(EXTRACT)

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New Zealand's fresh waters:
Values, state, trends and human impacts

12 April 2017

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Box i. What is meant by "Swimmability"?

A range of characteristics need to be considered when assessing a water body's suitability for swimming, including depth, temperature, current strength, visual appeal (clarity and colour), the absence of nuisance weeds or algae, and human health risks from microbial pathogens or toxic algae. Microbial pathogens in the water can enter the body by ingestion, or through the ears, nasal passages, mucous membranes or cuts in the skin, and can cause gastrointestinal illness, respiratory symptoms, or more harmful diseases like hepatitis A. Microbial contamination is a concern in in both rivers and lakes, whilst the presence of toxic cyanobacteria is primarily a concern of lakes.

Suitability for swimming – assessing microbial contamination

The test used to assess the presence of pathogens in New Zealand freshwater systems is detection of *Escherichia coli* (*E. coli*). Detecting *E. coli* signals the presence of animal or human faeces in the water, and the likelihood that other harmful water-borne pathogens such as *Campylobacter*, *Cryptosporidium*, *Giardia*, hepatitis A viruses, and Salmonellae may also be present. Faecal contamination from animals can occur via runoff from farms during rainfall events, or if animals have direct access to waterways. Human faecal contamination of waterways can occur via poorly treated sewage or septic tank systems, or during heavy rain when sewerage systems cannot cope and they overflow into stormwater systems. Because of these heightened health risks from runoff and stormwater, people are often advised to avoid swimming for 48 hours after prolonged or heavy rain.

There are two distinct components to assessing the suitability of a site for swimming – grading and surveillance. Grading assesses the general suitability of a site for swimming over the long term (and uses long term monitoring to determine that) whilst surveillance assesses the suitability of a site for swimming in the short-term (is it OK to swim today?). Surveillance also reduces the risk of selective assessments and allows for long-term trend assessment to ensure that there is progressive improvement at sites that are not optimal. Guidelines established by the Ministry for the Environment and the Ministry of Health in 2003 included both grading and surveillance, whilst the National Policy Statement for Freshwater Management (NPS-FM) 2014 considered only grading. The proposed changes to the NPS-FM included in the 2017 'Clean Water' consultation package brings both grading and surveillance together again, with proposed surveillance criteria being numerically identical to the 2003 guidelines for microbial water quality.

Under the surveillance criteria, during the swimming season authorities should warn against swimming when *E. coli* levels in rivers and lakes are detected at a concentration at or above 540 counts per 100 millilitres (ml). Such a sampling result indicates that the water, at that time, has exceeded the upper level of contamination that is considered acceptable for swimming – beyond this threshold the risk of infection from full immersion can be more than 5%. To ensure that risk remains low, the surveillance criteria also specify that if *E. coli* concentration on a given day exceeds 260 per 100 ml, daily sampling is required until the concentration falls below 260. Because storm events in particular can lead to a transient high count due to faecal runoff and/or wastewater overload, it is logical to have a rating system that considers the possibility of such extreme measures and focuses on the anticipated range of measurements when swimming is likely.

In order to ensure an overall low level of risk for swimming in a particular water body, standards have been established that require the level of *E. coli* to be well below the 540 /100ml swimmability threshold most of the time. This is one aspect of the grading criteria. Importantly, the use of a guideline that includes a low median value (which means that half of measurements made at a site must be below that level) is an effective way of putting an obligation on waterway management to reduce continual or repeatable sources of contamination to generally very low levels. The 2017 'Clean Water' package proposes that all 'swimmable' water bodies should have a median *E. coli* concentration of no more than 130 /100ml. The risk of infection at this level is extremely low (approximately 0.1%, or 1 in 1000 exposures). This means that at least 50% of the time, even in rivers that are only graded as 'fair' (yellow or C grade category in the NPS-FM), there is very low risk to swimmers.

Rivers are also graded on how often they exceed a level of 260 *E. coli* per 100 ml – a level conferring between 0.1 and 1% risk. For the proposed gradings the *E. coli* level must be lower than 260 /100ml at least 70% of the time and below the 540 /100ml threshold at least 90% of the time for a 'good' (green or B grade) rating. An 'excellent' (blue or A grade) rating requires 80% below 260 and 95% below 540 /100ml. Overall, this proposed grading would mean that the risk across all time (disregarding weather events or other risk factors which would reduce the likelihood of swimming in any case), the risk of infection from contact in rivers graded as 'swimmable' is very low. For example, the risk would be approximately 1% for an A grade river, and if one knew nothing else and could swim at any time, but in practice the risk will be much lower because the highest risk would be at times when swimming is least likely.

Box i. (continued)

Swimming in lakes – assessing toxic cyanobacteria

Councils monitor lakes, with a focus on popular recreational sites, for presence and amount of the planktonic cyanobacteria, which can produce a variety of toxins. For a lake to be considered safe for swimming, in addition to meeting the requirements for *E. coli* as for rivers, potentially toxic cyanobacteria cannot be present in quantities that could harm people's health.

Assessments of lake state and trend for toxic algae are based on total cyanobacterial biovolume. If potentially toxic cyanobacteria are present, the threshold level for contact recreation (e.g. swimming) is a cyanobacterial biovolume >1.8 mm^3/L. These guidelines are based on the assumption that all species of cyanobacteria in the lake are toxic, which might not be the case. This is precautionary and is likely to suggest a higher risk in some situations than actually exists. If no known toxin-producing species are detected on further investigation, the upper limit is 10 mm^3/L biovolume.

When cyanobacterial biovolume exceeds guideline levels, the lake is more actively monitored and warnings are put in place. If an algal bloom is suspected, swimming is not advised, and dogs should be kept on a lead – accidental consumption or exposure to the water could be harmful.

Another concern about water quality regards the safety of domestic animals, including dogs, because *Phormidium*, a potentially toxic cyanobacterium that is generally associated with low-flow conditions in streams with compromised water quality, appears to be becoming more widespread.

INTRINSIC ENVIRONMENTAL AND CONSERVATION VALUES

At a more fundamental level of ecosystem services (i.e., not just the services of direct benefit only to water users), freshwater systems perform filtration, flood control, nutrient cycling[9] and carbon sequestration[10] functions.

New Zealand freshwater systems are naturally diverse, reflecting the diversity of the landscapes they are located within. High proportions of our freshwater invertebrate, fish and bird species are not found elsewhere in the world (endemic), including many species that are classified as threatened or at risk[11] (notably 28% of native fish species).[12] This uniqueness brings with it both conservation responsibilities and the need for application of local research and knowledge to protect them. Many of these endemic species are vulnerable to changes in environmental conditions, and concerns exist about their resilience to current and future pressures.

From a conservation perspective, many of New Zealand's rivers (especially the eastern South Island's large braided rivers) are biodiversity hotspots for endemic and threatened species of birds (e.g., black-billed gull, black stilt and wrybill – the only bird in the world with a beak curved to the side) and for many species of plants and terrestrial invertebrates (e.g., the robust grasshopper). They also play an important role as hosts for migratory birds globally. Some of these rivers and many others around the country are important native fisheries habitats,

[9] Nutrient cycling is the movement and exchange of nutrients (elements) from organic and inorganic matter back into the production of living matter.

[10] Carbon sequestration is a natural process by which carbon dioxide is removed from the atmosphere and held in solid or liquid form. For example, freshwater wetlands act as 'carbon sinks' because their plants absorb carbon dioxide from the atmosphere through photosynthesis, and standing water reduces respiration of that carbon dioxide back to the atmosphere.

[11] The conservation status of native species is assessed by the Department of Conservation according to the risk of extinction they face within New Zealand. http://www.doc.govt.nz/nature/conservation-status/

[12] Conservation status of New Zealand freshwater fish. Allibone, R., et al. (2010). *New Zealand Journal of Marine and Freshwater Research*, 44, 271-287.