



Australian Government

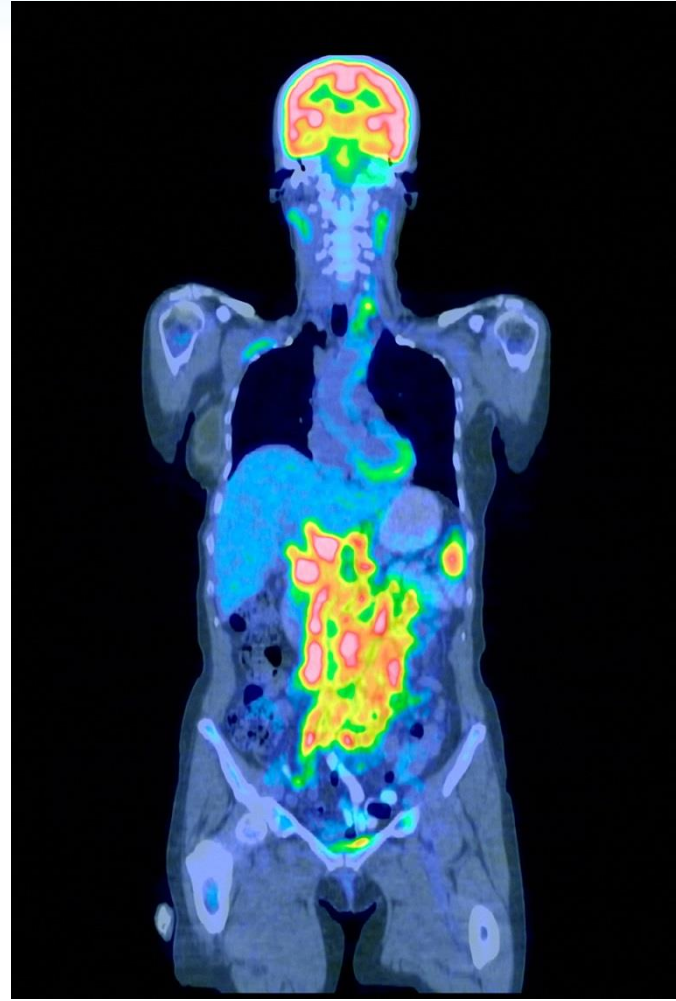
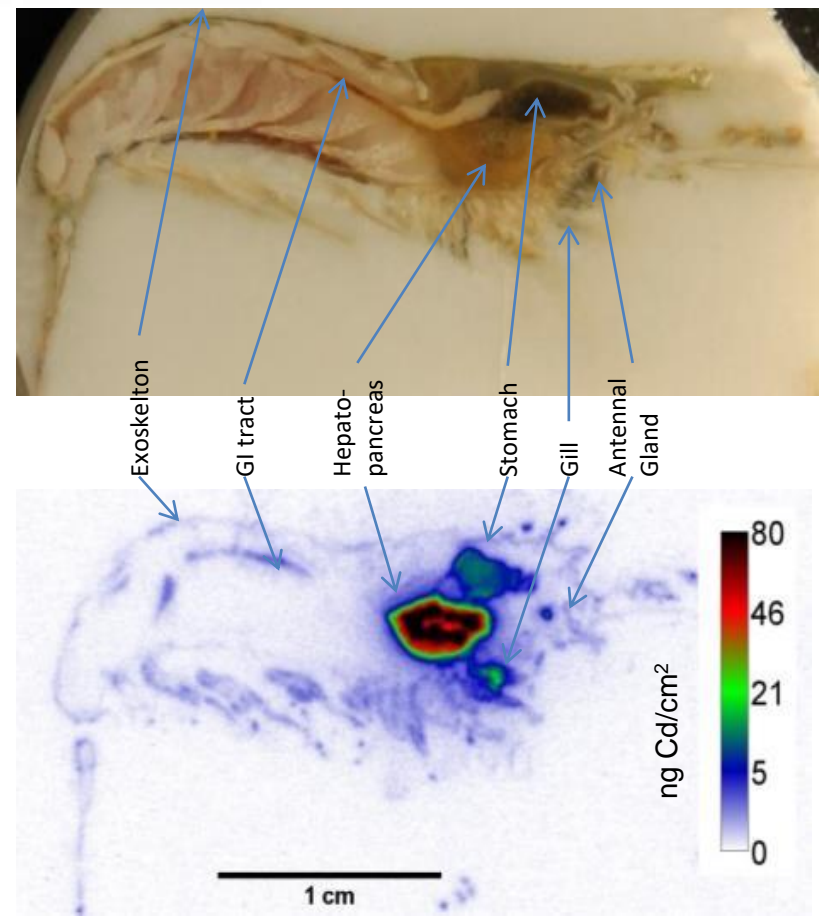


Radiotracer Methods for Understanding Contaminant Dynamics in Aquatic Environments

Cath Hughes, Tom Cresswell, Mat Johansen
ANSTO Environment Research Theme

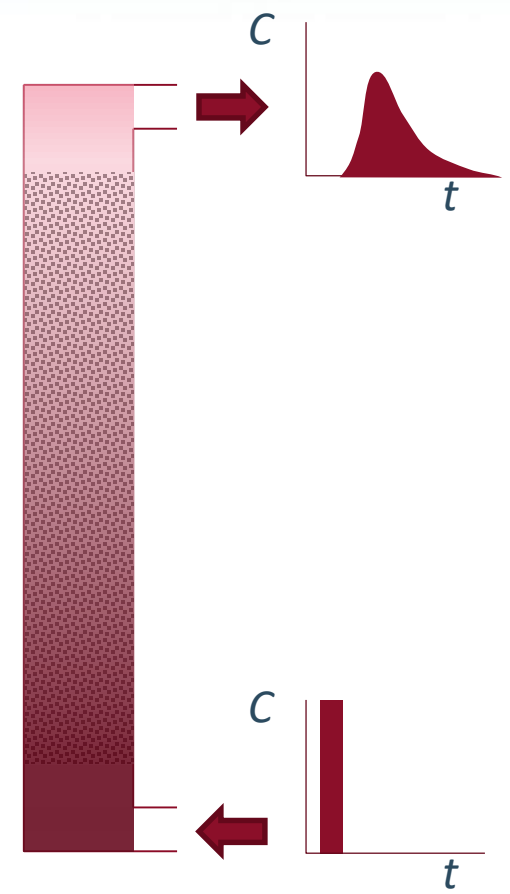
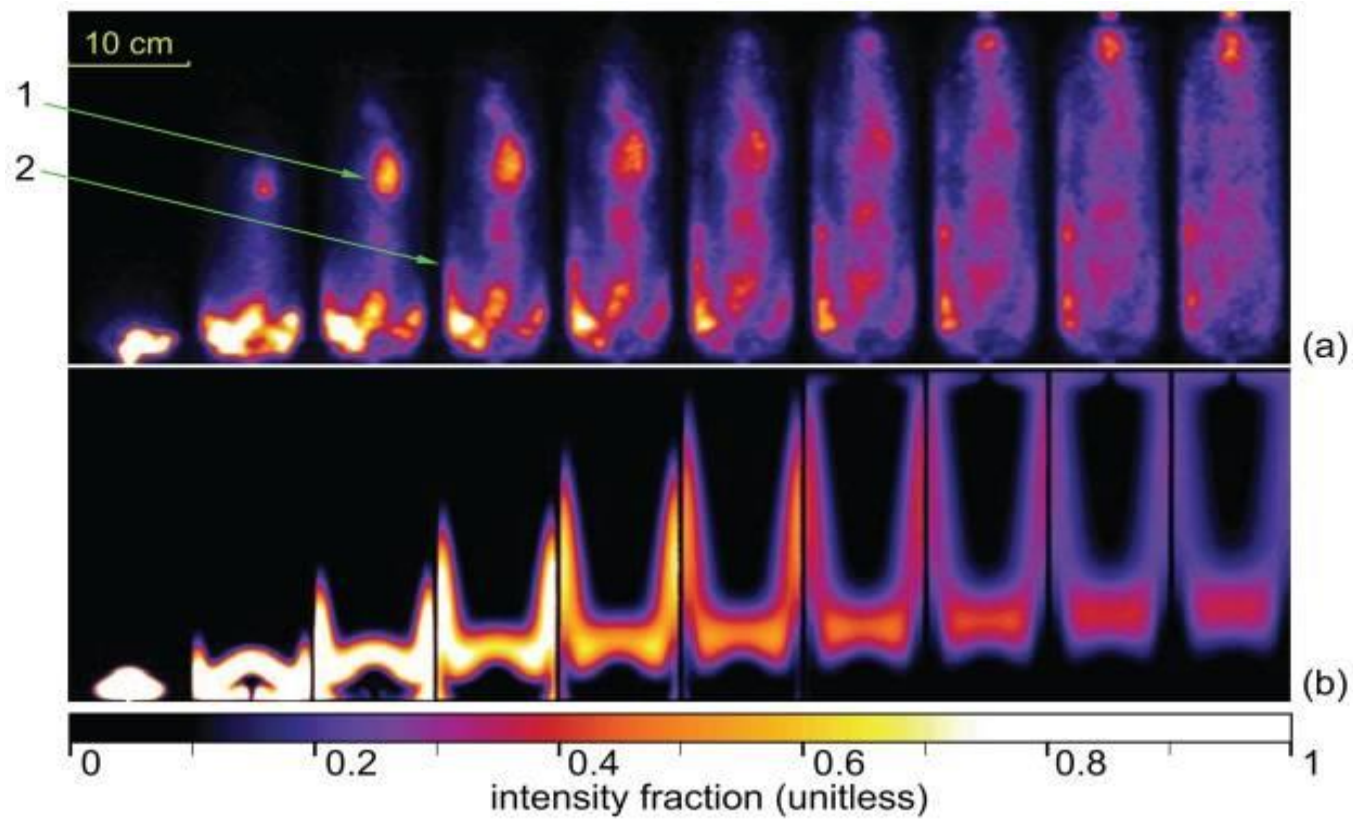
What is radiotracing?

Three weeks exposure to Cd-109 $T_{1/2}=463d$



Cresswell, T. *et al.* 2015. *Environ. Sci. Technol.* 49, 1182-1189.

What is radiotracing?



Bourchko, R. *et al.* 2012. *J. Appl. Geophys.* 76, 74-81.

Why are radiotracers useful?

- Unique – no/low natural background
- Direct analogue for chemical under study
- V small mass so no toxicity/concentration effects
- Easily detected in situ or in samples
- Short half life = no memory effect

Hydrodynamics & effluent dispersion

^{99m}Tc	^{82}Br	^{198}Au
^{131}I	^3H	

Sediment transport

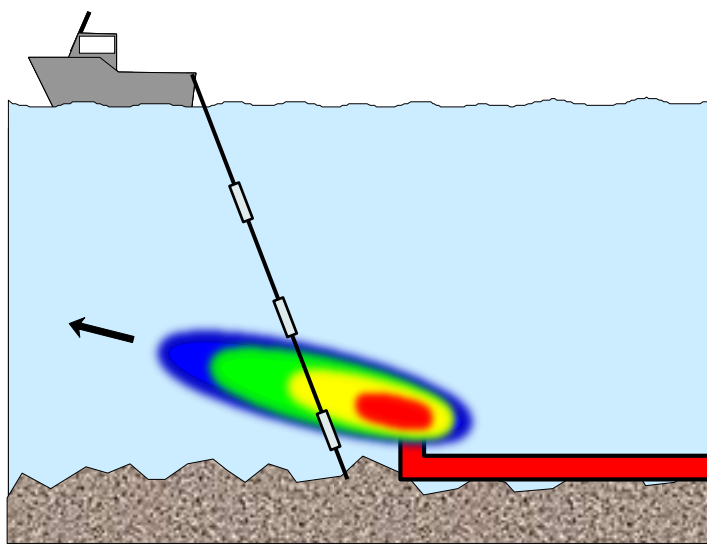
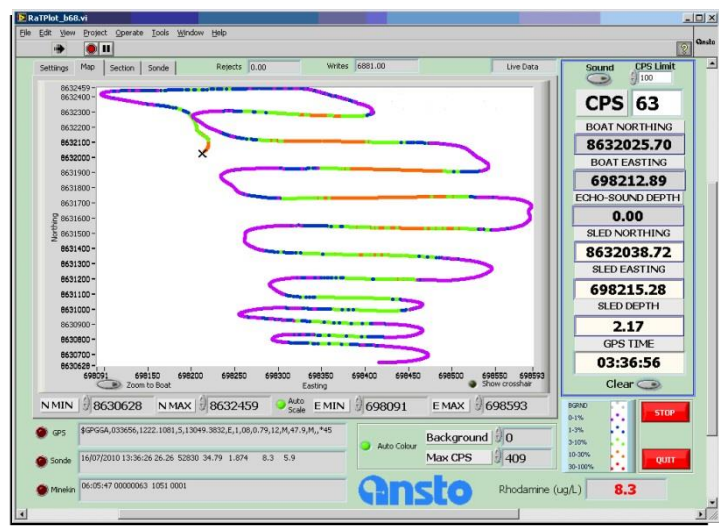
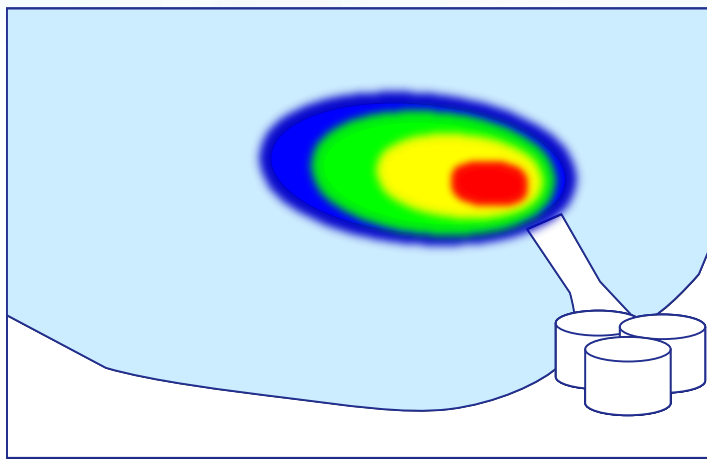
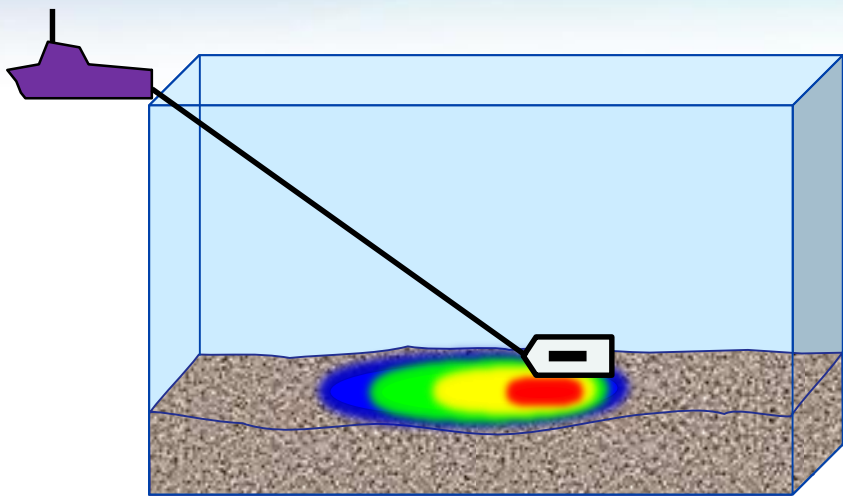
^{192}Ir	^{198}Au	^{46}Sc
^{181}Hf	^{51}Cr	^{110m}Ag

Biological and chemical uptake

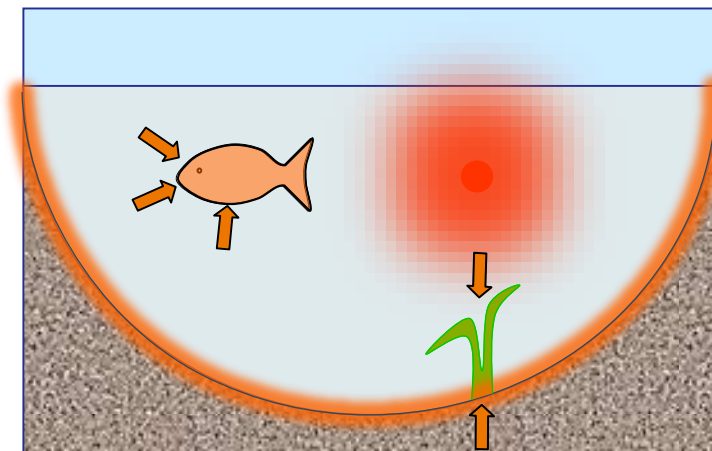
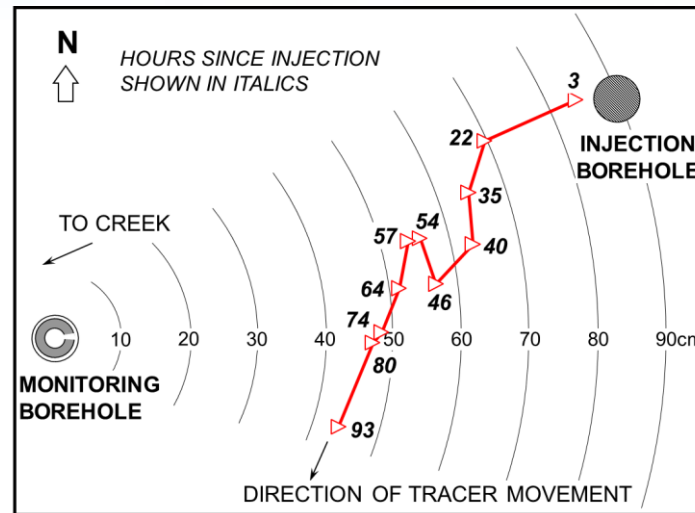
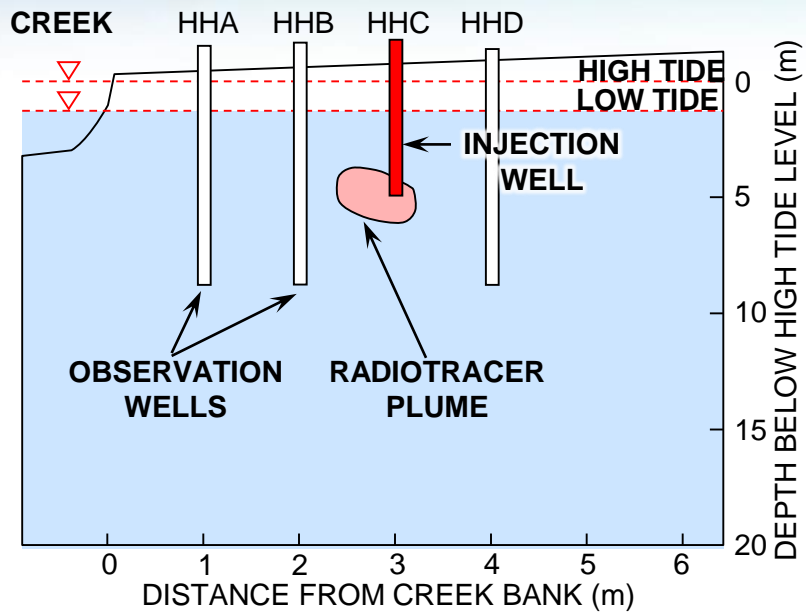
^{65}Zn	^{59}Fe	^{203}Hg	^{109}Cd	^{75}Se	^{54}Mn	^{35}S
^{134}Cs	^{60}Co	^{133}Ba	^{48}V	^{32}P	^3H	^{14}C

Radiotracers are sometimes isotopes not found in nature or produced in the nuclear industry

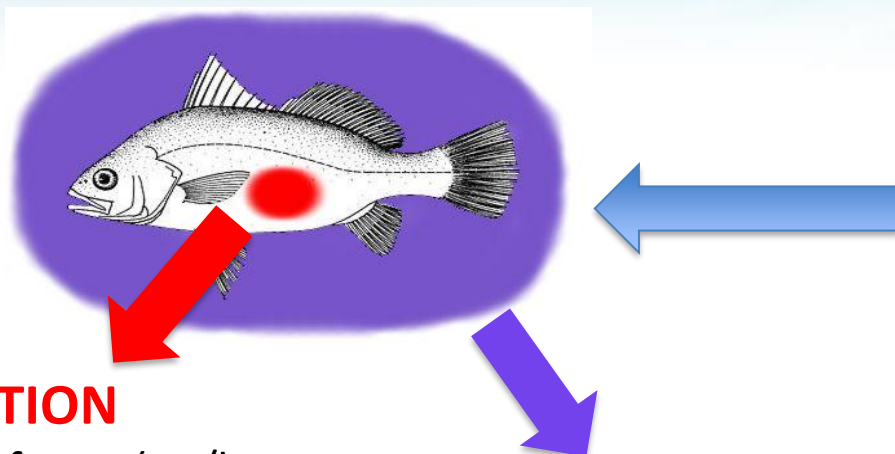
Radiotracing *outside* the lab



Radiotracing *outside* the lab



Is it safe for the environment?



DETERMINE EXPOSURE

- Radionuclide conc. (Bq/L,kg)
- Organism geometry
- Habitat factors (surface, benthic, water column)
- Occupancy factor (%)

INGESTION

- Concentration factor (Bq/kg per Bq/L)
- Dose conversion coeff (μGy/h per Bq/kg)

IMMERSION

- Dose conversion coeff (μGy/h per Bq/L)

IS IT A RISK?

- Dose:response data
- Dose guidelines

INTERNAL DOSE

+

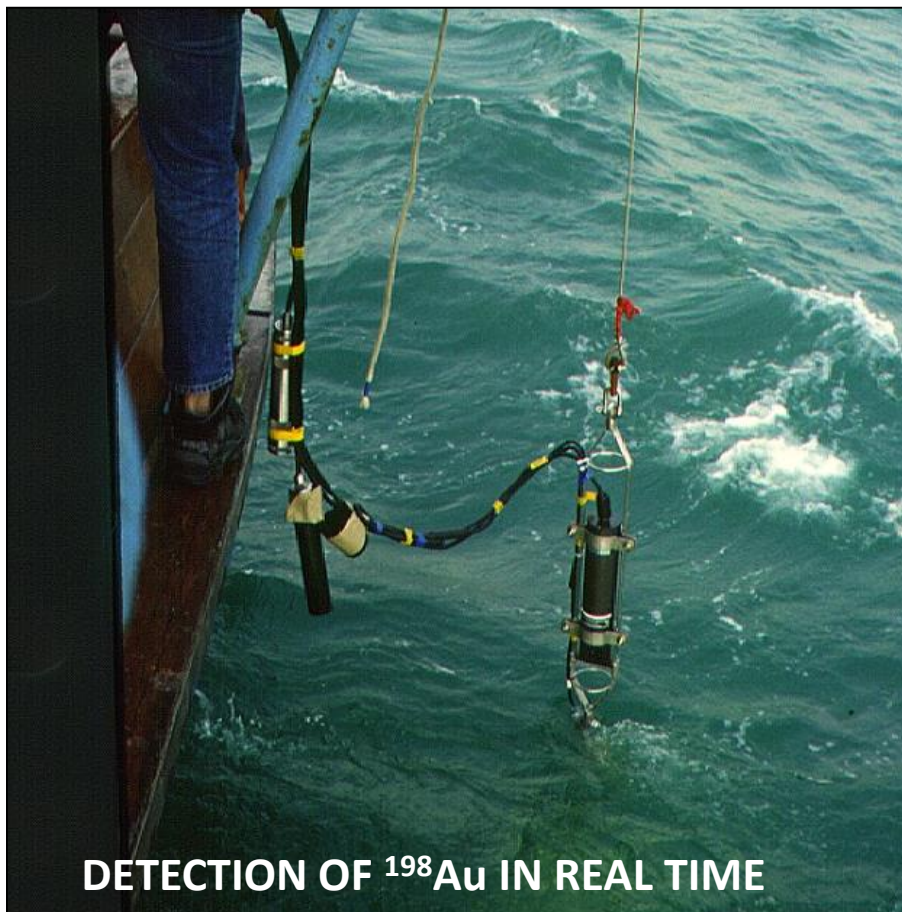
EXTERNAL DOSE

=

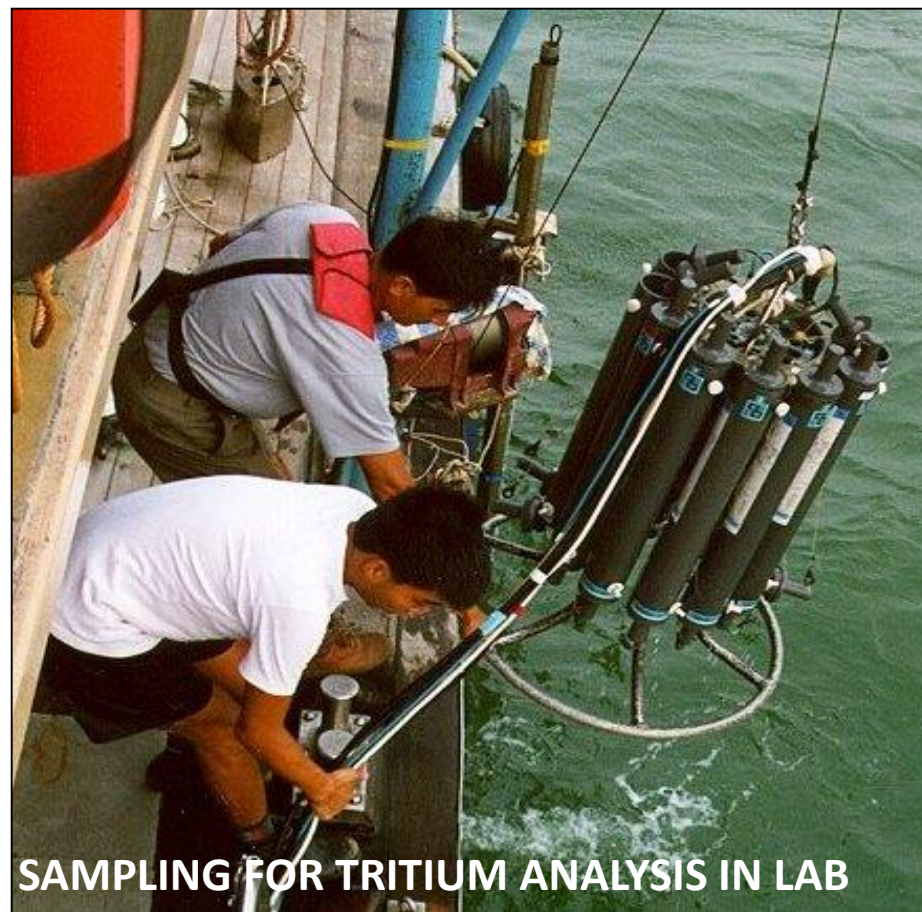
TOTAL DOSE

We now have the tools to ensure that doses for all organisms will ensure no adverse effects

Tracing sewage effluent



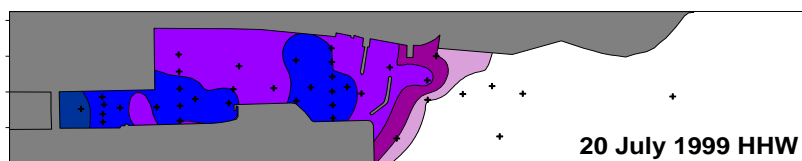
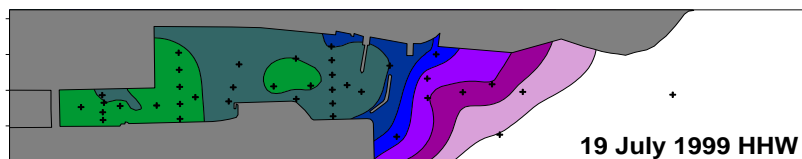
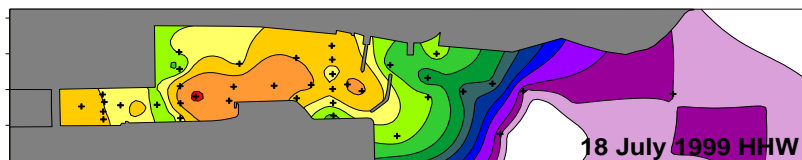
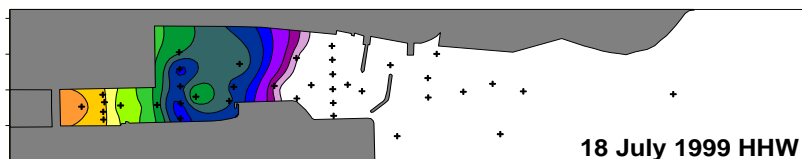
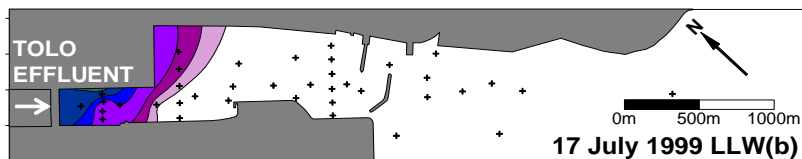
DETECTION OF ^{198}Au IN REAL TIME



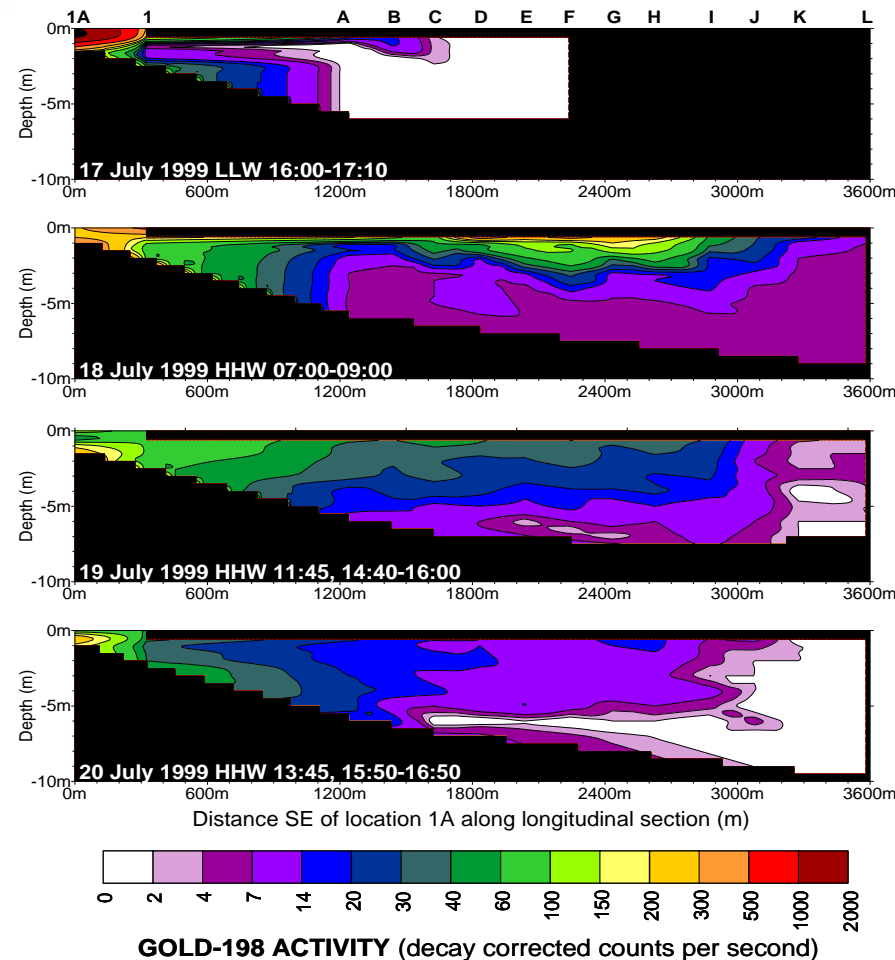
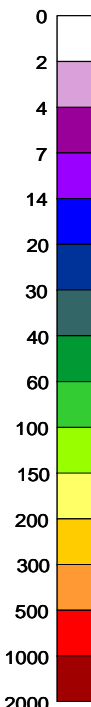
SAMPLING FOR TRITIUM ANALYSIS IN LAB

Gold-198 and tritium used to trace sewage
in Hong Kong

Tracing sewage effluent

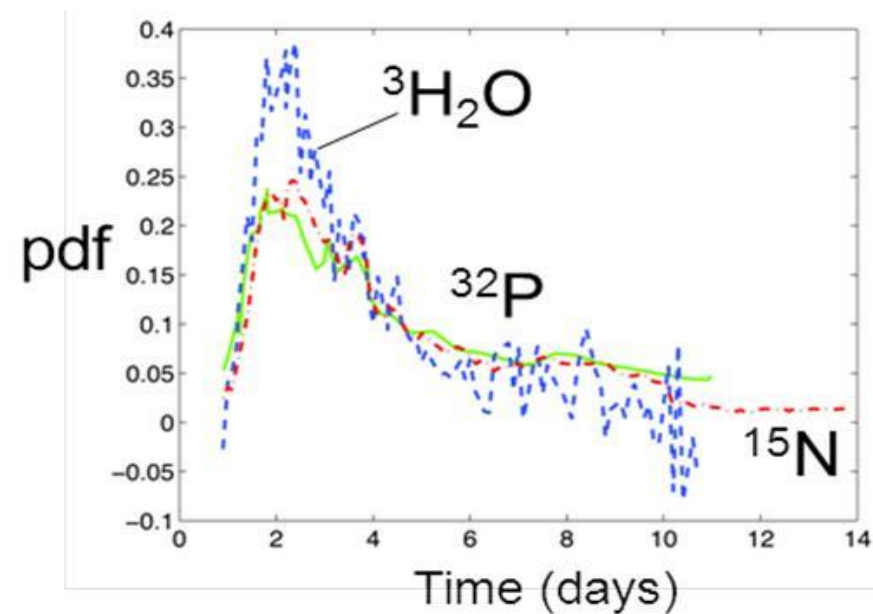
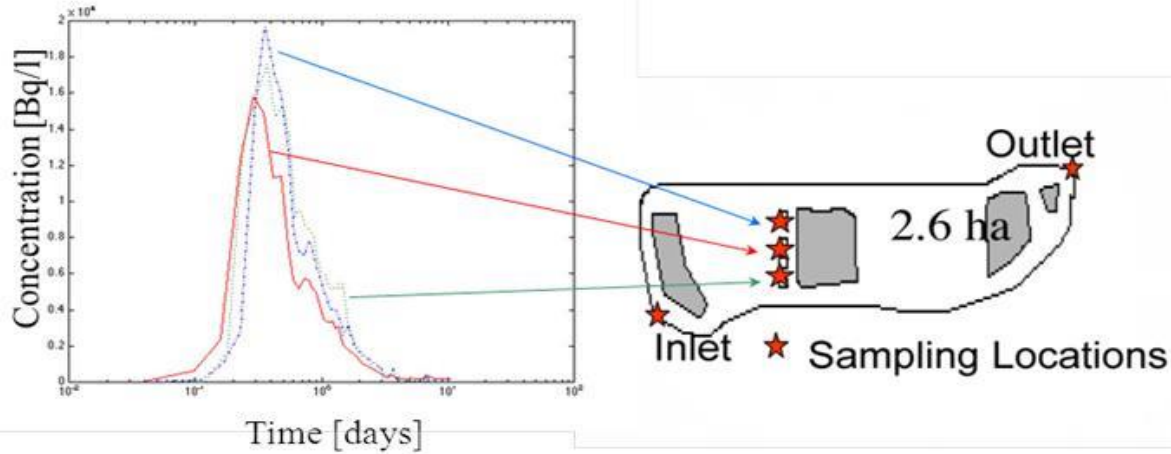


**GOLD-198
ACTIVITY**
(decay corrected
CPS)



Gold-198 and tritium used to trace sewage
in Hong Kong

Wetland flow and nutrients



Streamflows & reactive transport



Säva Brook

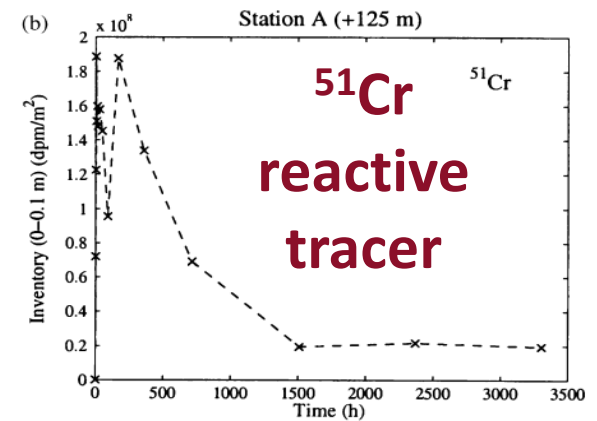
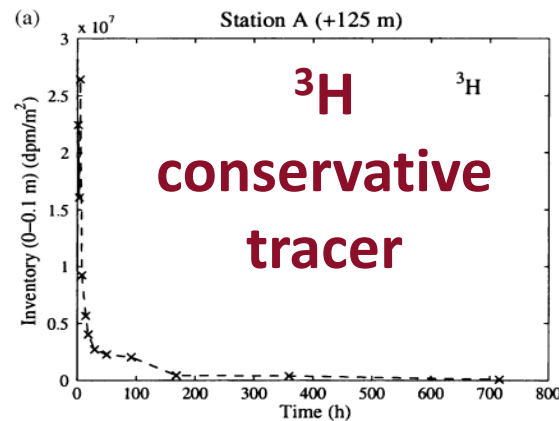
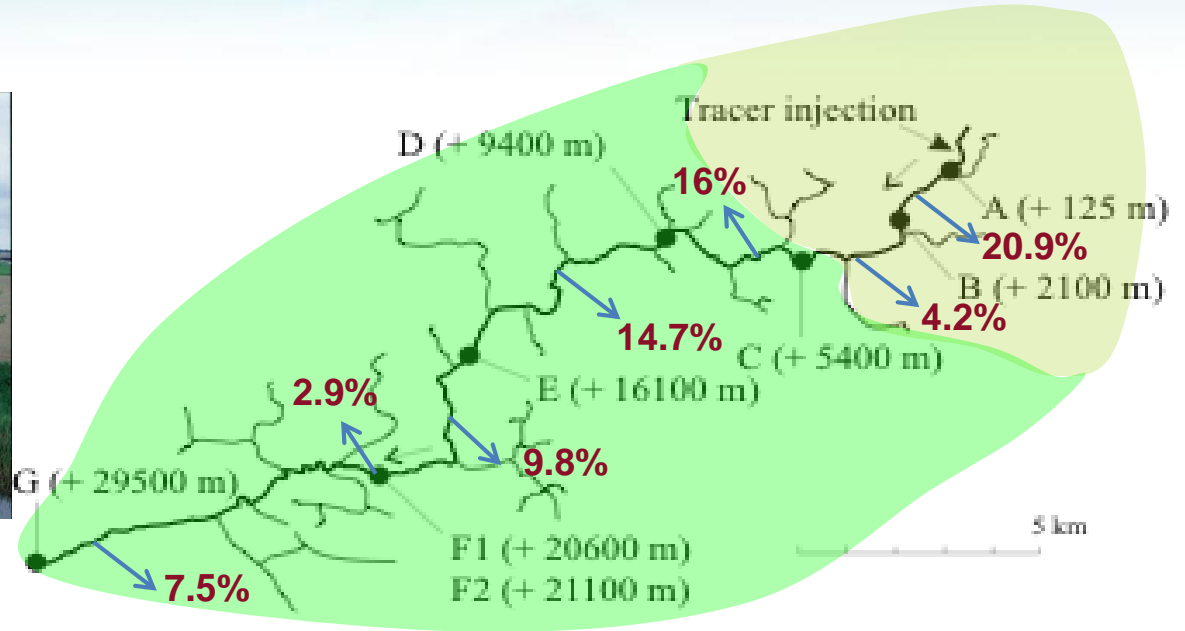
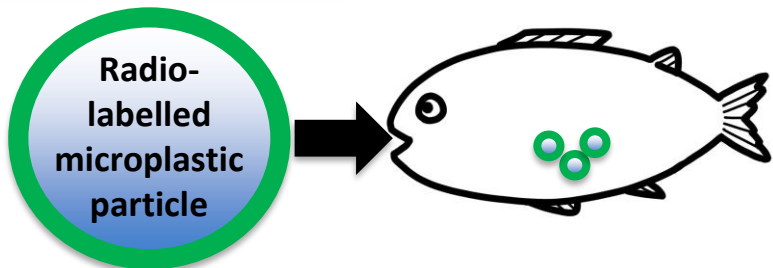


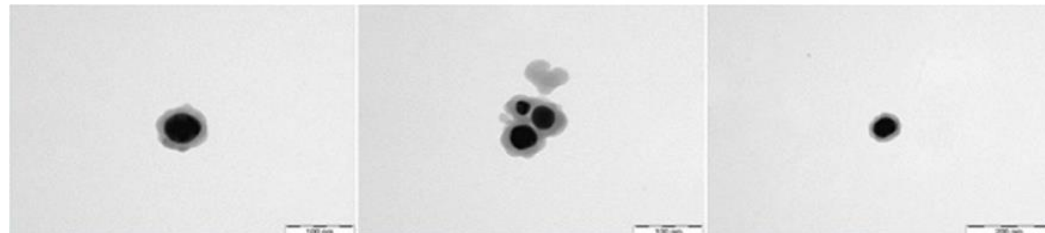
Fig. 5. Breakthrough curve of the mass inventory in the bed sediment (0–10 cm) at station A (a) tritium (b) chromium.

Jonsson, et al 2003. Hyporheic Exchange of Reactive and Conservative Solutes in Streams – Tracer Methodology and Model Interpretation, *J Hydrology* 278:153-171.

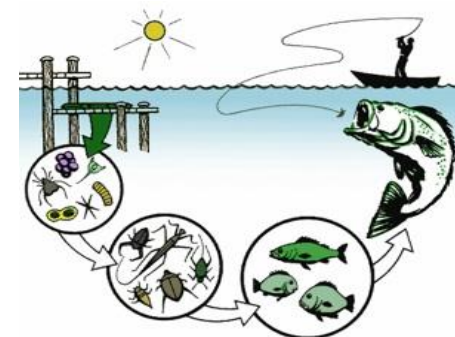
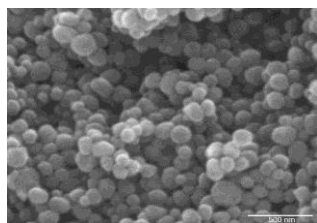
Future development in tracers



Radiotracer labelled contaminants



^{198}Au nano particles coated with SiO_2
120nm dia – suspended sediment tracer



Bulk, ionic and nano ^{141}Ce to study contaminant pathways in aquatic ecosystems

Study with Dr. Lisa Golding from CSIRO Land and Water Flagship



Australian Government

Ansto

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