The weed Mimosa pigra grows in vast impenetrable stands across northern Australian wetlands (photo CM Finlayson)

How are the results used?

Results of acute toxicity tests are used to calculate the concentration of toxicant that will result in a percentage of individuals being affected. The statistical software package Toxcalc® is used to perform analyses and generate reports. For example, the median lethal concentration (LC_{50}) or the median effect concentration (EC_{50}) represent the most widely used index of population tolerance. Such estimates are often used to compare the toxicity of different chemicals. Results of chronic toxicity tests are used to determine a no-observed-effect concentration (NOEC) and lowest-observed-effect concentration (LOEC). Such estimates are often used for calculating 'safe' levels of toxicants in aquatic ecosystems.

Aerial photo of Energy Resources Australia (ERA) Ranger Mine, July 1999 (photo R van Dam)

Protection of tropical wetlands

Tropical wetlands are under increasing threat. ***eriss*** ecotoxicological research has provided valuable information on tropical species to the revision of water quality guidelines for environmental protection, and is also carrying out wider tropical risk assessment research.

More specific applications of the expanded suite of toxicity tests include the impacts of weed herbicides Kemmat (used to control the floating weed *Salvinia molesta*) and Tebuthiuron (applied as a ground pellet to control the invasive wetland weed *Mimosa pigra*) on non-target aquatic organisms. Aluminium, cadmium, copper and other heavy metals are common in the waste waters from mines located in the wet-dry tropics.

eriss ecotoxicology lab has also helped with testing for other potential environmental pollution including sunscreens and insect repellants in plunge pools used by vistors in Kakadu National Park, and a recent study to determine if petroleum hydrocarbons from outboard motors are a threat to a highly valued wetland open to tour boats and recreational fishing boats.

The Environmental Research Institute of the Supervising Scientist's ecotoxicology program plays a major role in assessing potential impacts of toxicants in the wet-dry tropics of Australia and through the newly established National Centre for Tropical Wetland Research (NCTWR) is now developing links into South-east Asian wetland issues.

eriss *carries out scientific research for the protection of people and the environment in places that are highly valued by the Australian community.*

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eriss notes

ECOTOXICOLOGY

AQUATIC ECOTOXICOLOGY IN THE AUSTRALIAN WET-DRY TROPICS

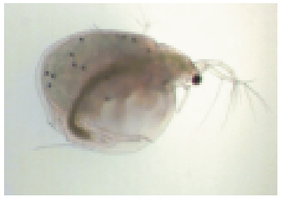
Ecotoxicology seeks to understand how toxic chemicals (toxicants) affect the structure and function of natural ecological systems (populations, communities and ecosystems). The ***eriss*** ecotoxicology program (within Wetland Ecology and Conservation at ***eriss***) investigates the risks and impacts of pollutants (toxicants) to the highly valued wetland ecosystems of northern Australia. Included in these ecosystems are the World Heritage and Ramsar listed wetlands of Kakadu National Park (KNP).

The ***eriss*** ecotoxicology program was established in the late 1980s to assess the toxicity of, and determine 'safe' dilution levels of waste water from the Ranger uranium mine in Kakadu National Park. However, the wetlands of Australia's wet-dry tropics are under threat from a variety of chemical contaminants, including heavy metals from a range of mining activities and pesticides from agriculture. Thus, in recent years the program has expanded and diversified, and now uses its expertise to assess the potential environmental impacts of a range of regionally relevant chemical stressors.

Whole organism toxicity bioassays have been developed at the ecotoxicology laboratory to determine the acute and chronic toxicity of chemicals, environmental samples or complex effluents, to tropical freshwater organisms.

This ***eriss*** note describes the philosophy and approach of aquatic ecotoxicology at ***eriss***.

Magela floodplain in Kakadu National Park is classified as part of a World Heritage Area, and is a highly valued and protected ecosystem (photos C Camilleri)



Water flea (Moinodaphnia macleayi) (photo C Camilleri)

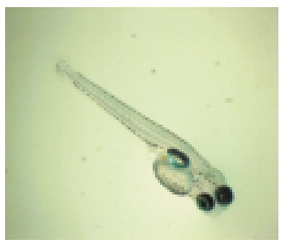
Green hydra (Hydra viridissima) (photo C Camilleri)

Adult purple-spotted gudgeon (Mogurnda mogurnda) (photo C Camilleri)

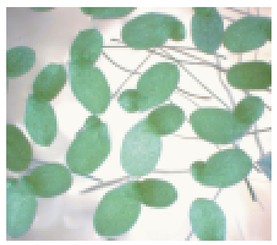
Table 1 Detailed summary of toxicity tests developed at or in consultancy with *eriss* ecotoxicology laboratory

Organism	*In situ*/Laboratory	Test duration	Endpoint	Substances tested	Wetland habitats represented
Plants					
Marine alga (diatom)* (*Nitzschia closterium*)	Laboratory	72 h	population growth	Cu	estuaries, coastal mangrove swamps**
Green alga (*Chlorella* sp.)	Laboratory	72 h	population growth	Cu, Tebuthiuron	lowland streams, floodplains
Duckweed (*Lemna aequinoctialis*)	Laboratory	4–7 days	plant growth	Tebuthiuron, Kemmat	permanent billabongs, floodplains
Animals					
Green hydra (*Hydra viridissima*)	Laboratory	96 h	population growth	U, Cu, Mg, Na, whole effluent mine waste water	permanent billabongs, floodplains
Cladoceran (*Moinodaphnia macleayi*)	Laboratory	3 brood (~ 6 days)	reproduction	U, Cu, Cyanide, Mn, NO_3, Cd, whole effluent mine waste water	permanent billabongs
		24 h	feeding inhibition		
		3 brood (~ 6 days)	survival		
Chironomid* (*Chironomus crassiforceps*)	Laboratory	5 days	larval growth	U, Cu	permanent billabongs, floodplains**
Purple-spotted gudgeon (*Mogurnda mogurnda*)	Laboratory	96 h	larval survival	U, Cu, whole effluent mine waste water, Al	escarpment streams – floodplains
Freshwater gastropod (*Amerianna cumingii*)	*In situ*	96 h	reproduction, juvenile survival	Whole effluent mine waste water	permanent billabongs, floodplains
Black-banded rainbowfish (*Melanotaenia nigrans*)	*In situ*/Laboratory	96 h	larval survival	U, Cu, whole effluent mine waste water	escarpment streams – floodplains

* not used routinely at *eriss* ** presence in floodplains is unconfirmed, but likely



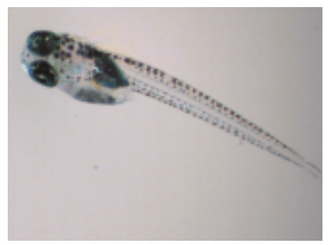
Purple-spotted gudgeon – Sac-fry (<24-h old) (photo C Camilleri)



Duckweed (Lemna aequinoctialis) (photo C Camilleri)

Green alga (Chlorella sp.) (photo C Camilleri)

Adult black-banded rainbowfish (Melanotaenia nigrans) (photo G Schmida)



Rainbowfish fry (photo C Camilleri)

Toxicity tests

The toxicity tests developed at ***eriss*** use aquatic species from the tropical freshwater ecosystems of Kakadu National Park. Test species were identified from local creeks and billabongs following a broad survey in the late 1980s. This was necessary due to strict quarantine restrictions on the importation of exotic species from outside the park. Hence the species are not only indicative of those in receiving waters of potential or actual toxicants, but are representative of many other aquatic ecosystems of the wet-dry tropics, including Australia and South-east Asia.

Criteria for selection of toxicity test organisms are based on:

- Relevance to the ecosystem of interest
- Sensitivity to the toxicant being assessed
- Ability to culture the species in the laboratory
- Representation of different levels of the aquatic food chain

Three out of 20 candidate species were eventually selected – *Moinodaphnia macleayi* (water flea), *Hydra viridissima* (green hydra) and *Mogurnda mogurnda* (purple-spotted gudgeon) – to determine the toxicity of waste water from a uranium mine. The responses measured in each of these tests are reproduction, population growth and sac-fry survival, respectively. The tests take 4–5 days to complete and are carried out in a laboratory (see table 1).

Test species used in the wet-dry tropics

Aquatic animals used for toxicity testing include fish, shrimps, snails, mussels, water fleas, midges and hydra. Plants like duckweed and algae are also used. Cultures of cladocerans, hydra, fish, algae and duckweed are routinely kept and maintained in the ***eriss*** ecotoxicology laboratory.

Test methods

All tests are carried out in the laboratory under strict quality control criteria. Observations of test organisms are recorded at 24 h intervals. Three replicates are used in all tests. The test dishes are kept in a constant temperature incubator at 27 ± 1˚C, with a photoperiod of 12 h light : 12 h dark. Tests solutions are renewed every 24 h, following recording of test information. Validity criteria for tests are specific (eg 80% survival of sac fry in controls, pre-determined growth rate K for hydra population growth). Conductivity, pH and dissolved oxygen (DO) are measured on fresh (t_0) and 24-h-old (t_{24}) test water daily until test completion. Tests are carried out by highly trained staff, guaranteeing exceptional quality of test results and interpretation.