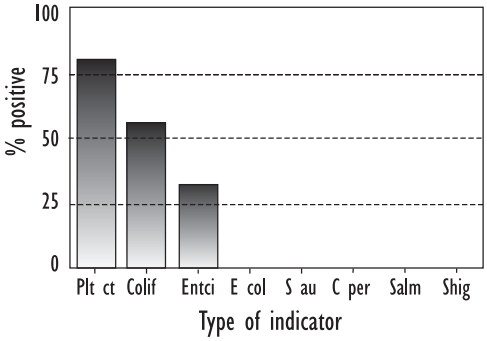


Figure 1.2: Hygiene indicator profile for meat products processing plant: during health education intervention

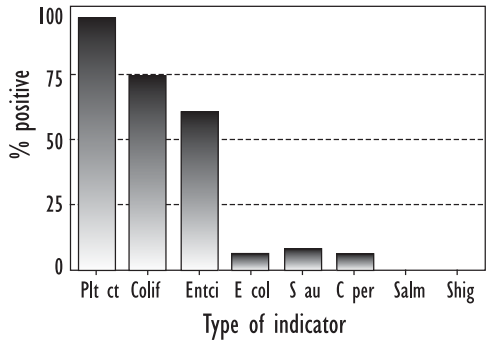


Figure 2.2: Hygiene indicator profile for bulk caterer: during health education intervention

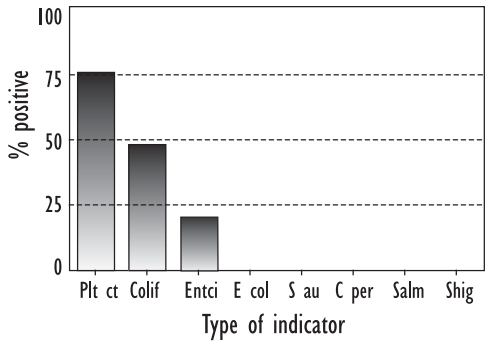


Figure 1.3: Hygiene indicator profile for meat products processing plant: after health education intervention

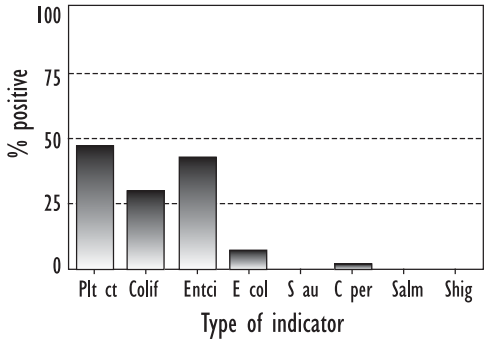


Figure 2.3: Hygiene indicator profile for bulk caterer: after health education intervention

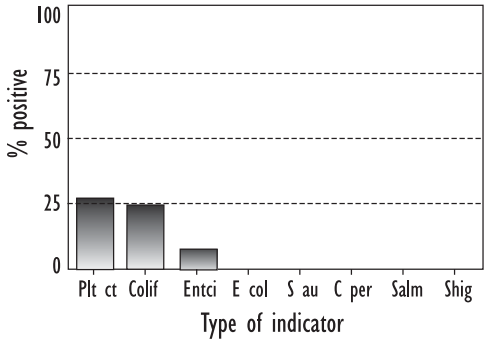


Figure 3.1: Hygiene indicator profile for bakery/confectionery: before health education intervention

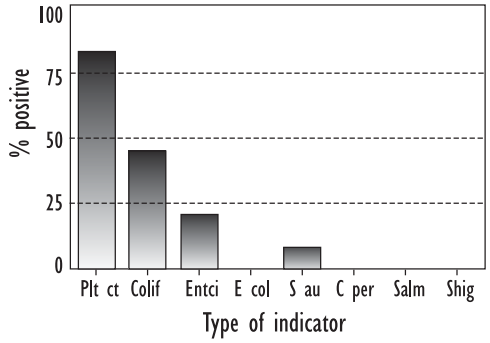


Figure 3.2: Hygiene indicator profile for bakery/confectionery: during health education intervention

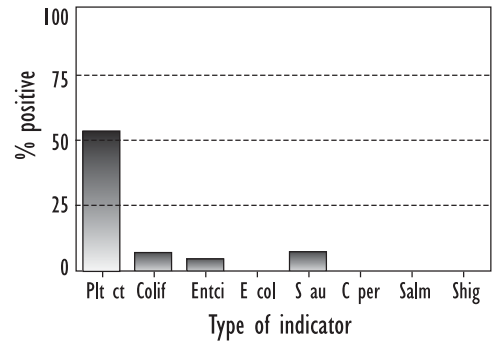
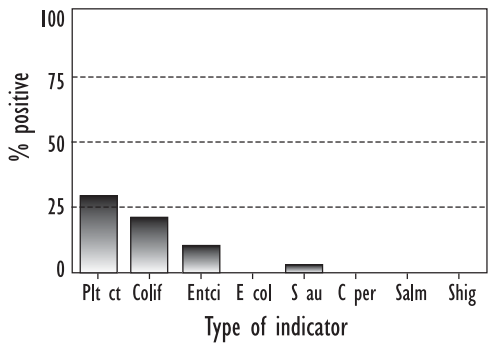


Figure 3.3: Hygiene indicator profile for bakery/confectionery: after health education intervention



Discussion

The indicator for which positive results were most frequently recorded during baseline establishment, prior to educational intervention was plate count, with approximately 88% (n = 554) positive swabs from all three premises.

The next indicator in terms of frequency of positive results was coliforms with 61% (n = 384) positives, followed by enterococci with 44% (n = 277) positives, *S aureus* with 7% (n = 44) positives, *E coli* with 6% (n = 38) positives and *C perfringens* with 1% (n = 6) positives. No positive results were obtained during the study for *Salmonella* or *Shigella* at any of the premises.

Following the health education intervention, statistically significant reductions in positive results for baseline organisms were observed for plate count and coliforms ($p < 0.001$) at all three premises, while similar reductions were observed for enterococci ($p < 0.001$) at the meat products processing plant and bulk catering premises. The reduction observed for enterococci at the industrial-scale bakery/confectionery was not statistically significant at the accepted level ($p = 0.05$).

S aureus was only detected at the meat processing plant and bakery/confectionery, with reduction occurring to the point of complete removal following health education intervention. The reduction observed at the bakery was, however, not statistically significant.

C perfringens was only detected at the meat plant, but the small reduction recorded following intervention was not statistically significant.

While *S aureus* and *C perfringens* did not exhibit the sensitivity to apparent hygiene change shown by plate count, coliforms and enterococci, their inclusion in the profile was believed to have been justified in terms of regional epidemiology and the need to apply the precautionary principle within a risk management framework.

While a statistically significant reduction in the baseline count for *E coli* followed

health education at the meat plant, the organism was not detected at the other two premises. This absence may have been related to the relatively short survival time of the organism in environments in which gross organic matter usually serving a buffering and protective function for the organism has been reduced, and reinforces doubt as to the value of relying exclusively on *E coli* as indicator organism in situations where surface and equipment sanitation in terms of microorganic load reduction is a primary object. The rationale in the previous paragraph for the inclusion of *S aureus* and *C perfringens* in base profiles for reasons of pathogenicity can only be applied with circumspection to *E coli* as relatively few types are pathogenic.

Non-recovery of *Salmonellas* and *Shigellas* throughout the study suggested the need for further research relating to the cost-effectiveness of including specific pathogens in hygiene indicator profiles, and in this regard additional integrated research in the areas of microbiology, epidemiology and risk assessment is deemed to be essential.

Conclusion

Following targeted health education interventions, statistically significant reductions in the number of positive results for baseline hygiene indicators were observed for the three food industries with an appreciable level of consistency. Early reductions seen during the program suggest that targeted health education may be important in situations requiring early risk amelioration, such as high-risk food poisoning events or where line contamination exceeds a ceiling trigger in terms of HACCP protocols. Assuming the occurrence of real hygiene change during the present study, the non-pathogenic indicators most sensitive to that change were plate count, coliforms, and enterococci, while the pathogenic indicator most sensitive to change was *S aureus*.

The study challenged the value of *E coli* as universal hygiene indicator, particularly where surface, utensil and hand sanitation is the focus of assessement, but it should be noted that the organism is still likely to remain a useful indicator under different environmental or micro-ecological conditions. The benefit of including specific pathogens such as *Salmonella* and *Shigella* in hygiene indicator profiles was not borne out by the present study, but the inclusion of pathogens in any monitoring strategy needs to be based on application of the precautionary principle within a broad risk assessment framework, rather than on historic results of specific site assessments.

The study suggests that hygiene indicator profiling has the potential to yield meaningful results which could facilitate the inclusion of targeted health education as a measurable HACCP corrective action, but that the interpretation of such results requires an interdisciplinary risk management approach which takes into account the conceptually diverse areas of microbiology, health education, risk assessment, epidemiology and environmental health.

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PRACTICE, POLICY AND LAW

Promoting Active Transport: Where to Start?

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Increasing car usage contributes to traffic congestion, air pollution, as well as declines in levels of physical activity. Hospitals generate a large number of trips to and from them. These are mostly car trips. This paper describes the development of a transport access guide as a means of promoting the concept of active transport for hospital users. The transport access guide details transport options, highlights walking routes, and carries the message 'walking is good medicine'. A process evaluation was conducted by face-to-face interviews with 12 key informants who were department heads of the hospital. The results indicated that the transport access guide was well received, and overall achieved positive feedback from all staff interviewed. The transport access guide is now being used in a number of different ways by various sections of the hospital. It was considered a helpful tool for promoting alternative transport options among patients, visitors and staff. Production, promotion and implementation of a well-designed transport access guide with a large health facility have the potential to encourage people to adopt more active travel options and contribute to a healthier environment.

Key words: *Transport Access Guide, Physical Activity, Active Transport*

An increasing reliance on private motor vehicles has led to traffic congestion, and air pollution, and makes a significant contribution to greenhouse gas emissions. It has also been shown to contribute to lower levels of physical activity in the population. The World Health Organization (WHO) identified motor vehicle transport as the main cause of air pollution, the key factor in road accidents, and a major contributor to sedentary lifestyles (WHO 1999).

In Australia, there has been a 12-fold increase in the number of motor vehicles on the road over the past 50 years compared to a population growth of 2.4 times over the same period (Australian Bureau of Statistics 2001). The car trip has become 'the way of life' for most Australians while trips made by walking or cycling have diminished (Sustainable Energy Development Authority 1999). It is not uncommon for people to drive their cars, even if the journey is only a few kilometres. In Sydney over 55% of car trips are less than five kilometres, with approximately one third being three kilometres or less (NSW Department of Transport 1995). These distances are highly amenable to cycling or walking. A study of car trips found that only 20% of journeys are absolutely necessary and unavoidable (United Kingdom Royal Automobile Club 1995) suggesting that the number of car trips can be reduced.

Driving instead of walking or cycling contributes not only to an unhealthy environment, but also to an increasingly sedentary lifestyle. Although physical inactivity is widely recognised as a risk factor for many diseases (Blair, Kohl & Barlow 1995; Pate et al. 1995), almost half the population of NSW fails to reach a recommended level of physical activity (NSW Health Department 1999). Approximately one in five are classified as 'sedentary' (Armstrong, Bauman & Davies 2000). Current recommendations for physical activity state that every adult should accumulate about 30 minutes of

moderate physical activity on most days of the week. It is also suggested that physical activity can be accumulated in periods of as little as 10 minutes, several times throughout the day (Commonwealth Department of Health and Aged Care 1999).

One strategy to promote physical activity and to improve the environment is to encourage lifestyle physical activity through 'active transport'. Every day physical activity opportunities arise from the need to travel from place to place, such as going to school, work or shopping. Active transport is any form of transport that involves incidental physical activity, such as walking, cycling, and travelling by public transport (Davis 1999).

One of the key factors inhibiting more frequent active transport choices is lack of access information (Mason 2000; Black, Mason & Stantely, 1999) such as information about walking and cycling routes, and public transports services, as well as the time required by these means to reach a destination. Describing an Australian study, Mason (2000) reported that car users often used their cars because they were unaware of alternative transport options.

Many large organisations such as hospitals generate hundreds or even thousands of unnecessary car trips each day. These organisations can play an important role in promoting active transport in the community. However, few studies have addressed this issue (Black, Mason & Stantely, 1999).

To apply the concept of active transport, the program 'Walking is Good Medicine' was developed and implemented by the Central Sydney Health Promotion Unit in collaboration with the Canterbury Hospital and the Canterbury Child, Adolescent and Family Service. The aims of the program were to encourage these health organisations to recognise the benefits of active transport, promote the concept among users of the hospital, increase awareness of the benefits of incidental exercise, and encourage facility users to reduce car dependence.

Development and Implementation of the Program

Factors related to the program

The main strategies of the project were: i) to develop an active transport transport access guide that suggested walking routes to the hospital campus, highlighted public transport options, and carried the key message: 'Walking is Good Medicine'; and ii) to promote the transport access guide to department heads and centre management in order to ensure the smooth distribution of the transport access guide to staff, patients, guests and visitors. In developing an appropriate active transport access guide, a series of factors were considered including location, opportunities and barriers.

Location

The Canterbury Hospital campus is located in the suburb of Campsie. It can be reached from Belmore and Campsie stations by a 15-minute brisk walk, or a three-minute bus trip. The area boasts a lively shopping centre with a range of amenities, government agencies, financial institutions, restaurants, and green belts. Most streets leading to the hospital are wide and tree-lined. The Canterbury hospital campus is well served by buses. At least four bus stops servicing five different routes are located around the hospital.

Opportunities

The project time frame coincided with the pre-Sydney Olympic Games 2000 period. Transport was altered to go along Olympic routes, two of which were in close proximity to the hospital. It was expected that the spirit of the Games would stimulate interest in fitness and physical activity.

At the time neither the hospital nor its parallel services had an transport access guide to the campus. Transport access guides have become a highly regarded feature in the provision of quality service within the health system (Australian Council of Healthcare Standards 1996). The hospital

had just been renovated and internal signage was being completed.

Barriers

A potential barrier to the promotion of active transport was the new undercover parking area. Located at the centre of the campus, the parking service was managed by private operators who offered staff discounted weekly fees. Another major barrier was the perception of the area around the hospital as 'unsafe' resulting from past incidents of petty crime highlighted by the local media.

A brief needs assessment

Six hundred questionnaires were distributed attached to personnel pay packets in order to identify travel habits, attitudes, and barriers to active transport. Only 40% of the questionnaires were returned. The results identified that 95% of these staff used a car to get to work. The majority of those who drove felt public transport was 'too poor and unreliable'.

The environment audit

A presentation to local council members was organised to engage their support. The Canterbury Council Maps Unit assisted in providing base-resources (street maps) to help design the transport access guide. Walking routes to the hospital from the nearest stations were audited. Safe and attractive streets were identified for suggested walking routes based on local knowledge. The time it took to walk from these stations to the hospital was calculated, and the frequency and availability of buses and bus stops around the hospital was assessed.

Production and Promotion of Active Transport Access Guide

Features of active transport map

The transport access guide was planned, designed, and produced in consultation with health professionals and with clients of the local Child, Adolescent and Family Service. Information about travel options, time, and distances was highlighted. While parking information was provided, it was given less prominence on the guide.

The transport access guide was integrated into the design of a new Canterbury Child, Adolescent and Family Health Service brochure. The service is part of the Canterbury Community Health Centre and is located on the hospital campus. A new version of the map was later produced for the hospital and the entire campus. The slogan 'Walking is Good Medicine' featured as the main message.

Promotion of the transport access guide

To promote active transport awareness to hospital visitors a four-colour version of a two by one-and-a-half metre transport access guide was built and placed outside the car park of the hospital. A smaller version was distributed throughout the hospital. The hospital's Medical Director officially launched the transport access guide. The event was given front-page coverage by the local paper. The project was also promoted in other health publications, council and intersectoral presentations, staff and general practitioner's newsletters.

Distribution strategy

The transport access guide was designed to be easily included in meeting agenda notices, information brochures, and web pages, and to photocopy well. The distribution strategy included the following sites: reception desk for visitors; the hospital communication unit to facilitate the guide's copying and reproduction; pay-slip attachments for new staff; unit heads for placing on agenda for meetings; and local surgeries.

Process Evaluation

Post-intervention, key informant interviews were conducted for the process evaluation. The main purposes of the evaluation were to

assess whether the transport access guide was accurate, appropriate, acceptable, and understood by the hospital population; and to obtain feedback on the project's implementation and impact for appropriate changes and improvements.

Two staff members of the Central Sydney Health Promotion Unit conducted twelve face-to-face semi-structured interviews with selected department heads and hospital staff. Ten of these interviews were tape-recorded and then transcribed. The data were analysed and coded manually, with a coding frame being developed through a thematic analysis.

Main Findings

Traffic and health benefits of walking

There was general consensus that traffic pollution has detrimental effects on health. Congestion on the main arterial road to the hospital was noted:

> *'If I lived on it, it would drive me insane'.*

All staff knew about the benefits of physical activity on health and most had knowledge of the importance of 30 minutes walking per day. While most incorporated physical activity into their leisure time, this was not seen as practical in daily activities.

> *'Whilst goals are really important we have to be reality-based about where it is practical and reasonable'.*

In addition, the majority of respondents felt that bicycles were not safe and cycling was not seen as a good substitute for travelling by car.

Attitudes to adoption of active transport

While in principle many respondents felt that active transport could be a way of achieving regular physical activity and was a very important form of exercise, they also felt it was not always practical:

> *'Now I drive. I would prefer to commute but distance from the station with a full brief case is a problem…wouldn't give it a go here not an easy commute plus a 20 minute walk'.*

> *'People are lounge lizards and apathetic'.*

Some respondents, however, did feel that active transport was a good form of physical activity and achievable during work time:

> *'Good way to build in some form of activity into daily life'.*

> *'Definitely, if you can get people to use it as part of their day to day activity'.*

> *'…as a stimulus to make me think about what sort of exercise I get…'.*

A number of respondents mentioned that public transport was unreliable and unsafe especially for shift workers, and that walking in the area was unsafe. Incidences of robbery, shootings and problems with youth were mentioned.

An accurate and detailed time schedule, safety, and more reliable and frequent transport were seen as requirements to motivate people to take up active transport. The cost of parking was also seen as something that may motivate people to use active transport and it was suggested that cheaper parking could be provided for those who car pool. A number of respondents felt that active transport needed more promotion, or even a prominent campaign.

> *'Increased level of public transport as during the Olympics…half an hour between buses at peak hour. Staff pay a lot of money to park – should reward if people car pool'.*

Another suggestion to motivate people to take up active transport was for people who do walk to promote the benefits to others. One department had plans to commence a walking club during work hours. Others mentioned that fear such as a health scare would motivate people.

Opinions on the transport access guide

The majority of respondents had seen the transport access guide in the hospital. Specific areas where it had been sighted included the cafeteria, department tearooms, the switchboard, admissions, the front reception desk, main foyer, other public areas, and ward areas.

All respondents spoke positively about the map and commented on the fact that it was colourful, eye catching and well set out. Some saw the 'walking is good medicine' as the main message, both for walking to and from the hospital and for exercise in general. Many felt that the actual locality guide component was the main message:

> *'It is a better directory than a walking promotion'.*

It was generally thought that the transport access guide covered all bases without overloading and showed there are alternatives to cars. One respondent commented that a positive aspect of the transport access guide was that it did not show driving.

In one particular area of the campus the transport access guide had been promoted to staff and clients, and as a result, a number of staff members began walking to work. A lot of patients who come to this service live locally and it has been a constant reminder for them as well. There was mostly positive feedback about the transport access guide itself:

> *'Staff love it … very proud of brochure'.*
>
> *'Yes,* [the guide] *is working because we are getting value out of it…we can use it for a lot of things'.*
>
> *'Staff say it has made it easier for them to assist, direct and provide information to clients. Before they had to draw up their own map … made life a lot easier for them'.*

Discussion

The transport access guide developed for the Canterbury Hospital campus was well received and overall achieved positive feedback from hospital staff. The guide was praised for its content, message, presentation and usefulness and is now being used in a number of different ways by various sections of the hospital. It has been considered a particularly helpful tool for promoting alternative transport options amongst patients, visitors and staff, but perhaps less effective in promoting general physical activity in the community.

The project initiated a new, relatively simple strategy to address an emerging public heath concern. It has encouraged and enabled other organisations to take health promotion action by providing active transport access guides for their clients. The results of the process evaluation demonstrate a positive response to the provision of travel option information.

It would be unreasonable to expect that people would automatically adopt active transport behaviours after having looked at an transport access guide only once or twice. But in looking at the options the idea of alternative possibilities has been introduced. While people are fully aware of the ill effects of traffic congestion, a considerable shift in thinking has yet to occur about the viability of not using cars, coupled with the availability of safe and reliable alternatives. It is essential that a walkable and safe environment around any organisation should be taken into account when promoting active transport.

Western Australian research on the effectiveness of providing information about public transport, walking and cycling demonstrated that it not only leads to increased use of services, but can also influence understanding about policy proposals to reduce car reliance (Rose & Ampt 2001). The active transport access guide has the potential to play a role in influencing people's choice of transport.

Conclusion

Health facilities, as large employers of staff and as large trip generators, could have a significant impact on the way staff, patients, and visitors travel to health facilities. Production, promotion and implementation of a well-designed transport access guide with a large health facility would be setting a standard for good practice by not only supporting the population to participate in physical activity, but also in reducing the traffic congestion and pollution in a crowded city.

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Field Evaluation of Dyna-mate Carmel Carrier 11: An Alternative to Diesel in Thermal Fog Generators

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A study was conducted in Balibo, East Timor, to investigate the suitability and efficacy of Dyna-mate Carmel Carrier 11 as an alternative thermal fog dispersal agent to diesel. Reslin used at 6%, formulated in Dyna-mate CC11, at both 1 part in 5, and 10 parts water, was effective in controlling sentinel adult Culex quinquefasciatus mosquitoes.

Keywords: *Mosquito, Thermal Fog, Dyna-mate Carmel Carrier 11, Diesel, East Timor, Malaria*

The traditional method of dispersing pesticides using Thermal Fog Generating equipment has been to utilise diesel as the primary carrier of choice. Perceived health issues associated with diesel usage in other areas (Diesel Working Group 1995; Office of Environmental Health Hazard Assessment 2000), combined with economic and environmental factors, prompted a review of current Preventive Medicine (PVNT MED) Thermal Fogging procedures associated with Australian peace keeping personnel in East Timor.

Dyna-mate Carmel Carrier 11 (Dyna-CC11) is a Poly Glycol mixture used as an anti-evaporant and fog carrier for the dispersal of wettable powders and liquid pesticides, germicides and disinfectants. Poly Glycol mixtures have been utilised for more than 10 years in industries (e.g., Abattoirs) where oil based primary carriers, such as diesel or kerosene, cannot be used.

When used in Thermal Fog generators, Dyna-CC11 diluted with water, as a replacement for the use of diesel as a primary carrier, substantially reduces the rates of pesticide usage (pesticide manufacturer recommends application rates at half oil-based rates when using water as the carrier). Dyna-CC11 diluted with water has also been shown to be more suitable to the environment, as no oil-based residues are produced.

This article details the results of trials using the water-based Dyna-CC11 formulation over a range of concentrations in order to establish the most suitable formulation regime to effectively control adult mosquitoes.

Methods

A study of the suitability and efficacy of Dyna-CC11 formulations with water as the fog dispersal agent was conducted during June and July 2001 using Australian Defence Force (ADF) in-service Curtis Dyna-Fog®, Super Hawk, Model 2605/1 and Curtis Dyna-Fog®, Black Hawk, Model 2620/2, equipment available, and in use, in Balibo, East Timor by PVNT MED personnel.

Balibo is a small rural township situated in the south west of East Timor. Balibo is located in a hilly area at approximately 530 metres altitude. There are no records for weather conditions in the area, other than the occurrence of the wet and dry seasons. Temperatures during the trial period ranged from average overnight low of 18°C to average maximum 30°C. The Australian peace keeping personnel are located within the township, and much of the local housing is within a few hundred metres. Local

population is approximately 3000 persons within the Balibo township, and approximately 9,000 persons in the immediate district.

Balibo is located in a region where malaria and dengue are endemic (Kitchener, Auliff & Rieckmann 2000). Other mosquito-borne diseases are also likely (Whelan, 1999). A scheduled regular outdoor and indoor fogging program was established to control adult mosquitoes using Reslin and oil-based dispersal applied with Thermal Fog Generators, and has been in operation in Balibo since late December 1999 when ADF peacekeeping forces established a permanent camp. The Reslin concentration when mixed with diesel has been approximately 12%. Larvicide (VectoBac, liquid and granule forms, and AltoSid-XR®, briquettes and AltoSand,) is also regularly applied to known and likely mosquito breeding sites.

For the purposes of this study, a 20-litre container of Dyna-CC11, manufactured and supplied by Airscape Pty Limited, Wamberal, NSW, was used. Pesticide used for the trial was the pesticide used for routine daily application using oil-based Thermal Fog Generators. The pesticide is available as a 5 litre can on NSN 6840-66-023-2935 through normal ADF supply means, and is Reslin (50 g/L bioresmethrin synergised with 400 g/L piperonyl butoxide) manufactured and supplied by AgrEvo. 1 – 2 day old *Culex quinquefasciatus* (Say) adult mosquitoes from Balibo were used as sentinels. Mosquitoes were collected as larvae from disused mandies (concrete troughs for hand washing) located adjacent to toilets in Balibo and raised to the adult stage.

The routine indoor fogging program encompasses all accommodation and work areas within the Australian controlled encampment. These include a mixture of existing disused buildings that have been partially repaired and re-roofed, and military style canvas tentage. Sanitation and waste services within the encampment are well established and pose no health threats.

Manufacturer recommendation for Dyna-CC11 dilution rates is between one (1) part Dyna-CC11 and either two (2), three (3) or four (4) parts of water (1:3; 1:4; 1:5 respectively), when used with Thermal Fog equipment. In order to evaluate the suitability of Dyna-CC11 as an alternative to using diesel as the primary carrier in ADF Fog Generating equipment a testing protocol was developed to consider a range of variables, including dilution rates greater than those recommended by the manufacturer. The Reslin concentration when mixed with the Dyna-CC11 formulation was maintained at 6% (half the oil-based rate) throughout the trial.

Dyna-CC11 dilution rates with water were tested in the range from 1: 10 to 1:3, in conjunction with changes to Thermal Fog Generator jetting orifice sizing (with Super Hawk only). Manufacturer supplied orifice for the Super Hawk is '72'. This works very effectively with oil-based formulations, however water-based formulations require the smaller orifices – '24', '28' and '36'.

Study conditions were designed in order that operation of the existing in-service equipment should not be compromised. Changes to formulation flow rates required to accommodate the different characteristics of the water-based solution would only utilise current jetting orifices available from the Fog Generator equipment manufacturer.

The Super Hawk Fog Generators are used to hand fog through the tentage and buildings three (3) times per week. The Black Hawk Fog Generators are vehicle mounted and are used for broad area outdoor fogging through the Australian encampment and adjacent Balibo streets. Outdoor fogging occurs four (4) times per week on evenings alternate to the indoor fogging program. Timing for these programs are a compromise between personal comfort and optimal timing for maximum numbers of adult mosquitoes flying. Indoor fogging occurs between 0800 to 1100 hours, and the outdoor fogging is at dusk between 1830 to 1930 hours.

Formulation effectiveness was assessed in order to demonstrate control of adult mosquitoes under local East Timor conditions. Sentinel *Culex quinquefasciatus* adult mosquitoes were enclosed in modified, rectangular PVC food containers, covered with a section of metal 'fly screen', to allow for entry of pesticide containing fog. These test containers were placed in four (4) locations to assess the effectiveness of pesticide concentrations using the Super Hawk Thermal Fog Generator fitted with the '24' orifice during normal fogging operations.

The control sentinel mosquitoes were placed in a reasonably airtight laboratory shelter (Location A). The three (3) test sentinel groups were placed in different accommodation tents on either reasonably exposed open areas (Locations B & C), or relatively sheltered shelving (Location D), and were not targeted specifically during the routine fogging. Fogging time and nozzle direction was maintained as normal as possible. Fogging time for each tent was approximately 15 seconds, with the Fog Generator nozzle directed in and around the bedding and furniture to obtain an even distribution. Each tent has an empty volume of approximately 50 cubic metres.

Results and Discussion

The water-based Dyna-CC11 formulation cooled the Super Hawk exhaust nozzle to a point such that the 1:10 dilution would stall the engine as soon as formulation was applied unless the smaller '24' and '28' orifices were used. The 1:5 dilution increased the orifice size to include the "36" orifice, whilst maintaining efficient engine performance and "dry fog" conditions. The higher Dyna-CC11 concentrations of 1:4 and 1:3 produce a denser fog than the 1:5 dilution (Table 1).

Table 1: Carmel Carrier 11 - Test Protocol Outline & Observed Results Dyna-Fog, Super Hawk, 2605/1

Test Serial	Dilution Rate (CC11)	Pesticide Final %	Fog Generator Jetting Dyna-Fog Super Hawk, 2605/1	Observations
1	1:10	12%	28 (10.0 lph)	Good dispersal; very strong smell of pesticide
2	1:10	6%	28	Good dispersal; normal smell of pesticide; fog generator continually cut out – possible cooling of exhaust due to excessive formulation
3	1:10	6%	36 (17.5 lph)	Wet fog produced; stalled fog generator if applied for more than two seconds
4	1:10	6%	24 (5.7 lph)	Good dispersal; fog slow to initiate (? to 1 sec); fog generator operated well
5	1:10	6%	24	Test effectiveness of fog with adult mosquitoes at 1/2 previous rate (6% c/f. 12%); Ref. Table 3 for effectiveness results; fog generator operated very efficiently
6	1:5	6%	36	Good dispersal; dry fog produced; fog generator operated very well
7	1:5	6%	28	Good dispersal; dry fog produced; normal smell of pesticide; fog generator operated very well
8	1:5	6%	24	Good dispersal; dry fog produced, but still slow to initiate; fog generator operated very well
9	1:5	6%	24	Test effectiveness of fog with adult mosquitoes; Ref. Table 3 for effectiveness results; fog generator operated very efficiently
10	1:4	6%	28	Good dispersal; dry fog produced; fog generator operated very well
11	1:4	6%	24	Good dispersal; dry fog produced; fog generator operated very well
12	1:3	6%	28	Good dispersal; dry fog produced; fog generator operated very well
13	1:3	6%	24	Good dispersal; dry fog produced; fog generator operated very well

Note: Standard jetting (orifice) from manufacturer delivered on the Dyna-Fog Super Hawk is '72', which disperses fog at a rate of 42 lph

The smallest orifice available for the Black Hawk ('39') was already in use. The 1:5 dilution used satisfactorily with the Super Hawk for indoor applications produced satisfactory engine and fog performance with the Black Hawk (Table 2), however the fog distribution when used for outdoor application was not over a broad swath. The fog spread was approximately five (5) metres on either side of the vehicle. Further study and combination with an Ultra Low Volume (ULV) sprayer is recommended.

adult mosquitoes available during this trial under operational conditions warrant further investigation. Operator safety when using Dyna-CC11 rather than diesel is improved, due to lower risks associated with Glycol Fogging agents (American Conference of Government Industrial Hygienists 1991). Appropriate recommended protective equipment should be utilised when dealing with the pesticide formulation. Anecdotal evidence gained from questioning personnel in the vicinity of sprayed areas indicated a higher acceptance

Table 2: Carmel Carrier 11 - Test Protocol Outline & Observed Results Dyna-Fog, Black Hawk, 2620/2

Test Serial (CC11)	Dilution Rate	Pesticide Final %	Fog Generator Jetting Dyna-Fog Black Hawk, 2620/2	Observations
1	1:10	6%	39 (18.9 lph)	Wet fog produced; fog generator worked as normal
2	1:5	6%	39	Reasonably dry fog produced; fog generator worked as normal
3	1:3	6%	39	Reasonably dry fog; fog generator worked normally
4	1:2	6%	39	Reasonably dry fog; fog generator worked normally

{Note: Standard jetting (orifice) from manufacturer delivered on the Dyna-Fog Black Hawk is '89' (none), which disperses fog at a rate of 68.1lph.}

Table 3 Mosquito Mortality Testing

Dilution Rate (CC11)	Fogging Time (sec)	No of adult Mosquitoes	Mean Mortality after 30 mins	after 60 mins	after 120 mins
1:10	0	5	0	0	0
1:10	15	22	82% (18/22)	91% (20/22)	95% (21/22)
1:5	0	16	0	0	0
1:5	15	45	96% (43/45)	96% (43/45)	98% (44/45)

The results indicate that the formulation, at these dilution rates, is effective at eradicating adult mosquitoes, despite the variability available within the test due to exact fogging times, air flow rates within the tentage and position of test containers within the individual test areas.

Fogging time of 0 sec relates to the control mosquitoes in the enclosed laboratory.

Specific testing to assess formulation efficacy in controlling adult mosquitoes for water-based Dyna-CC11Thermal Fog carrier indicates that Reslin applied at 6%, half the oil-based rate, is effective (Table 3). Mortality rates 30 minutes after exposure were greater than 82%. Mortality rates 120 minutes after exposure were greater than 95%.

These results show good correlation with AgrEvo claims, however, low numbers of of the water-based fog over the traditional oil-based fog.

Conclusion

It has been shown that a change from the current in-use oil-based Thermal Fog procedures to a water-based carrier, using Dyna-CC11 at a 1:5 dilution rate, would be justifiable on pesticide efficacy, operator safety and environmental grounds.

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Learning from Indigenous Cancer Rates

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Recently-published data on age-standardised Indigenous cancer rates in 13 Indigenous communities in Queensland reveal some elevated and some decreased rates for a range of anatomical sites. One third of these cancers are linked to cigarette smoking. It is proposed that promotion of traditional use of native tobacco – which is not smoked but held in the mouth – may be a way to diminish respiratory and other smoking-related cancer in Indigenous communities. On the positive side of the data, colorectal and prostate cancer rates were reduced in comparison to Australia-wide data. Efforts ought to be expended in understanding this phenomenon, especially to determine if there are dietary chemopreventive agents at play.

Key Words: *Indigenous Cancer Incidence, Smoking, Mingkul*

Discussion of issues related to Indigenous environmental health in Australia has been extensive and will continue unabated for some time. Relatively new though in the knowledge base of most health professionals will be the issue of cancer among the Indigenous population. This is probably due in large part to the paucity of published data. While Australian cancer registries have collected data on Indigenous status, the data collection is from secondary sources and of uncertain quality. Also, publication of these data has been limited due to the small numbers of Aboriginal cases on most registry data files. For example, the Cancer Registry in South Australia, which was one of the first in Australia to collect and analyse cancer incidence and mortality data for people notified as being Indigenous, began recording such data in 1977 and first published these data in 1993 (SA Cancer Registry 1993).

Against this background of a dearth of data on Indigenous cancer rates, a recent paper by Coory and colleagues (2000) makes an important contribution. The following discussion centres on these data, in particular on the incidence of smoking-related cancers and of cancers that appeared less common than in the general population.

Increased Cancer Incidence

The article by Coory, Thompson, and Ganguly in the Medical Journal of Australia presents details of a study of cancer incidence and mortality rates during 1982-1996 in 13 predominantly Indigenous communities in rural and remote Queensland (Coory, Thompson & Ganguly 2000). Emphasis was given to elevated age-standardised incidence rates (SIR) of stomach, lung and cervical cancer in women (SIR 336, 267 and 467, respectively), and of lung and other smoking-related cancers in men (SIR of 213 and 205, respectively); these findings are consistent with reports from the South Australian Cancer Registry (SA Cancer Registry 1993; 1997). The ensuing discussion of ideas for pegging back these elevated cancer rates focused on cervical cancer with its appallingly poor prognosis (standardised mortality ratio SMR – 1335). However, regarding smoking-related cancers – with overall SIR of 213

and SMR of 267 – no specific proposals were suggested for dealing with this problem among Indigenous people (Coory, Thompson & Ganguly 2000).

Proposal for Reducing Smoking-related Cancers

The lung and other smoking-related cancers in the above study clearly represent a major disease burden, being 32% of the total number of cancers (89/280, Coory, Thompson & Ganguly 2000). Therefore efforts to reduce cigarette smoking among Indigenous people need to be implemented, as Coory and colleagues also point out. Tobacco control is identified by the National Environmental Health Strategy as an important chemical hazard management activity in Australia, and especially among socio-economically disadvantaged groups (enHEALTH 1999). Smoking prevalence among Aboriginal and Torres Strait Islanders is estimated to be about 50%, that is, double the prevalence in the Australian population, and is known to be as high as 75% (women) to 83% (men) in some parts of the country (Andrews & Stephenson 1993; Ivers 2001; Madden 1994).

One idea for reducing reliance on cigarettes might be to revive the use of native tobacco, which is not smoked but chewed or sucked. Prior to white settlement of Australia, Indigenous people in many areas were accustomed to using and enjoying wild tobacco, of various *Nicotiana* species (Jessop 1981). In the area of Central Australia where the Yankunytjatjara lived, leaves of *Nicotiana excelsior* (mingkul) were traditionally dried, mixed with ash of the bark, twigs or leaves of certain tree species, then placed in the mouth, rolled into a quid (kaputu) and sucked on (Institute for Aboriginal Development [IAD] 1985). The subsequent feeling of contentment, probably related to the nicotine content, has been documented and is still experienced today in various locations in the Outback.

With some foreknowledge and entrepreneurialism, one might imagine that it could be possible to mass-cultivate mingkul and to prepare it commercially in a way that can be used with ease to the satisfaction of the user, and without having to employ the intermediate step of generating campfire-ash. For example, synthetic flavours could be added to mimic the taste of traditional components. In recent discussion with a Yankunytjatjara elder on the general idea of mingkul production, the author received an enthusiastic endorsement of its likely popularity.

However, since little is known of the health effects of mingkul usage, some basic toxicological testing and research should first be necessary. The hope would be that long-term mingkul use would cause fewer health problems than those induced by cigarette smoking, and that oral cancer – as associated with chewing tobacco in other countries – would be minimal if at all existent. A further consideration would be for possible synergistic interaction with other agents known to increase the carcinogenicity of mainstream tobacco smoke at certain anatomical sites, for example, alcohol. One recent study in India showed that for people who chew tobacco and drink alcohol, there is a more than multiplicative increased risk of premalignant oral erythroplakia (Hashibe et al. 2000).

Any serious thought given to the above mingkul idea will need to be guided by principles espoused by Indigenous people and which have been echoed by the National Indigenous Environmental Health Forum, that is that environmental health strategy and initiatives should embrace the concept of community self-management and cultural sensitivity (Jolley et al. 1999; O'Donoghue 1999). It is interesting that other authors too are advocating various alternative nicotine delivery regimens as a way of reducing the harmful effects of cigarette smoking (Bates 2000). In Sweden for example, only 17% of men smoke, but 19% use a form of oral tobacco called 'snus'

(which does not seem to cause mouth cancer); as a result, Swedish men have the lowest risk of death from a smoking-related disease in Europe (Wilson 2001). Cardiovascular health associated with smoking among Indigenous Australians has been highlighted as a particular area of concern (Walsh 2001).

Reduced Cancer Incidences in the Indigenous Population

Of note also, though given only passing mention by the authors, were the results in the Queensland study which showed reduced incidence rates for colorectal cancer (SIR – 40 for women, 29 for men) and prostate cancer (SIR, 31) (Coory, Thompson & Ganguly 2000). Again, this has been observed in other studies (SA Cancer Registry 1997). Such findings can seemingly be lost in the importance attached to the elevated Indigenous cancer rates and in discussions of their causes and proposed amelioration programs. However, it is the opinion of this author that commensurate efforts should be given to research aimed at identifying the reasons for the reduced cancer rates. Therein might lie extremely valuable information. For example, detailed examination of the Aboriginal diet, as reported in a recent study in the Brisbane area (Stuart-Fox 2000), and Aboriginal lifestyle in different regions, might reveal clues that could assist in reducing incidence rates of colorectal and prostate cancer in the non-Indigenous community in Australia and elsewhere. These cancers are especially prevalent in Western countries (Whelan, Parkin & Masuyer 1990).

Research elsewhere is revealing that aetiology of cancer and other diseases is linked not only to environmental factors but to genetic factors as well (Lichtenstein et al. 2000; Olden 2001; Tomatis 1990). It is possible, therefore, that work aimed at unraveling any genetic contribution to Indigenous cancer rates can also provide important insight into causality.

Conclusion

Putting to best advantage the relatively recent information on Indigenous cancer rates in Australia will probably require some lateral thinking. This paper has presented some ideas and it is hoped there will be others. Such efforts are required urgently to address in particular the adverse health impact of smoking among Indigenous people.

Doubtless, the above proposal for mingkul use raises a number of questions that would require exploration. For example, would users of mingkul compound nicotine and other xenobiotic intake by smoking as well? Anecdotal evidence suggests that current mingkul users in Central Australia tend not to smoke; this might be due to sufficient delivery of nicotine from mingkul alone, but is likely also to be related to the economic advantage of using the locally available *Nicotiana* species (S Rainow, personal communication). A further question is what legal and bureaucratic hurdles might be encountered in establishing any formal mingkul industry? While this is beyond the scope of the present paper, it would seem reasonable that at least in unincorporated areas of the country which are under Indigenous control, mingkul use could be promoted with a minimum of legal encumbrances.

On a final note, one may suppose that the line of thought surrounding the notion of seeking traditional Indigenous knowledge could be extended to include additional areas of public and environmental health importance, such as mental and social health. In this regard, we would stand to gain significant knowledge and wisdom from our Indigenous population.

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Sustainable Development: A Cornerstone of Public Health
Promoting Ecological Sustainable Development and Health in Public Health Education in Australia

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Background: Sustainability and Health

This article describes a project designed to facilitate the adoption of the principles of Ecological Sustainable Development into public health education courses around Australia. A substantial body of evidence is indicating that changes in world ecology will have a significant impact on the health of human populations around the world (McMichael & Beaglehole 2000; McMichael 2001; Soskolne & Bertollini 1998). To make a start in alleviating the emerging problems, public health courses around Australia are being asked to take an active interest in incorporating Ecological Sustainable Development policy and practice in their course designs.

The aim is to reposition public health practitioners as key stakeholders in the changing relationship between humans and ecological systems, as the relationship moves from ownership to partnership. The process for this project demonstrates in practice the principles of Sustainability and Health and will be of interest for all Public and Environmental Health practitioners who act as agents of change. This project has been supported by the foresight of the Population Health Division of the Federal Department of Health and Ageing with a PHERP Innovations Grant. In this article we outline the innovative process that has been adopted by the management group to facilitate the adoption of these principles in public health curricula.

Sustainable Development as a Public Health Issue

There is increasing evidence that humanity is one of the few species capable of "soiling its own nest" to the extent that it is no longer habitable. McMichael suggests, "Since their hunter gatherer origins humans have been mobile 'patch disturbers', depleting one patch and moving onto another" (McMichael 2001, p. 14). The question for this generation of humans is now that our disturbed patch is the planet, the whole of our habitat, what do we do next?

The Commission for Sustainable Development (1998) predicts that water scarcity will be the first environmental crisis to cross an irreversible threshold, triggering major global economic and ecological disruption, accompanied by equally major risks to health. Water resources, one of the key factors in the green revolution, which has allowed food production to keep pace with population increase, have depended on the improvement in the supply of water from the world's aquifers. These, we now realise, are dropping at a rate of metres annually in some regions (Postel 1999). World

population is expected to peak at around 8-10 billion people within the next 50 years. Brown et al. make the point that "…there has been more growth in population since 1950 then during the four million years since our early ancestors first stood upright" (Brown et al. 1998, p. 89). Many ecologists are arguing that this will seriously over stretch the earth's carrying capacity. Already it is estimated that 40% of the global disease burden arises from environmental causes (Pimental & Pimental 1999).

Carbon dioxide, traditionally a harmless gas, is now believed to be a major threat to humanity as the primary cause of global warming, which is expected to lead to increases in average temperatures of between 1 to 4 degrees. As our ecosystem is complex no one can predict accurately the full extent of the impact of temperature changes, although they will certainly aid the spread of tropical and sub-tropical diseases such as dengue and malaria. (Ayres 2001; McMichael 1993; Working Group on Public Health and Fossil-fuel Combustion 1997). A large proportion of the world's population is unable to reach their full potential as human beings because of unequal access to unpolluted environments, health and financial resources, leading to growing inequality in access to healthy living conditions among the world's population (Lynch et al. 2001; Ravallion 2001).

The purpose of presenting this limited list of the potential risks to public health from environmental change is to highlight the extent of threats to health that each of these assaults already presents. The SaH project is based on the proposition that it is critical for public health practitioners, as key stakeholders in the health of populations, to improve their understanding of and become active in working to the goal of global sustainability as a cornerstone of public health (Soskolne & Bertollini 1998). In order to facilitate public health's role in advancing sustainability, the Sustainability and Health (SaH) Project team is working collaboratively with all Australian Public and Environmental Health professional courses with the aim of ensuring that SaH becomes integral to public health practice around Australia.

Public Health Education as a Change Management Process

The Sustainability and Health Project has three guiding committees and a management group. The Steering Committee, with representatives of Public and Environmental Health interests, and the Expert Advisory Committee of ten of the most authoritative authors on the global environment and health worldwide[1], have agreed that:

The SaH project is about change and transformation in environmental governance for health; it is not about revolution, but neither is it about keeping to business as usual;

- The project is transdisciplinary, including local knowledge and strategic knowledge of environmental change as well as the specialised knowledge of the academic disciplines; and

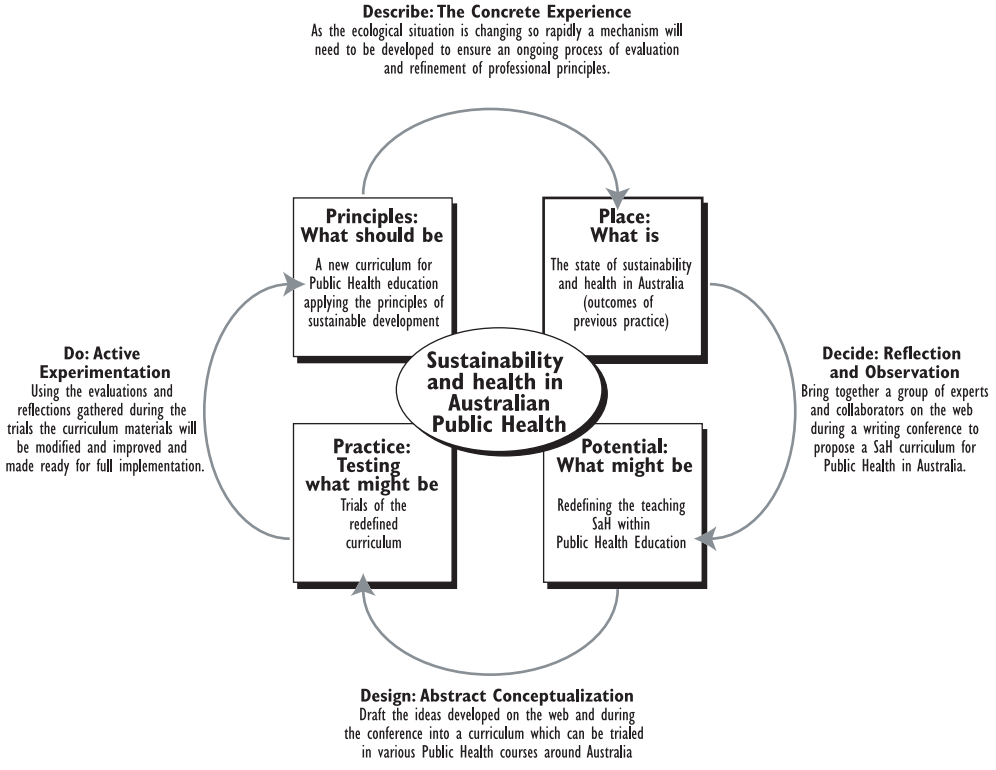
- The teaching program will need to be different to traditional courses, in that it is about the future as well as the present, and about what to change as well as about what to keep.

The designers of the teaching program will be members of the third SaH committee, the Collaborative Committee, made up of members of public health teaching course around Australia.2 The framework underlying the teaching programs, course materials, field experience and ultimately a Resource Book for Sustainability and Health is based on a combination of experiential learning principles (Kolb et al. 1974), and place-based change management (Brown 2001, Western Sydney Organisation of Councils [WSROC] 2000).

Kolb et al. (1974) argue that adult learning is best characterised as a form of personal inquiry into real world problems. Kolb outlined four stages in the experiential learning cycle: concrete experience, observation and reflection, abstract conceptualisation and testing the new idea to lead to another new experience (Figure 1). Kolb et al. demonstrated that different professions concentrated on one or more of the stages and argued that often the individual did not complete the learning cycle and that therefore the learning was incomplete. Kolb's ideas strongly influenced the field of action research, are now used as a framework for life long learning in a number of professions; and gave rise to the idea of the learning organisation, a key concept in organisational development circles (Senge 1995).

As it became apparent that the future for human wellbeing depended upon integrated and systemic solutions to the linked social, economic and ecological issues, it also became apparent that aids to integrative, systems-based decision-making would be needed as well. Among such aids is the P4D4 decision-making framework designed to be used as a guide in the management of change (Figure 1) (Brown 2001). The framework was first developed in partnership with Local Government Authorities as a monitoring and evaluation model for local and regional state-of-the-whole-environment reporting (WSROC 2000). Since then the framework has been used in a diverse range of change management processes, such as redesign of a curriculum (BappSc Environmental Health at the University of Western Sydney); and in forging alliances between community groups and local Councils. In incorporating sustainable development principles into Australian public health education and so into public health Practice, the change process includes (Figure 1).

Figure 1: Decision-making for Change Management in Environment and Health: P4D4 Framework (adapted from Brown 2001, p. 31)



Deciding on the Principles: Building on Concrete Experience

The context of Public Health and SaH is changing rapidly in Australia. In response to this it is important that the process of clarifying, expanding, and modifying content incorporating sustainable development principles takes place in all public health teaching programs. The educational philosophy the project aspires to is not primarily about information transfer, even if it were quality information. This project is about preparing students for a key role as agents of change in sustainable governance of our increasingly hazardous health ecosystem.

Describing place: Reflecting and observing

The process begins with an examination of the present situation in public health education, the status of SaH in Australia and how it is currently being incorporated into programs. The current situation varies from public health courses that do little on sustainable development, to courses where it is a central focus. A mass of information will be examined in order to explore ways of moving forward. This information will include leading international thinkers in the field contributing their most up-to-date ideas, Australia's key advocates for sustainability talking about new technologies and initiatives, and coordinators of public health courses describing their experiences in implementing SaH programs. To bring together this bank of experiences, the group of national and international experts in SaH and the collaborators from public health and environmental health education courses around Australia will work together for four months in an interactive web based forum.

Designing potential: Abstract conceptualisation

The data collated within the web will be exposed to critical reflection by all participants in the interactive web forum. This will commence an iterative process that will lead the group to redefining SaH for Australian conditions. The discussion on the web will be interactive and will enable many viewpoints about the way forward to be heard. During this phase the principles of dialogue developed by David Bohm (1996) which encourage entry of new ideas will be the basis for the ongoing discussion. All ideas and discussions that take place on the web will be collected and discussed at a three-day writing conference. At this workshop, curriculum materials will be designed and shaped so as to give the best possible results for students who in the future will take on key roles as agents of change. All participants will be recognised as the authors of the resultant SaH Resource Book.

'Doing' practice: Active experimentation

The curriculum materials will be trialed by the collaborators in the various public health education courses around Australia. The creative ideas of the SaH project collaborators and experts will be put into practice, leading to new information to guide the final preparation of curriculum resources. It is expected that the experiences of the collaborators during the trials will lead to further modifications of the curriculum materials, and design of a SaH monitoring system.

Deciding on the Principles: Reviewing Concrete Experience

The context of public health and SaH is one of a system in the process of change. In responding to this ongoing change, it is hoped that review and re-evaluation of the application of sustainable development principles in public health will continue past the life of the SaH Project and become indeed a cornerstone of public health and environmental health practice in Australia.

Project Timetable

The interactive web site for this project is due to commence in early May and the

writing conference is due to take place in September. The editing of the Resource Book and the various sets of curriculum materials for short courses, undergraduate and postgraduate programs will follow, so that materials are ready for teaching in early 2003. The process is an open process throughout, so that parallel international events such as the major world meeting on sustainable development in Johannesburg in 2002, Rio Plus Ten to commemorate the major precedent in 1992, the establishment of the world wide community-based Earth Charter, and the learning from the global programs of Healthy Cities and Local Agenda 21, can be incorporated during the SaH Project process. It will be important to embed the teaching process within a clearly described and shared body of knowledge. As adaptability to change and adoption of innovation are central aims, the process being employed to design the curriculum is also being trialed as a teaching process for the SaH courses. The move to Ecological Sustainable Development worldwide has been slow, but is now accelerating. Public health is one of the professions that need to urgently reconsider its role in maintaining the health of human populations, in the light of current state of the world environment reports. The description of the SaH project outlines one small action to bring about this repositioning.

Notes

1 Alan AtKisson, Principal, AtKisson Inc; Professor Fran Baum, Flinders Department of Public Health, University of South Australia; Dr Gillian Durham, Deputy Director- General, Sector Policy, New Zealand Ministry of Health, New Zealand; Dr Trevor Hancock, Public Health Consultant, Toronto; Honorary Professor Ian Lowe, School of Science, Griffith University; Professor Tony McMichael, National Centre for Epidemiology & Population Health, Australian National University; Mr Phillip Mills, District Manager, Torres Strait and Northern Peninsular Health Services District; Professor William Rees, School of Community and Regional Planning, University of British Colombia; Professor Colin Soskolne, Department of Public Health Sciences, University of Alberta; Dr Mathis Wackernagle, Consultant, Redefining Progress.

2 If any reader is interested in participating in this innovative project they may contact John Grootjans at j.grootjans@mailbox.gu.edu.au

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Primary Health Care Policy Review Project: Diocese of Tarawa and Nauru

William P. Hannigan

Diocese of Tarawa and Nauru

This report by the Diocese of Tarawa and Nauru forms part of a survey on health in the Pacific Islands by the World Health Organization, which is updating its previous data. Many of the recommendations are pertinent to environmental health issues.

The Catholic Church in the Republic of Kiribati is the largest religious body by numbers of all the Christian denominations. The total population of Kiribati is approximately 77 658 people. Of these 42 164 people belong to the Catholic Church. Because these statistics refer to 1995 Census it would be reasonable to assume that the population has now grown to over 80 000 persons. I submit that the Catholic population percentage would reflect the 1995 figures.

Having regard to these figures would indicate a certain influence by the Catholic Church on the population of the Republic of Kiribati. It is hoped that that influence is for the good of the nation.

Policy

The Catholic Church does not have a formal health policy for its congregation and no doubt would not seek to impose one on the people. However, an implied good health outcome could be expected from Catholic people should they all follow the gospel teachings to "Spread the Good News". However, the church is not so naive as to believe that all members of the congregation will take up a healthy lifestyle.

Church Influence

There are a number of ways that the Catholic Church can influence health outcomes to its members. I now list them in point form:

- Upholding gospel values in respect to "Love of God, Love of Neighbour" should lead to a more harmonious population so that stress levels between the population is kept to a minimum. This should ensure fewer disputes and therefore less aggravation resulting in a more stable, healthy environment in which to live and raise children.

- Gospel values regarding the use of sex will enhance health outcomes in regard to sexual abuse, spread of HIV/Aids and procreation issues.

- Church group fellowship can lead to health within the population, its good exercise (dancing) and singing generally leading to a harmonious relationship between peoples.

- Church involvement in schools plays a major role in health outcomes. Teaching staff are continually giving advice on healthy living issues

  – school home economic classes also give good advice in regard to health matters within the home

  – school discipline in respect to smoking and drinking is a health issue where the school/church has an influence

- school sport leads to healthy outcomes

- Catholic boarding schools have a unique opportunity to give health guidelines to students in respect to such matters as personal cleanliness, sexual health, good housekeeping issues, healthy diets, healthy personal habits

- Catholic schools are uniquely placed to raise the level of general knowledge of the population, through its teaching to students, of overall healthy lifestyles – "Teach the Children Teach the Parents".

Catholic Church Facilities

Teitoiningaina Women's Centre

This is the centre "For the Women – By the Women". Its purpose is to strengthen the women of Kiribati in the areas of equality, self assurance, self worth, self protection, and general support for all women especially in crisis situations, for example, male abuse, family abuse, intoxication abuse. It is obvious to see the outcomes of this institution on the health and welfare of women who gain support of the Teitoiningaina.

Teitoiningaina outer island support work. This work involves going out to outer islands and the invitation for outer island people to come to the Women's Centre for training in matters listed above. This outreach work spreads the health message to all sectors of the Kiribati women's community.

The Teitoiningaina work in respect to training in catering, crafts, and sewing is a positive in regard to women's health. Learning and carrying out these tasks gives the women a sense of worth and esteem to live a healthy lifestyle.

Christian family life

This catholic work operates as a family health support for couples, singles, men and women. The work involves education of adults in respect to family health – reproduction, family planning and good health education in regard to sexual matters. The need for family planning is a major concern for Kiribati. The Life Centre of Kiribati does excellent work in this field. The work is also taken to outer islands so that family planning matters are not limited to Tarawa.

St. Paul's Communication Centre

This centre is able to produce materials such as radio programmes, videos, tapes and articles dealing with health outcomes for the general population of Kiribati. Media education can be a very powerful source to assist in healthy outcomes to our people.

Mental health assistance

This is a project taken on by the Good Samaritan Sisters of the Catholic Church. This gives mental and personal stimulation to the people affected with a mental disorder. The old attitude of putting such people away is now slowly diminishing and is replaced by mental stimulation to give the clients a more worthwhile life. The work can also have the added advantage of giving respite to the home and hospital carers of these people so afflicted with mental illness.

The involvement of senior students and in volunteer work associated with this project also has an educational aspect in that students exposed to this work may at some future date be the professional staff of the Mental Health Institute of Kiribati.

AA Services

The Catholic Church is deeply involved in this work with some real success. Men and women have been directed to this organisation by the church members in an effort to overcome the scourge of alcoholism within Kiribati. Lives have been turned around as a result of this good work.

Prison outreach

This is a work of the Catholic Marist Brothers who work with prisoners in an effort to get them to turn their life around. No doubt this work leads to health benefits for these people, and those with whom they come in contact.

Conclusion

As can be seen from this report the Catholic Church in Kiribati is not generally in a formal role of preventative health. However, through its outreach, both spiritual and physical a good preventative health outcome can result.

Our resources are limited so more work is difficult. Our desire is that preventative health is a major plank in any Health Ministry of Government, otherwise the problems of acute health care rises dramatically.

As an example, in Australia hospitals were built in the 1900s for communities for acute care with some hundreds of beds. Now because of preventative health measures bed numbers have been reduced, in some cases from 110 bed hospitals to 36 bed hospitals. This is a massive saving to the health budget. Funds spent on preventative health care can save much expense on acute health care.

Recommendations

That:

(a) Taxes are placed on such items as alcohol and tobacco products that will reflect health care expenses.

(b) Active campaigns be run to stop the use of alcohol and tobacco.

(c) Hotel opening hours be put in place to limit hotel sales of alcohol.

(d) Laws be put in place to stop underage drinking and smoking. Such laws to be policed.

(e) Efforts be made to control the production, distribution and sale of sour toddy products.

(f) Greater efforts be made to ensure the installation of a sewage system and potable water reticulation system for the whole of Tarawa.

(g) Supply of composting type toilets to outer islands communities.

(h) Supply of good tank water to outer islands.

(i) Health education workers to be assigned to each island with a mandate to run health workshops to groups, schools and so on.

(j) HIV/Aids workshops are conducted on a regular basis throughout the republic and through the local radio station.

(k) Stronger efforts are made to educate the population regarding the diabetes message.

(l) Family planning educational seminars be conducted especially in the Tarawa Atoll to limit the overpopulation and subsequent problems that arise from it.

(m) Health workers are employed for mental and physical welfare of Kiribati people.

(n) Efforts are made to fund modern sporting facilities for the people of Kiribati and programs are put in place to use these facilities for the health benefits of all people of Kiribati.

(o) Immunisation for all pupils entering Kiribati schools should be made compulsory – Polio, Measles, Mumps, Whooping Cough, Tetanus, Diphtheria, Hepatitis B.

(p) Mass screening of women for cervical and breast cancer.

(q) Heart disease programs are made available to the population through health education staff.

(r) Central government and/or local government actively promote employment of Environmental Health Officers and Building Surveyors to ensure adequate health, building, and welfare measures are taken in respect to preventative health. This is especially necessary in regard to septic tanks, burials, drainage, plumbing, building, garbage disposal, waste management, sewerage systems, water reticulation and aspects of town planning.

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Development of a Professional Certification Scheme for Environmental Health Practitioners

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A number of other countries operate a certification scheme for environmental health practitioners. However, in Australia such a scheme does not exist. As such, it has been proposed that the Australian Institute of Environmental Health establish a Certified Environmental Health Practitioner scheme that forms part of an integrated framework of professional development activities. To initiate discussion on this issue, this report provides some background to the certification process, an overview on certification schemes operated in other countries, and one possible model for certification in Australia.

In many professions, some form of postgraduate certification/registration is required for practitioners to obtain full professional status (e.g., CPA for accountants, admission to the bar for solicitors). In the environmental health field, certification/registration schemes are operated in a number of countries (e.g., UK, Canada, USA). In Australia, a formal certification scheme for environmental health practitioners is not in operation, however, the Board of Directors of the Australian Institute of Environmental Health (AIEH) has supported the establishment of such a scheme and are currently examining the associated development and management issues.

The aim of this discussion paper is to provide: (a) some background to certification; (b) an overview of a number of certification schemes for environmental and occupational health that are operating in other countries; and (c) an overview of issues that are currently being considered at the initial stages of developing such a scheme for Environmental Health Practitioners in Australia.

Background

Most professional representative bodies have acknowledged that there is a defined pathway toward the development, recognition and acceptance of a particular vocation as a profession. The usual steps include:

- development of specific (tertiary) education and qualification courses that provide the entrée into the profession as a practitioner;
- establishment of a professional representative organisation. In the case of the AIEH the goal of maintaining and improving environmental health standards is achieved through the professional development of its member practitioners;
- active involvement in the development of government policy pertinent to the area of practice. In many ways, this defines a major role of a peak professional organisation like the AIEH and is critical for any moves towards self-regulation; and
- development of professional accountability through the development of ethical standards, practice standards, and continuous professional development.

Underpinning these steps is the development of a capacity to be influential with government, development of a capacity to research and develop professional best

practice, and development of a public profile of both the representative organisation and the profession.

The Australian Institute of Environmental Health is the peak national professional organisation in Australia that provides advocacy on environmental health issues and represents the professional interests of environmental health practitioners. Much of the efforts of the AIEH over the last ten years have been directed at establishing a national organisation and developing the administrative and governance structures required for such an organisation. Although there have been substantial developments in the environmental health arena, there has been little integration and development of professional practice standards within the profession.

The 1999 National Environmental Health Strategy identified the following issues of importance for the environmental health workforce:

- The need for environmental health practitioners to be multiskilled, but with an increasing need for specialisation;
- Environmental health training to ensure maximal links between current training and future practice;
- Increased level of continuing professional development; and
- Further development of post-graduate research and training.

As highlighted above, the need for environmental health practitioners to maintain up-to-date skills and knowledge is crucial to the continued development and influence of the profession. There is also a clear expectation that the AIEH leads the development of both professional practice and environmental health capacity.

Currently, membership of the AIEH is open to professionals from a range of environmental and health disciplines, with the AIEH offering a 'Certificate of Professional Recognition' to 'professionally practice as an Environmental Health Officer' to those members who have successfully completed an AIEH accredited Bachelor's degree majoring in environmental health. The AIEH also operates a voluntary Continuing Professional Development Program. To provide an integrative framework for these activities, it has been proposed that the AIEH establish a Certified Environmental Health Practitioner (CEHP) scheme that will have the objectives of:

- developing a certification scheme for members meeting appropriate criteria and itself being a criteria for advancement within the AIEH;
- gaining recognition by employers of members who are participating in the Scheme;
- developing national standards of professional practice and professional accountability; and
- developing a robust continuing professional development program.

The notion of 'best practice' is gaining more and more currency and the CEHP Scheme is seen as a mechanism for members to demonstrate that they are utilising best practice in their environmental health activities for their employers.

Existing Certification Schemes

To provide a basis for the development of a certification scheme in Australia, it seems prudent to review the types of schemes operated by comparable professional bodies in both Australia and overseas. As such, the certification schemes of the following professional bodies were reviewed:

- Chartered Institute of Environmental Health (CIEH), UK
- National Environmental Health Association (NEHA), USA
- Canadian Institute of Public Health Inspectors (CIPHI)
- American Board of Industrial Hygiene (ABIH)
- Safety Institute of Australia (SIA)

Each of these organisations provide a range of membership categories as well as offering a certification scheme that is linked with a continuing professional development (CPD) program. In the UK however, registration to practice as an Environmental Health Officer (EHO) is mandatory, but full membership of the CIEH is voluntary and contingent on certification (refer to the Example). In Canada, full membership of the CIPHI is also conditional on certification, but in the USA, membership of the NEHA and its certification scheme are separate. In general, to obtain certification, some form of assessment is required along with a minimum number of years of professional experience. This assessment may be either a written exam or interview, but covers both the theory and practice of the discipline. To retain the certification, a person must undertake a minimum amount of CPD activity (e.g., 12 or 20 hours/year) over a particular time period (e.g., 2 or 5 years) and report this activity to the certification board. A comparison of the schemes is contained in Table 1.

Comments on the other schemes

In general, it would appear that the CPD requirements of these other schemes are not overly onerous and many environmental health practitioners in Australia would be able to complete these if they were to maintain their current level of involvement in CPD activities (including those activities organised by the AIEH). Also, the assessment requirements appear to be achievable for many people provided they have completed a recognised degree and have some professional experience.

Example: In the United Kingdom, a Certificate of Registration from the Environmental Health Officers' Registration Board is required to practice as an EHO. In addition to this, a person must have completed two years of professional practice and an Assessment of Professional Competence to obtain full membership of the CIEH. To retain this membership, a person is required to participate in the CPD program in which they need to undertake 20 hours of appropriate CPD activity each year.

In each of the countries, the certification schemes are not legislatively required for the practice of environmental health (apart from the first component of the CIEH's scheme, the Certificate of Registration), but this has not limited the popularity of the schemes. It would seem that the main

Table 1: Comparison of certification schemes

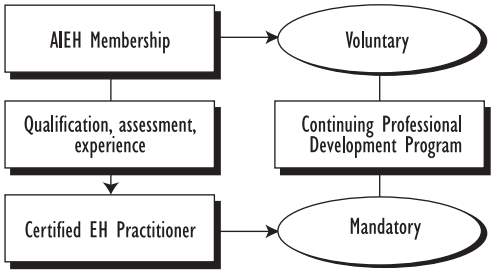
	CIEH	NEHA	CIPHI	ABIH	SIA
Does this professional body operate a certification scheme (credential)	Yes	Yes	Yes	Yes	Yes
Credential abbreviation	MCIEH	REHS	CPHI(C)	CIH	CFSIA
Is the credential separate from regular/full membership	No	Yes	No	Yes	Yes
Credential requirements:					
- Bachelors degree	Yes	Yes	Yes	Yes	Yes
- Relevant experience	2 years	2 years	12 weeks supervised practicum	5 years	3 years
- Assessment	Case study, log of professional practice, interview	Exam: 250 multiple choice questions	Oral exam, inspection reports	Exam: 250 multiple choice questions	Competency assessment
Does the professional body operate a CPD scheme	Yes, mandatory for members	Yes, mandatory for credential	No	Yes, mandatory for credential	Yes, mandatory for members and credential
CPD requirements	20hrs/year	24 hrs/2 years	-	40 CM points /5 years	50 CPD points /5 years

incentives that drive people to obtain these certifications are financial and status related: most of the middle to higher level jobs require applicants to have these certifications, and the certifications are deemed to provide a benchmark for excellence in professional practice.

A Possible Model for Certification

Based on the review of the other certification schemes, a possible model for operation of the 'Certified Environmental Health Practitioner' scheme appears in Figure 1.

Figure 1



Features of this model are:

- The current Certificate of Recognition to practice as an EHO would be replaced by the credential 'Certified Environmental Health Practitioner' (CEHP).

* To obtain the CEHP credential, a person must meet minimum qualifications (eg. degree plus experience) and undertake some form of assessment. This assessment may be on technical knowledge, professional skills, or a mixture of both of these.

- To retain the CEHP, a person must participate in the CPD program. CPD points could be earned by an appropriate mix of structured and unstructured activities, including attending AIEH conferences and workshops, authoring articles for journals, a professional development quiz that is run in-conjunction with the AIEH's Environmental Health peer reviewed journal, undertaking other professional training courses, and participating in a range of other environmental health and related professional development activities.

Issues for consideration include:

- The relationship between AIEH membership and certification needs to be clarified, that is, are they separate, sequential or integrated processes?

- The criteria for certification need to be determined in terms of the content of the assessment and the minimum qualifications for a potential wide range of practitioners who may wish to participate in the Scheme.

- The establishment of a management structure e.g., a certification board or committee to oversee the scheme's operation.

- A review of the current CPD scheme to accommodate both mandatory and voluntary usage and to more closely align it with other AIEH activities.

- Should the AIEH lobby for the Scheme to be incorporated into a regulatory framework e.g., a Board established under legislation, or should participation in the Scheme be market-driven?

Conclusion

In a number of other countries, certification schemes are in operation for environmental health practitioners to help ensure that

professional standards of practice are maintained, and to help practitioners meet the requirements of current and future professional practice. These schemes require practitioners to meet a range of postgraduate standards and to participate in a CPD program. In Australia, there seems to be a need for such a scheme to help the profession meet the enormous challenges that lie ahead and, importantly, to further establish the profession. It would also seem that the AIEH would be the most appropriate professional organisation to operate a certification scheme for environmental health practitioners, particularly due to its current membership, and existing structures and activities. Such a scheme would provide environmental health practitioners with a recognisable benchmark for professional practice and should be viewed as the next stage in the evolution of the profession.

To assist with the development of a certification scheme in Australia, comments from members are encouraged and can be forwarded to either of the authors.

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Basic Environmental Health

Annalee Yassi, Tord Kjellstrom, Theo de Kok and Tee L. Guidotti

Oxford University Press, 2001, 441 pp, $130.00 (hardback), ISBN 0-19-513558-X

If you could only afford to buy one general environmental health textbook, this would be it. *Basic Environmental Health* is an impressive text that provides excellent coverage of both the 'traditional' and 'emerging' areas of environmental health. It is a very readable text that provides a good overview for the beginner, while containing some in-depth coverage of particular issues of relevance to the experienced practitioner.

The central aim of the authors (that has been achieved) was to produce a university level text that was1 interdisciplinary in its approach, so as to appeal to and provide environmental health training for a wide variety of professional groups. To achieve this aim, the text was developed under the auspices of the World Health Organization (WHO), with assistance from various international organisations. As such, the text deals with issues in a non-parochial manner.

The textbook contains 12 chapters and is divided into three main sections. The first section, Chapters 1 to 4, introduces concepts and methods applied in environmental health. This includes an overview of the macro-level influences on health, a description of the nature of environmental health hazards, and an outline of the principles and processes of risk assessment and risk management. The second section, Chapters 5 to 7, discusses environmental health issues by the following routes of exposure: air, water and sanitation, food and agriculture. The third section, Chapters 8 to 11, deals with sustainable development. Topics covered include housing, energy, industry, and trans-boundary and global environmental health concerns. Chapter 12 then ties the overall discussion together by focusing on ethical principles and the role of environmental health professionals.

The interdisciplinary approach of this text shines through in the material covered in each of these chapters and the many examples that are included. Some of the issues covered are biological, chemical, physical, mechanical and psychosocial hazards, principles of toxicology and epidemiology (particularly as applied in risk assessment), risk perception and risk communication, cost effectiveness analysis and cost benefit analysis of interventions, air pollution in the workplace and community, water quality, nutrition, food borne illness and quality assurance, housing and urbanisation, the 'healthy cities' approach, use of fossil fuels and nuclear power, occupational health and safety, health consequences of war, climate change, deforestation, biodiversity, disasters, and the notion of 'think globally and act locally'.

As shown above, the text covers a great deal ground, but does it in a very user-friendly way. Each Chapter contains a statement of learning objectives, a detailed summary of the contents, a well thought-out structure to the sections and sub-sections, a large number of boxes, figures and tables highlighting and illustrating the salient points, and study questions. A comprehensive reference list is also provided at the end of the text.

To enhance the effectiveness of the text as a teaching resource, a Teachers Guide, which contains a large number of problem solving exercises, tables and figures, is available through the WHO website <http://www.who.int/environmental_infor

mation/beh/Behtgtoc2.htm>. Together, the textbook and the Teachers Guide form an extremely worthwhile 'teaching kit' for environmental health. When applied within the local or regional context, these resources would be useful as the basis for introductory courses at both the undergraduate and postgraduate levels. The only drawback I can see is the price of the text, which would probably be out of reach for many students.

Overall, *Basic Environmental Health* provides a comprehensive and balanced coverage of the broad field of environmental health and would make an excellent core reference text for both the student and practitioner.

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