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IMPLEMENTATION OF A BIOAVAILABILITY APPROACH FOR NICKEL IN AUSTRALIAN SURFACE WATERS

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INTRODUCTION

The biotic ligand models (BLMs) for nickel have been developed and validated using North American and European laboratory test species and natural waters. However, there is regulatory interest in accounting for the bioavailability of nickel in regions outside of those for which the models were originally developed. This programme of work has set out to assess the applicability of these chronic nickel models to freshwaters in a different geographic and biological region; namely Australia. In order to do this, it is necessary to determine firstly if the ranges and combinations of physico-chemical parameters for which the BLMs were developed in the EU and US are similar to the ranges in Australia, and hence determine if the models are applicable; and secondly to verify that the physiological relationships developed for the three trophic levels for EU and US standard species are valid when applied to species from Australia.

The key hypothesis being tested in this project is that the physico-chemical and the physiological relationships upon which the models are based are universal and not locale-specific; i.e. the competitive binding of major cations and nickel for the biotic ligand are constant across organisms with only the intrinsic sensitivity being different.

METHODS

The protocols followed here are similar to those outlined in Delebeek et al. (2007) and Schlekat et al. (2010) for waters in North America and Europe. Water samples, representative of varying water chemistries, were collected in the field from sites around Australia. Chronic ecotoxicity tests, using typical Australian test species (both tropical and temperate) were then undertaken in these waters. The results from these tests were then compared with the predictions from the existing NiBLMs. There are four chronic BLMs for nickel, two for cladocerans (*Daphnia magna* and *Ceriodaphnia dubia*) one for fish (*Oncorhynchus mykiss*) and one for algae (*Pseudokirchneriella subcapitata*). The results from these comparisons can then be used to modify the intrinsic sensitivity of the predictive models for each tested organism.

Water collection

The first task in this programme was to determine the ranges of physico-chemical characteristics in a variety of Australian freshwaters, with specific emphasis on those factors that influence nickel bioavailability, namely dissolved organic carbon (DOC), pH, calcium and hardness.

The waters selected for testing following collation of all the available Australian data, are shown in Table 1. One water was amended to increase its pH, (using sodium bicarbonate) to provide a water of, theoretically, high nickel bioavailability (Peechelba).

Ecotoxicity Testing

Due to the climatic range experienced in Australia it was important for the validation exercise to include temperate and tropical freshwater test species. Chronic tests were therefore carried out in each of the selected waters using *Chlorella* sp. (Australian strain), *Melanotaenia splendida* (rainbow fish), *Ceriodaphnia dubia* (Australian strain), *Hydra viridissima* (tropical strain) and *Lemna aeuinoctialis* (tropical species).

The tests were undertaken by Ecotox Services Australia in Sydney and the Environmental Research Institute of the Supervising Scientist in Darwin.

EARLY RESULTS AND DISCUSSION

The chemistry data from each test are currently only nominal values (but are being measured) and therefore the predictions shown in this section should be considered as tentative. No results are yet available for the Peechelba water.

Provisional ecotoxicity test results for *Hydra* are shown in Figure 1. The Figure shows the predicted verses observed EC10 values for *Hydra* using the BLMs originally developed for *Ceriodaphnia dubia* and also *Daphnia magna*. The model that most effectively predicts the observed chronic effect level, albeit from these provisional data, appears to be the D. *magna* BLM. Generally, from previous similar studies, predictions within a factor of two of the observed results have been considered acceptable (Schlekat et al. 2010).

As data become available and the analytical chemistry results are confirmed, we will establish which models best fit the ecotoxicity data derived.

Challenges will likely be encountered with the predictions from some models for some of the test species as Australian water chemistries are very different from those for which the models were originally developed (Europe and North America). The scale and form of this challenge cannot be determined until all the results and chemistry data from the tests are available.

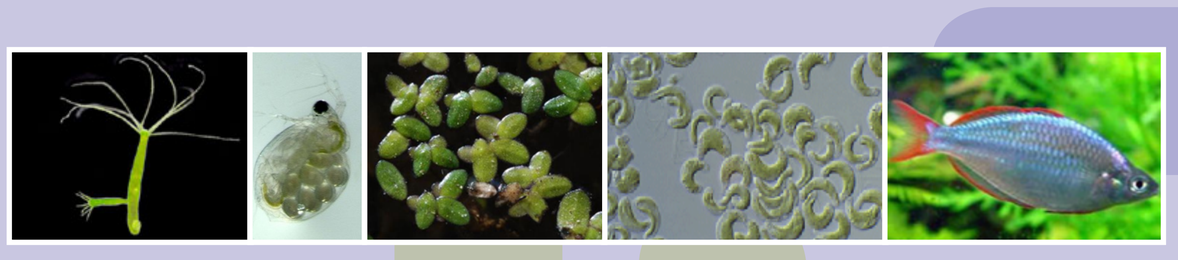
WHAT NEXT?

- The data will be finalised in late 2013 and the full validation exercise using all of the reported data will take place.
- Australian regulators and researchers will undertake the assessment and recommend changes in intrinsic sensitivities of the models where required.
- It is possible that modifications to the existing models in the light of the water chemistries will need to be undertaken in order to provide robust predictions for Australian freshwaters.
- If successful, this validation exercise will demonstrate the applicability of the NiBLMs to regions outside those for which they were originally developed.

Table 1. **Physico-chemical parameters of freshwaters selected to validate the NiBLMs and the 10th and 90th percentiles of 11744 samples from 1465 sites.**

Site	State or Territory	pH	DOC (mg/L)	Ca (mg/L)
Tea Tree	QLD	6.4	10	2
Woronora River	NSW	6.7	4	2
Peechelba	VIC	7.8(8.1)*	3	2
Wellington	SA	7.4	6	12
Magela Creek	NT	6.1	5	0.2
10th percentile	All	6.0	2	0.5
90th percentile	All	7.6	12	30

*see method



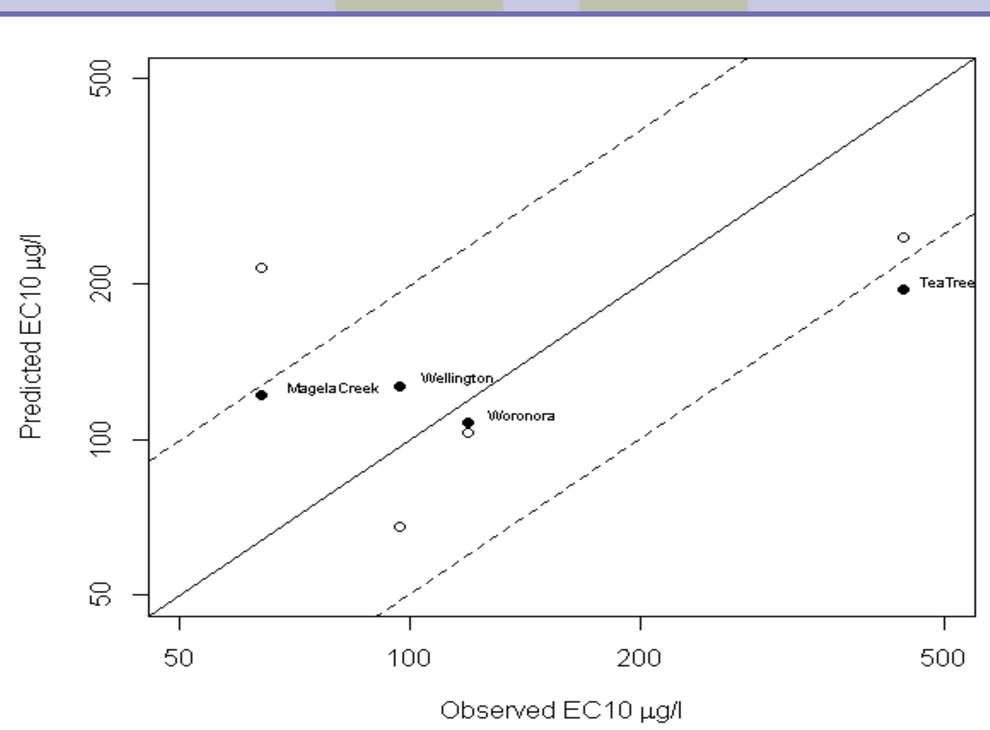


Figure 1. **Comparison of observed and BLM predicted EC10 values for H. *viridissima* using BLMs developed for D. *magna* (closed circles) and C. *dubia* (open circles). The solid line indicates a 1:1 relationship, and the dotted lines indicate a factor of 2 from the 1:1 relationship.**

References:

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Deleebeeck, NME, Muyssen BTA, De Laender F, Janssen CR, De Schamphelaere KAC. 2007. Comparison of nickel toxicity to cladocerans in soft versus hard surface waters. Aquat Toxicol 84: 223-235.

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