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**Indicator Organism Sources
and
Recreational Water Quality:**

**A Study on the Impact of Duck Droppings on the
Microbiological Quality of Water at Hataitai Beach**

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of
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ABSTRACT

The aim of this study was to identify the possible sources of faecal pollution of recreational water at Hataitai Beach, a small Evans Bay beach that is a popular Wellington Harbour location for swimming, canoeing, kayaking and fishing. Since 1994 the water quality at Hataitai Beach had deteriorated to the extent where the beach was closed for bathing between February 1996 and January 1997, and again in January 1998. Results of routine membrane filtration tests for indicator organisms performed on marine water samples from Hataitai Beach by the Wellington City and Regional Councils' laboratories had been unable to determine if the source of raised bacterial levels were of animal or human origin. Consequently it was not firmly established if the ducks that frequented Hataitai Beach were the main reason for the high counts or whether they contributed to a pollution problem that was thought to be exacerbated by leaking sewers and private drain faults. Following remedial work on sewer and stormwater pipes carried out by the Wellington City Council in 1998, Hataitai Beach was re-opened for swimming in December 1998 and remained open throughout the 1999-bathing season.

In this study 400 marine water samples (500 ml volumes) were collected from various sites at Hataitai Beach from July 1998 to April 2000. The Enterolert™ system (IDEXX Laboratories, USA) was used for the detection and enumeration of *Enterococci* and the Colilert-18™ system (IDEXX) for *Total coliforms* and *Escherichia coli* detection and enumeration. The results were analysed to:

- Determine water quality compliance at Hataitai Beach.
- Ascertain the impact of duck numbers on indicator organism levels.
- Identify the principal sources of faecal pollution at Hataitai Beach.

Six marine samples (130-500 litres) were also collected for the capture of *Giardia* and *Cryptosporidium* on filter cartridges for subsequent purification of (oo)cysts by the DYNAL® immunomagnetic bead separation technique (DYNAL A.S., Norway) and

the detection of (oo)cysts by the Merifluor® *Cryptosporidium/Giardia* (Meridian Diagnostics, USA) direct immunofluorescent monoclonal antibody (IFA) procedure.

In addition, 279 duck faecal samples were collected from Hataitai Beach for the detection of *Giardia* and *Cryptosporidium* by the Merifluor® *Cryptosporidium/Giardia* IFA procedure and subsequent DNA analysis of oo(cysts) by the Polymerase Chain Reaction (PCR) amplification procedure.

The results from this study indicate that despite the stormwater and sewer upgrades by the Wellington City Council there is still a pollution problem at Hataitai Beach and that this pollution is primarily caused by a combination of duck droppings and meteorological events. The microbiological water quality can be degraded directly by the resident mallard ducks defaecating in the water or indirectly from droppings deposited on the beach sands. Faecal bacteria in the droppings on the beach sands can be carried into the water by tides, rain, and wind erosion or unwittingly by the action of beach users.

On 64 occasions during this study there were exceedences of the water quality guidelines at Hataitai Beach, especially in water samples collected from the B3 site where ducks were frequently seen loafing on the beach or swimming in the water. Moreover, on 41 occasions the *Enterococci* levels in samples from the B3 site were strikingly over the *Action Red* mode guideline value of 277 *Enterococci* per 100 ml - exceedences that require local authorities and health authorities to warn the public that the beach is unsafe for recreational activities and erect warning signs. The median value of 63 *Enterococci* per 100 ml for samples collected from the B3 site was well above the *Green* - "safe for bathing" guideline value of less than 35 *Enterococci* per 100 ml.

While no *Giardia* cysts or *Cryptosporidium* oocysts were detected in the marine water samples, protozoan cysts morphologically resembling *Giardia* spp. were detected in 29% of the duck faecal samples. However, since no detectable PCR amplification products were obtained in any cysts of the Merifluor®C/G IFA positive samples tested, attempts to genotype the *Giardia* cysts proved unsuccessful. After closer inspections and measurements of these Merifluor®C/G IFA positive protozoan cysts it was

established that the organisms were in fact *Caryospora* spp. and not *Giardia* cysts. Since *Caryospora* are phylogenetically related to *Cryptosporidium*, it appears that *Caryospora* can cross-react with *Cryptosporidium* antibody preparations but have the appearance of *Giardia* cysts when viewed under fluorescence microscopy.

Because of their aquatic lifestyle and highly mobile behaviour, ducks may be exposed to a diverse array of potentially pathogenic organisms such as *Campylobacter jejuni*, *Escherichia coli* O157:H7, *Salmonella* spp., *Pasteurella multocida*, *Giardia* and *Cryptosporidium* spp., and *Cercarial* trematodes. These organisms can originate from several sources including human sewage, agricultural runoff, and animal faecal matter. The microbiological health risk of humans acquiring infections from the ducks at Hataitai Beach depends on several factors, including the presence and survival of pathogenic organisms in the droppings after their deposition on the beach sands and in the water, as well as the types of recreational activities that expose humans to these droppings. In order for the public to be adequately informed of the risk so that they can make informed personal choices about engaging in recreational activities at Hataitai Beach, it seems prudent that efforts should be made to grade this beach so that the beach's suitability for recreation can be established. This should include a catchment risk assessment that considers the potential sources and transmission routes of faecally derived pollution at Hataitai Beach with an assessment of the microbiological data.

In the meantime common sense dictates that at Hataitai Beach the authorities should limit the food sources of ducks in the areas surrounding the beach by officially prohibiting people from feeding the ducks.

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DEDICATION

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