



Australian Government  
Department of the Environment and Heritage  
Supervising Scientist

*internal  
report*



Review of *eriss*  
achievements and  
outputs as listed in the  
Supervising Scientist  
Division Strategic Plan  
2003–04



Environmental Research InstituteE  
of the Supervising ScientistE

October 2004E



# **Review of *eriss* achievements and outputs as listed in the Supervising Scientist Division Strategic Plan 2003–04**

Environmental Research Institute of the Supervising Scientist  
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**Department of the Environment and Heritage  
Supervising Scientist**



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# **Review of *eriss* achievements and outputs as listed in the Supervising Scientist Division Strategic Plan 2003–04**

## **Introduction**

This report presents a review of achievements and outputs from the Environmental Research Institute of the Supervising Scientist (*eriss*) workplan 2003–04 (refer Internal Report 460, October 2003). The information is presented in line with the priority activities listed in the Supervising Scientist Division Strategic Plan 2003–04 with additional information added as required. The Strategic Plan 2003–04 did not cover projects undertaken through the receipt of external funds.

A consolidated list of publications, presentations and other science-related activities (eg, reviewing papers and theses, participation in expert committees or panels, and networking) will be produced separately with components being reported in the Supervising Scientist Annual Report 2003–04.

## **Workplan Thematic Structure**

The research undertaken by the Environmental Research Institute of the Supervising Scientist (*eriss*) has in the past been divided into four programs. This structure enabled administrative tasks to be undertaken alongside research projects. The research program was more integrated than shown by the administrative structure and addressed both short-term immediate goals and longer-term strategic outcomes that cut across administrative lines. A thematic format was adopted in 2003–04 in response to the Alligator Rivers Region Technical Committee (ARRTC) articulation of a number of Key Knowledge Needs.

The workplan for 2003–04 comprised seven themes derived after internal discussion of the ARRTC articulated Key Knowledge Needs. These themes enabled us to better represent the multi-disciplinary approach behind our research, assessment and monitoring activities. Each theme is presented with a short description of the aim and an annotated list of the major activities undertaken in 2003–04.

## **Theme 1 – Rehabilitation**

The aim for this theme was to provide advice on the implementation of mine rehabilitation strategies and assessment of rehabilitation sustainability. An important issue to be addressed in 2003–04 was the establishment of a process to bring together and gain consensus between stakeholders on agreed rehabilitation completion criteria.

### **The priority activities in 2003–04 were to:**

- *Undertake and publish a comprehensive review of rehabilitation issues, with particular reference to Ranger Uranium Mine, with respect to mine closure criteria; indicators to monitor success and baseline data requirements to assess rehabilitation performance;*

This activity was replaced by the comprehensive review of mine-related research in the Alligator Rivers Region that was submitted to ARRTC and will be published as a

Supervising Scientist Report. Information contained within the review was used in the revision of the Key Knowledge Needs that highlight the research required under this theme.

Discussion on mine closure criteria was commenced through ARRTC but has not been completed. A discussion paper on water quality closure criteria for Georgetown Billabong was reviewed. The Office of the Supervising Scientist was assigned the role to coordinate further discussions on behalf of the Supervising Scientist.

- *Develop a technological framework to assess the impact of mine site erosion products on stream systems.*

Assessment of the impact of the Jabiluka mine on Ngarradj was undertaken using simulations of soil loss and runoff. An event-based mud transport model was derived for the Ngarradj catchment for future impact assessment and a consultancy was established to undertake sensitivity and power analyses of proposed monitoring strategies for suspended mud. The use of turbidimeters to continuously monitor stream mud movement was also investigated. This research was published in 1 paper (Hydrological Processes) with 3 being submitted to journals (Journal of Hydrologic Engineering, Water Resources Research and Australian Journal of Water Resources).

#### **Other activities included:**

- *Complete baseline stream channel stability characteristics for Ngarradj and Gulungul Creeks and publish the results.*

Annual wet and dry season work towards baseline determination was continued in Ngarradj Creek and several temporary gauging stations were instrumented/installed in Gulungul Creek. A journal paper was submitted and accepted for publication (Geografiska Annaler) and a Supervising Scientist Report produced and another drafted. A presentation was made at the ANZGG conference, Mt Buffalo, February 2004.

- *Apply and assess landform modelling using GIS technology for the Ngarradj catchment*

The Siberia landform modelling software was successfully integrated with GIS technology and applied to the Ngarradj catchment. A PhD thesis was submitted and accepted, and two papers published (Australian Journal of Water Resources and Australian Geographical Studies).

- *Apply and assess landform modelling and GIS technology for the rehabilitated Nabarlek minesite with a view to future application for the Ranger minesite.*

The landform evolution of the rehabilitated Nabarlek landform was modelled and the method prepared for publication and presented as an option for assessing other rehabilitated landscapes, such as the Ranger mine.

- *Assess rehabilitation success at Nabarlek and Rum Jungle minesites using high resolution remotely sensed CASI data.*

Compact Airborne Spectrographic Imager (CASI) data were acquired to develop cost-effective and accurate remote sensing methods to monitor and assess minesite rehabilitation. Ground-based reflectance data were also acquired to spectrally characterise a number of land cover features, including selected vegetation spectra (Nabarlek) and indicators of acid mine drainage processes (Rum Jungle). A presentation was made to the Spatial Sciences Conference, September 2003, and another to the Nabarlek Minesite Technical Committee, May 2003

- *Develop revegetation monitoring techniques at Nabarlek minesite using remote sensing and ground-based surveys to assess revegetation success.*

Vegetation surveys were conducted at the Nabarlek mine-site and Quickbird satellite data acquired in September 2003 and May 2004. These data will be used to assess the condition of the vegetation, for example, the presence of weeds and preferred species of trees etc, on the rehabilitated structure, and to develop cost effective and accurate methods to further assess the success of revegetation. A presentation was made to the Nabarlek Minesite Technical Committee, May 2003

## **Theme 2 – Landscape analysis**

The aim for this theme was to establish a landscape scale analysis and monitoring program to differentiate mining related impacts from other causes; and contribute within the broader context to the monitoring of the natural World Heritage values of Kakadu National Park.

The theme comprised two discrete components: (1) the development of a conceptual transport pathways model for on-site management within a risk framework; and (2) assessment of World Heritage values in the Alligator Rivers Region (for example, waterbirds & wetlands, coastal environments, key habitats & species).

### **The priority activities in 2003–04 were to:**

- *Develop a conceptual pollutant/propagule transport pathways model for Ranger Uranium Mine and associated predictive sub-models, within a risk management framework that accounts for uncertainty in data and knowledge.*

A draft conceptual model developed in 2002-03 was progressed to a more detailed form. This was presented as a Discussion Paper to ARRTC, March 2003. A presentation on the development of the conceptual model and its benefits for assessing and quantifying risks was given at a workshop on Contaminants and Ecological Risk Assessment, Adelaide, April 2004.

- *Undertake a review of landscape analyses being conducted in the Alligator Rivers Region.*

An overview of wetland landscape issues in the Region was presented to the International Association of Landscape Ecology Conference, Darwin, July 2003.

- *Catalogue, map, assess and monitor significant habitats and native species in the Alligator Rivers Region.*

With assistance from traditional owners, field sampling continued in stone country streams of Kakadu National Park to catalogue and map endemic species, particularly amongst the aquatic macrocrustaceans (isopods, crabs and shrimps). Processing of samples and data compilation continued and a preliminary report on the molecular genetics of selected isopod populations was prepared for the Supervising Scientist's Annual Report for 2003–04. A proposal was successfully submitted for funds to undertake a taxonomic study of isopods in the Alligator Rivers Region in conjunction with the Australian Museum.

- *Assess multiple ecological risks on Boggy Plain, a non-mining reference site on the South Alligator River.*

Cost-effective remote sensing methods were developed to monitor changes in the condition of wetland vegetation in the Region. This was undertaken in partnership with traditional owners and park staff and enabled the benefits (enhanced natural & cultural values) of traditional burning practices on Boggy Plain to be ascertained. A presentation was made to the International Wildlife Management Congress, New Zealand, November 2003.

- *Assess mangrove response to environmental change in the Alligator Rivers Region and surrounding regions (particularly climate change).*

Baseline data on mangrove community structure, composition and distribution in the Park were obtained using advanced remote sensing methodologies. This resulted in the development of a baseline for further coastal change in the region and a cost-effective remote sensing method that can be applied to mangroves elsewhere.

The importance of early warning systems for climate change and interactions with other pressures on wetlands were included in presentations made at the International Association of Landscape Ecology Conference, Darwin, July 2003, and the Global Waterbird Conference, Edinburgh, Scotland, April 2004.

- *Assess landscape-wide ecological risks of threats to wetlands in the Alligator Rivers Region, particularly invasive species and infrastructure impacts.*

An ecological risk assessment of three major wetland weeds on the Magela floodplain was completed and included decision support tools for park managers to assist in developing effective environmental protection through more cost-effective weed risk management.

A framework for managing feral pest impacts on the Park was developed in partnership with other researchers, park managers and traditional land owners, and provided a base for more effective environmental protection of natural and cultural resources through more cost-effective pest risk management. This was based on a spatial population model for feral pigs and a map of the current distribution and extent of pig damage.

The presence and significance of endocrine disrupting compounds (EDCs) in recreational water holes in the Park and from stormwater and treated sewage from the Jabiru township was assessed and a report produced.

Information on infrastructure (highways, sealed roads and tracks, localities, locations of airfields) within the ARR is being compiled at available scales and will be combined to assess the extent of infrastructure change associated with mining and other activities.

A report on the geomorphic landscapes of the Kakadu region is being finalised, a poster of the biophysical mapping activities on the Magela floodplain has been accepted for presentation at the Intecol Wetlands Conference in July 2004, and a Supervising Scientist Note describing changes in *Melaleuca* community distribution has been completed. A Supervising Scientist Report reviewing the suitability of spatial datasets for wetland inventory within the Park and across northern Australia has been completed.

Two manuscripts documenting previous research on the toxicity and ecological risks of the herbicide tebuthiuron were submitted and accepted for publication to international journals (*Australasian Journal of Ecotoxicology* and *International Journal of Human and Ecological Risk Assessment*). The risk assessment paper represents one of the few examples in Australia of a fully quantitative ecological risk assessment for an aquatic contaminant.

- *Assess the status of World Heritage waterbird values in the Alligator Rivers Region within regional, national and international frameworks.*

A survey of the distribution and abundance of key waterbird species in Kakadu was completed to provide a basis from which to assess change since comprehensive surveys were undertaken in the 1980s.

A meta-data analysis is being undertaken of all existing waterbird survey data in the Region since the early 1980s, and is one of the most comprehensive biological spatial-temporal data sets for a tropical wetland ecosystem in the world. Seasonal population models have been developed for keystone species that will allow broader landscape-wide impacts of invasive species and climate change to be differentiated from potential mining-related impacts. A major outcome of this work is the potential for increased ecosystem protection through use of more rigorous quantitative ecological risk assessment, particularly the explicit link between the negative impacts of wetland weeds on waterbird habitat.

A framework for assessing the ecological values associated with waterbirds was drafted with components being presented in presentations at the Australasian Ornithological Conference, Canberra, December 2003, the Global Waterbird Conference, Edinburgh, Scotland, April 2004, and the Southern Gulf Birds and Wetlands Forum, Karumba, May 2004.

- *Integrate socio-economic frameworks and indigenous perspectives into ecological risk assessment and management frameworks.*

A non-mining reference site was established in collaboration with traditional owners undertaking active management of floodplain resources on Boggy Plain wetland (South Alligator River) to compare landscape-scale ecological impacts (e.g. invasive species, fire, salt water intrusion) with those on Magela floodplain downstream of Ranger mine.

The development of a framework for assessing the value of ecosystem services produced by or derived from the wetlands has been postponed until 2004-05 as part of a larger project being undertaken on tropical rivers.

### **Theme 3 – Ecotoxicology and biophysical pathways**

The aim of this theme was to continue to assess the aquatic ecotoxicity of regionally relevant toxicants with the aim of developing or enhancing site-specific water quality guidelines. Further, bioaccumulation and trophic transfer information for aquatic pathways from the mine sites in the Region will be reviewed in the context of both the current operational and future rehabilitation phases.

#### **The priority activity in 2003–04 was to:**

- *Review bioaccumulation and trophic transfer information for aquatic and terrestrial pathways from the mine sites.*

Bioaccumulation and trophic transfer information was incorporated into the conceptual model being developed under the Landscape theme.

### **Other priority activities included:**

- *Assess the toxicity of enhanced levels of magnesium sulphate in Magela Creek through laboratory and field studies and derive site-specific water quality guidelines.*

An assessment of the toxicity of magnesium to six freshwater species was finalised, resulting in the derivation of a default water quality trigger value for Magela Creek. Building on this, the ameliorating effect of calcium on magnesium toxicity was assessed with the aim of refining the magnesium trigger value. This was presented as a Discussion Paper to ARRTC, March 2003. This research is contributing to one of the most rigorous site-specific assessments in Australia of an individual metal.

- *Refine and develop ecotoxicological procedures (ongoing) and models, using local aquatic species.*

Laboratory toxicity tests were finalised for the freshwater gastropod *Amerianna cumingi* and the freshwater macrophyte *Lemna aequinoctialis*. An article on the relevance of tropical ecotoxicological testing and risk assessment was published (SETAC Globe). The ongoing refinement of existing tests and development of new tests is building capacity for future research and commercial activities in ecotoxicology and ecological risk assessment.

- *Maintain the quality control and quality assurance system of the new eriss ecotoxicology laboratory in Darwin (ongoing).*

A comprehensive review of the ecotoxicological program was undertaken and prepared as a Supervising Scientist Report. The regular quality control and assurance system was undertaken and new staff trained in laboratory procedures

### **Other activities:**

Pre-release toxicity testing of Djalkmara Billabong water was undertaken for Energy Resources of Australia (ERA) in December 2003 and February 2004.

## **Theme 4 – Groundwater pathways**

The aim of this theme was to monitor and investigate the transport of contaminants through groundwater pathways.

### **The priority activities in 2003–04 were to:**

- *Investigate dispersion of uranium in groundwater at Ranger Uranium Mine.*

Bore waters were collected once per year and analysed for ammonium, sulphate and sulphur isotopes. The samples were processed and subsequently archived for uranium and radium isotope analysis and for dissolved metals in 2004-05.

- *Continue monitoring of uranium and radium in groundwater at Nabarlek.*

Archived bore water samples from 1996 to 2002 were prepared for uranium, radium isotope and dissolved metal analysis.

## Theme 5 – Surface water monitoring

The aim of the surface water monitoring theme was to monitor water quality in Alligator Rivers Region creeks in order to assess effects of mining upon ecosystem and human health. An integral part of this work program was the ongoing review and refinement of current water monitoring techniques and the development of new techniques.

### The priority activity in 2003–04 was to:

- *Monitor and assess surface water quality in the Alligator Rivers Region creeks to assess effects of mining upon ecosystem and human health, including monitoring water physio-chemistry (chemistry including radionuclides) and biological monitoring (creekside monitoring, bioaccumulation, fish & macroinvertebrate communities).*

Monitoring of water physio-chemistry (suspended sediment, chemistry including radium) and aquatic biota was conducted with additional chemical and biological monitoring conducted to assess the Ranger drinking water incident.

A paper on radium-226 in waters of the Magela creek catchment was presented at the 13th Australian Institute of Nuclear Science and Engineering Conference, Sydney, November 2003.

### Other priority activities included:

- *Develop techniques for monitoring suspended sediments in Gulungul and Magela creeks.*  
Reported in Rehabilitation theme.
- *Present all monitoring protocols as Supervising Scientist Reports.*  
Not completed though significant progress made on drafting protocols.
- *Enhance all data management aspects of the monitoring program.*

Incomplete although progress made on a substantial task.

- *Review and refine all components of the monitoring program.*

Review conducted of the management and implementation of the stream monitoring program since its inception, with outcomes and recommendations presented in an internal report. Training of monitoring staff and upgrading of monitoring infrastructure continued where required

Honours project conducted to assess Diffusive Gradients in Thin Films (DGT) as a routine monitoring tool for uranium and other heavy metals in freshwater.

- *Present monitoring results in the Supervising Scientist Annual Report (and as specific protocols) and on the website; and ensure access to local stakeholders.*

Monitoring results were posted on the Supervising Scientist Division website, reported in the Supervising Scientist Annual Report 2002-03 with more detail provided in internal reports. A separate report was provided on the Ranger drinking water incident.

## Theme 6 – Radiological risk

The aim of this theme was to monitor and investigate radiological risk arising from present-day uranium mining operations in the Alligator Rivers Region; and to assist in planning for rehabilitation of former and present-day minesites from a radiological perspective.

### The priority activity in 2003–04 was to:

- *Provide radiological monitoring data and interpretation for the Ranger and Jabiluka minesites.*

Advice and radioanalytical data were provided on radionuclide concentrations in drinking water from Jabiru, Jabiru East and water from Mudginberri Billabong and Magela Creek after the Ranger drinking water incident, and a radiological assessment of the Jabiluka Association CDEP offices and workshops was performed for the Supervising Scientist after the CDEP bobcat incident.

Airborne radon progeny and long lived alpha activity concentrations were routinely measured throughout the year at three stations and data posted on the Supervising Scientist Division website regularly as part of a reassurance program for the general public about human health issues in the vicinity of mining activities. Airborne radon concentration was continuously measured and a journal paper completed (Journal of Environmental Radioactivity) and data on lead isotopes in dust deposited throughout the Park interpreted and presented in an internal report.

### Other priority activities were to:

- *Analyse data collected from the rehabilitated Nabarlek uranium minesites, abandoned minesites in the upper South Alligator River; and from other projects in the Region.*

Outcomes were presented in two journal papers (submitted to Environmental Monitoring and Assessment and The Scientific World), papers at the ARPS conference, Hobart, October 2004 and the AusIMM meeting, Darwin, November 2004, and in internal reports. Ground truthing at Sleisbeck was completed and outcomes reported to traditional owners and park rangers.

- *Assess and analyse data on airborne radon, radon exhalation and lead-201 deposition, and uptake of radionuclides by freshwater mussels.*

Data from the three year Nabarlek and Mudginberri airborne radon investigation were interpreted and a report prepared for posting on the Supervising Scientist website. An internal report on radon exhalation and lead-210 deposition in the vicinity of the Ranger minesite was produced. A journal paper (The Scientific World) on natural-series radionuclides in Aboriginal food items was published, and data on radionuclides and heavy metals in freshwater mussels from billabongs were reported in an internal report.

- *Investigate use of radionuclides and lead isotopes in creek sediments for mining assessment in the Alligator Rivers Region.*

An application for an ARC Linkage Grant in collaboration with Charles Darwin University was successful, and baseline sediment samples from the Ngarradj catchment were analysed.

## Theme 7 – Communications and knowledge management

Communications and knowledge management works across all the themes to provide support to the research programs and to develop communication programs to inform and involve Aboriginal communities and our other research partners and stakeholders in the activities of the Supervising Scientist.

### The priority activities in 2003–04 were to:

- *Increase and enhance external communication with stakeholders, in particular, traditional land owners.*

Consultations with traditional land owners on specific projects continued with specific involvement of the Northern Land Council and Gundjeihmi Aboriginal Corporation. Other associations were contacted as required and site visits undertaken to inform local people about research and monitoring activities and to provide assurance about environmental issues in relation to mining activities.

Briefings about research and monitoring activities are provided to staff from other organisations and visitors to the Jabiru field station.

- *Strengthen participation of traditional land owners in research and monitoring projects.*

Participation of traditional land owners in research and monitoring projects was extended and included water chemistry, ecotoxicology, landscape-scale analyses, macro-invertebrate and fish sampling. All activities involved training and supervision to ensure skills were being acquired and feedback obtained from participants.

- *Investigate the inclusion of traditional ecological knowledge into research and monitoring projects as appropriate.*

Traditional ecological knowledge has been included in the Landscape theme reported above. Discussions were initiated on other areas of interest and ideas presented for consideration of active projects in 2004-05 to cover parts of the Rehabilitation theme. Local people also provided advice to eriss staff about crocodile safety.

- *Identify new stakeholders and forge new professional partnerships for the Supervising Scientist Division*

New partnerships were formed with university researchers to support further investigations into revegetation and landscape analyses in particular; complementing the skills already available. The landscape analyses were linked with projects being undertaken by traditional owners and park rangers and provide a basis for the wider integration of multiple knowledge sources in future research projects. The concepts being developed through the landscape projects were articulated at local and international conferences (see under Theme 2 above) and resulted in greater interest and active involvement in our research projects, eg, extending the floodplain analyses to include ecosystem values, and providing opportunities to present our results in conference sessions on comparative biodiversity values.

- *Provide research and communication support across the **eriss** research and program themes.*

Communication support was provided to all programs in the form of report and publication assistance, production of communication materials, coordination of displays

and presentations at events and conferences, and assistance with stakeholder consultation and feedback.

- *Develop and implement an internal communication plan that integrates communication across the Division and within eriss and the Office of the Supervising Scientist*

An internal communication strategy was developed in conjunction with an external communication plan. Aspects of internal communication included reporting of program outcomes throughout SSD, internal newsletter, coordination of workplanning and other meetings across programs that highlighted communication activities, outputs and outcomes.

- *Provide coordination and promotional support to the activities and research projects of the NCTWR and implement the NCTWR Communications and Marketing Strategy.*

Administrative support was provided to the NCTWR Board of Management and Advisory Committee meetings, budgeting, project planning, filing and record keeping. The NCTWR website was updated and project submissions coordinated. The Communications and Marketing strategy was presented to the Board of Management for further advice and prioritisation.

## **Appendix 1 – ARRTC Key Knowledge Needs 2003–04**

This list of key knowledge needs was developed by the Alligator Rivers Region Technical Committee at their meeting in February 2003. It is to be refined through further discussion.

### **Primary objective: Protection of the Alligator Rivers Region**

#### **Mine operations (“now”) within a risk framework**

1. Reassess and quantify contaminant movement within biophysical pathways (concentration, species, loads, dynamics)
2. Contaminant movements through groundwater pathways from current operations
3. Linking ecotoxicological knowledge and biophysical pathways (first flush, terrestrial, food, sediments )
4. Human health risks associated with biophysical pathways (bush tucker, bioaccumulation, drinking water)
5. Radiological effects on people (source terms, dose assessment parameters, sampling and analysis)
6. Linking of conceptual models with onsite management (adaptive, not operationalising the science)

#### **Mine Closure (“future”)**

7. Completion criteria, shared reclamation objectives and indicators of success
8. Ecosystem establishment techniques (landform, vegetation, fauna, hydrology, geochemistry)
9. Sustainability of rehabilitation (weeds, fire, nutrients, resilience, extreme events)
10. Radon emanation and bioaccumulation of radionuclides from final landform
11. Adequate baseline data to underpin indicators of success (for example, hydrology of Gulungul)
12. Demonstrated ability to reconstruct an ecosystem (Nabarlek)

#### **Knowledge Management and Communication**

13. Between and within research providers (past, present and into the future)
14. Uncertainty analysis of data (for example, risk assessment) and communicating
15. Development of an integrated framework (landscape scale analysis)
16. Effective communication of science to stakeholders