

**Monitoring Bathing Waters - A Practical Guide to the Design and Implementation of Assessments and Monitoring Programmes**

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## **Chapter 11\*: OTHER BIOLOGICAL, PHYSICAL AND CHEMICAL HAZARDS**

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In addition to those described in Chapters 3, 7, 8 and 10 there are a number of other diverse biological, physical and chemical hazards that could be encountered in the recreational water environment. Many of these are local in nature and should be addressed in monitoring programmes where they are known or suspected to be locally important. The characteristics of the hazard and the local conditions define the appropriate remedial measures. It is important that standards, monitoring and implementation enable preventative and remedial actions in this time frame that will prevent health effects arising from such hazards. The WHO *Guidelines for Safe Recreational-water Environments* (WHO, 1998) emphasise the importance of identification of circumstances that will support a continuously safe environment for recreation. This includes awareness of biological hazards such as those discussed in this chapter.

The following sections provide a summary of the assessment and control of some biological, physical and chemical hazards encountered in recreational waters. The on-site visit form should be adapted to take account of locally-occurring hazards and any special features of a particular recreational-use area. Inspections should be carried out annually.

During an environmental health assessment, biological risks such as the presence of disease-causing, poisonous or venomous animals or plants, and physical hazards such as extreme water temperatures, should be noted. Effective ways of informing the public and, where possible, protecting them from such hazards should be recommended.

### **11.1 Biological hazards**

#### **11.1.1 Health hazards**

Injuries from dangerous aquatic organisms may be sustained in a number of ways, for example accidental encounters with venomous sessile or floating organisms when bathing or treading on stingrays, weeverfish or sea urchins.

**Table 11.1** Relative risk to humans posed by selected groups of organisms

| <b>Attacks and poisonings by dangerous organisms</b> | <b>Mild discomfort</b> | <b>Requires further medical attention</b> | <b>Requires emergency medical attention</b> |
|--|------------------------|---|---|
| <i>Non-venomous organisms</i>                        |                        |   |   |
| Sharks   |                        | ✓   | ✓   |
| Barracudas   |                        | ✓   |   |
| Needlefish   |                        | ✓   | ✓   |
| Groupers   |                        | ✓   |   |
| Piranhas   |                        | ✓   |   |
| Conger eels  |                        | ✓   |   |
| Moray eels   |                        | ✓   |   |
| Electric fish  |                        | ✓   |   |
| Giant clams  |                        | ✓   |   |
| Seals & sea lions                                    |                        | ✓   |   |
| Hippopotami  |                        | ✓   | ✓   |
| Crocodiles   |                        | ✓   | ✓   |
| <i>Venomous invertebrates</i>                        |                        |   |   |
| Sponges  | ✓                      | ✓   |   |
| Hydroids   | ✓                      | ✓   |   |
| Portuguese man of war                                | ✓                      | ✓   | ✓   |
| Jellyfish  | ✓                      | ✓   |   |
| Box-jellyfish  |                        | ✓   | ✓   |
| Hard corals  | ✓                      | ✓   |   |
| Sea anemones   | ✓                      | ✓   |   |
| Blue-ringed octopus                                  |                        |   | ✓   |
| Cone shells  |                        | ✓   | ✓   |
| Bristle-worms  | ✓                      | ✓   |   |
| Crown of thorns                                      | ✓                      | ✓   |   |
| Sea urchins (most)                                   | ✓                      |   |   |
| Flower sea urchin                                    |                        | ✓   | ✓   |
| <i>Venomous vertebrates</i>                          |                        |   |   |
| Stingrays  |                        | ✓   | ✓   |
| Catfish  | ✓                      | ✓   |   |

|             |   |   |   |
|-------------|---|---|---|
| Weeverfish  | ✓ | ✓ |   |
| Stonefish   |   | ✓ | ✓ |
| Surgeonfish | ✓ | ✓ |   |
| Snakes      |   | ✓ | ✓ |

Source: WHO (1998)

Unnecessary handling, or provocation of venomous organisms during seashore exploration, or invading the territory of animals when swimming may also lead to injury. Table 11.1 lists the relative risk to humans posed by venomous and non-venomous organisms which may be encountered in recreational bathing areas.

### 11.1.2 Monitoring and assessment

Routine monitoring for biological hazards is justified only where they exist. Monitoring should respond to local conditions; for example where there is a known hazard, such as jellyfish, it is important to identify the source and the nature of the hazard (Raupp *et al.*, 1996).

### 11.1.3 Remedial measures

Many serious incidents can be avoided through an increase in public education and awareness. Surveillance systems should be in place to provide warnings to the public in areas where it is known that sharks, jellyfish and other hazardous organisms are common (see examples given in Box 11.1) (Fenner, 1998). It is important to identify and to assess the risks from various aquatic organisms in a given region. Where the health outcomes are known to be mild, remedial measures should be based primarily upon raising public awareness and providing information to the public. This may be done in a number of ways (see Chapter 6) and may require only simple messages, such as advice to wear suitable footwear whilst exploring the intertidal area or to avoid handling marine or freshwater organisms. Where the health outcomes are known to be more severe it may be necessary to declare exclusion zones in bathing areas or to restrict bathing where or when appropriate.

## 11.2 Microbiological hazards

### 11.2.1 Leptospirosis

Leptospirosis (Weil's disease or haemorrhagic jaundice) is usually characterised by the sudden onset of fever and chills, severe headache, muscular pain, abdominal pain, nausea and conjunctivitis. The causative bacterium is of the genus *Leptospira*. Other symptoms may include aseptic meningitis, conjunctival haemorrhage, rash, jaundice and cough with bloodstained sputum. The organism enters the body either through abraded skin or by contact with mucous membranes. The incubation period is 10-12 days (range 3-30 days) and symptoms persist for approximately one week. Prolonged mental health symptoms may occur after leptospirosis but the relationship is not well documented.

### *Monitoring and assessment*

Water becomes contaminated with leptospires from the urine of infected domestic animals and rodents. Therefore, the common faecal indicator organisms cannot be relied upon as indicators of the presence of the *Leptospira*. The detection of pathogenic leptospires in water is difficult. They are relatively slow growing during enrichment and do not compete well against other more rapid growing organisms. Culture reactions and serology are required to distinguish pathogenic and saprophytic strains. Routine monitoring is not recommended but recreational waters should be examined for leptospires when they are suspected to be the source of an outbreak of leptospirosis. For example, a recent outbreak of leptospirosis following a triathlon race in Springfield, USA, clearly illustrated the need for monitoring, particularly where large numbers of people are at risk.

#### **Box 11.1 Remedial measures to deal with jellyfish in bathing areas in Barcelona, Spain**

Jellyfish are commonly found in coastal environments, although their normal environment is approximately 50 miles away from the coastlines in oceanic waters. The factors that govern their presence at the coastline are still unclear. Although dry weather conditions (dry years) are considered to contribute to jellyfish along the coastline, their presence should be considered a natural phenomenon not linked to pollution. Their presence usually indicates a flow of oceanic waters towards the coastline.

In order to alert bathers to the hazards posed by jellyfish an information leaflet has been produced for the public, including illustrations of the most common species, and a code of behaviour with recommendations in the event of encountering jellyfish. It also includes telephone numbers that sailors or fishermen can call if a large number of jellyfish are seen moving in the direction of the coast, so that preventative measures can be undertaken. The Jellyfish Expertise Centre, Institute of Marine Sciences, Barcelona has developed an Internet web page with practical information and recommendations. Jellyfish can be prevented from reaching the beach by removing them from the water using Pelican boats that are used to eliminate undesirable floating pollution on the water. More than 400 jellyfish have been removed in a single day by such means. Preventative measures that have been applied in other regions include the installation of nets and bubble screens. Unfortunately, jellyfish tend to clog nets and to break into pieces that continue to sting. If a jellyfish is detected at the beach, megaphones or loudspeakers alert bathers, safety warning flags can be changed to red to ensure that people stay out of the water. Additionally, the Red Cross and lifeguards can be prepared to deal with bather queries as well as to provide First Aid to those who have been stung. More than 40 stings have been attended in a single day when warnings have been ignored. Several municipalities within Barcelona now have small boats with shallow draughts that can remove jellyfish from bathing areas nearer to the beach.

A jellyfish stranded on the beach should not be handled because it can still sting - its venom-filled pouch remains active. Therefore, it is also important to remove any jellyfish on the beach, although it is necessary to be aware that small broken pieces may still be active while remaining moist. Lightweight protective clothing, such as a lycra suit, or a layer of petroleum jelly spread on unprotected skin, have been shown to protect swimmers against stings. Severe allergic reactions are uncommon unless a person has a history of allergy (atopy or asthma) or has been stung previously or has heart disease. However, cases of toxicity and allergic contact dermatitis and leukocytoclastic vasculitis have been reported following a jellyfish sting.

Source: Maria Figueras, Unitat de Biologia i Microbiologia, Facultat de Medicina i Sciences de la Salut, Sant Llorenç 21 43201 Reus.

### *Remedial measures, interpretation and reporting*

The risk of leptospirosis can be reduced by preventing direct animal access to swimming areas, by treating farm animal wastes prior to discharge and by informing users about the risks of swimming in water that is accessible to domestic and wild animals. Outbreaks of the disease are not common and the risk of leptospirosis associated with swimming areas is low. Outbreaks associated with salt water have never been reported. As a precautionary measure, domestic and wild animals should not have access to swimming areas.

#### **11.2.2 Schistosomes**

Among human parasitic diseases, schistosomiasis (sometimes called bilharziasis) ranks second behind malaria in terms of socio-economic impact and health consequences in tropical and subtropical areas. The disease is endemic in 74 developing countries and world-wide some 200 million people are infected.

The major forms of schistosomiasis are caused by five species of water-borne flatworms, or blood flukes, called schistosomes. Humans become infected after contact with water containing the infective stage of the parasite. Intestinal schistosomiasis caused by *Schistosoma mansoni* occurs in the Eastern Mediterranean, Sub Saharan Africa, the Caribbean and South America. Oriental or Asiatic intestinal schistosomiasis, caused by the *S. japonicum* (including *S. mekongi* in the Mekong River basin) group of parasites, is endemic in South East Asia and in the Western Pacific region. Another species of *S. intercalatum* has been reported from 10 African countries. Urinary schistosomiasis, caused by *S. haematobium*, is endemic in Africa and the Eastern Mediterranean. Each of the five species may give rise to acute or chronic disease with widely differing symptoms and clinical signs.

#### *Monitoring and assessment*

A computerised global database for schistosomiasis has been established by WHO. The database includes information on epidemiology, control activities, people responsible for control, and water resources for each endemic country.

Schistosomiasis and water are inextricably linked and the high prevalence of schistosomiasis in many parts of the world is closely related to human contact with natural water bodies. Some water contact is occupational and to some extent necessary, but most transmission of schistosomiasis occurs during water contact for domestic and recreational purposes. In endemic areas used by local populations or tourists, monitoring programmes should be implemented. Health education, information and communication are therefore important in a strategy to control morbidity. The objectives of health education are to help people understand that their own behaviour, principally water use practices and indiscriminate urination and defecation, as well as failure to use available screening services or to comply with medical treatment, is a key factor in transmission.

In the short term, where the prevalence of schistosomiasis is high, population-based chemotherapy can reduce the prevalence, severity and morbidity of the disease. Long-term operational and budgetary planning should be made for diagnostic facilities and re-treatment schedules, as well as treatment throughout the health care system and for

transmission control. In areas where tourism is important to the economy, molluscicides (chemicals that kill the aquatic intermediate host snails) may be applied at specific locations. However, molluscicides are expensive and have impacts on other aquatic life.

## 11.3 Sun, heat and cold

### 11.3.1 Health risks

Prolonged recreational use of water can lead to exposure to extreme cold or excessive solar radiation. Staying on the adjacent land area can also lead to enhanced exposure to ultraviolet (UV) radiation, because of the reflection of the sun's rays from the surface of the water. Children are often more at risk because they tend not to use sunglasses and because they spend long periods of time going in and out of the water without a protective sunscreen. Skin cancers and cataracts are important health concerns - the United Nations Environment Programme (UNEP) has estimated that over  $2 \times 10^6$  non-melanoma skin cancers and 200,000 malignant melanomas occur globally each year. It has been reported by WHO that over half of the world's blind population lose their eyesight because of cataract (WHO, 1993b). It is believed that in about 20 per cent of cataract sufferers disease is triggered by short wave ultraviolet light. Direct exposure to UV radiation has both harmful and beneficial effects on humans.

A number of epidemiological studies have implicated solar radiation as a cause of skin cancer in fair-skinned humans (IARC, 1992) and severe sunburn in children has been shown as a risk factor for malignant melanoma (Katsambas and Nicolaidou, 1996; Weinstock, 1996).

Severe heat stress is also a potential risk for anyone exposed to high temperatures. The most common clinical syndromes are heat cramps, heat exhaustion and heat stroke. Recreational water users commonly expose themselves to prolonged periods of high temperatures, which is often exacerbated if they are undergoing physical exercise.

Exposure to extreme low temperatures, such as often experienced by swimmers in the open sea can also present health risks. When the body temperature falls there is a sense of confusion, a reduction in swimming capability (coupled with an overestimation of swimming capability), a possible loss of consciousness, and death by hypothermic cardiac arrest or drowning.

### 11.3.2 Remedial measures

Health education campaigns play an important part in the prevention of health effects due to sun, heat and cold exposure. In the UK, for example, 89 per cent of health authorities were found by Sabri and Harvey (1996) to be implementing primary prevention programmes in an attempt to meet the Government's "Health of the Nation" target of stabilising incidence of skin cancer by the year 2005. However, relatively few of these prevention programmes have been evaluated (Melia *et al.*, 1994). Data from Australia have shown that the "Slip! Slop! Slap!" campaign that was initiated in 1980, and its follow-up campaign "Sunsmart" in 1988, were effective in increasing awareness and self-reported sun-protection behaviour (Harvey, 1995). Evaluation of other health education campaigns in various countries have reported improved public knowledge about the dangers of exposure to sunshine but no significant change in sun-protection

behaviour (Cameron and McGuire, 1990). Where a corresponding change in behaviour was reported, it was due to the use of sunscreens (Hughes *et al.*, 1993). To avoid the adverse effects of exposure to UV radiation, the correct use of sunscreens and protective clothing should be advocated, taking into consideration the UV index. Currently, however, there is no direct experimental evidence that sunscreens are effective in reducing skin cancer incidence (Sabri and Harvey, 1996). Melia *et al.* (1994) concluded that the benefits of education about sun protection are as yet unproven but, if organised effectively, education is likely in the long term to reduce the risk of most skin cancers and photo-aging. They noted that local initiatives require a multidisciplinary approach to ensure co-operation between general practitioners, dermatologists, pathologists and health promotion officers. Such initiatives should be supported by a national programme promoting sun protection and awareness together with national monitoring of changes in knowledge and behaviour.

Integrated coastal management (ICM) plans may help with remedial measures by displaying information in prominent places at the recreational bathing area, developing campaigns and high profile media events. At the local level, ICM has a large role to play in information dissemination.

## **11.4 Physical and chemical hazards**

### **11.4.1 Health hazards**

Local factors, such as agricultural or, industrial activity, can have a strong influence on the aspects of physical and chemical water quality. Therefore, before standards can be set, it is essential to understand the general characteristics of the water body of interest, together with the effect of local environmental conditions, the processes affecting the concentrations of the physical and chemical variables, and the factors that may modify the toxicity of these variables. It may, therefore, be more appropriate to identify water quality standards on a local basis rather than to adopt national standards for physicochemical aspects of recreational water quality. In determining the likely hazards of physicochemical variables, it is important to evaluate the degree of exposure that recreational users will encounter (the use of wet suits for example, will prolong immersion in cold climates).

### **11.4.2 Monitoring and assessment**

During an inspection for chemical hazards, attention should be paid to the presence of industrial effluent disposal facilities, such as outfalls, sewers and rivers, tributaries, streams or ditches. Adjacent activities and facilities, such as intensive agriculture, electricity generating stations, dredging operations, naval bases, shipyards and terminals, should also be identified and their impact should be assessed. The assessment should also consider the impact of physical characteristics of the local beach and of the meteorological conditions on the dispersion and dilution of contaminants in the recreational-use area. During an inspection it may be necessary to collect representative water samples to confirm the presence of specific chemical contaminants, to establish their magnitude and variability, to identify the source(s) and to evaluate human exposures and health affects. Chemical analyses should only be undertaken where standard, replicable and reliable methods are available. In some cases, simple physical tests, such as pH, turbidity or colour, can be measured on-site

and used as surrogates for general chemical contamination. Routine monitoring for specific chemicals should only be considered when the inspection indicates a significant hazard to human health.

In assessing local problems, initial screening for risks associated with ingestion may be undertaken by applying the WHO *Guidelines for Drinking-Water Quality* (WHO, 1993a, 1998), with an appropriate correction factor. Although the Guidelines for Drinking-Water Quality are not, generally, based upon short-term exposures, for the purpose of assessing the risk associated with occasional use of recreational waters, public health authorities can use a reference value of 100 times the value Guideline (for other than acute adverse effects) for an initial screening assessment of recreational water pollution with chemicals with known health effects arising from long-term exposure. It should be emphasised that the exceedence of such a reference value does not necessarily imply a risk, but indicate that public health authorities should evaluate the situation.

If, on consideration, it seems probable that contamination is occurring and recreational users are exposed to significant quantities, chemical analysis will be required to support a quantitative risk assessment. Care should be taken in designing the sampling programme to account, for example, for temporal variations and the effects of water currents. If resources are limited and the situation is complex, samples should be taken first at the point considered to give rise to the worst conditions. Only if this gives cause for concern should there be a need for more extensive sampling.

It is important when evaluating physicochemical hazards that the risks are not overestimated, in relation to risks from other hazards, such as drowning or microbiological contamination, which will be almost invariably much greater.

In areas that are used or proposed for bathing, it is suggested that physico-chemical variables such as pH, salinity, aesthetics, clarity, turbidity, colour, oil and grease, inorganic and organic chemicals are considered. Analytical methods and the minimum sample volumes to be taken for these variables are fully detailed in Bartram and Ballance (1996).

## 11.5 Elements of good practice

- Monitoring for other locally important hazards is justified only when it is suspected that hazards to human health may be significant. Such occurrences may be highly localised.
- Analyses should only be undertaken where standard, replicable and reliable methods are available for known variables.
- Approaches to the assessment of the significance of locally important hazards depend on the type of hazard and should take account of the magnitude and frequency of the hazards, severity and occurrence of health effects and other local factors.

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