

Tritium in British coastal waters

a review of UK monitoring data

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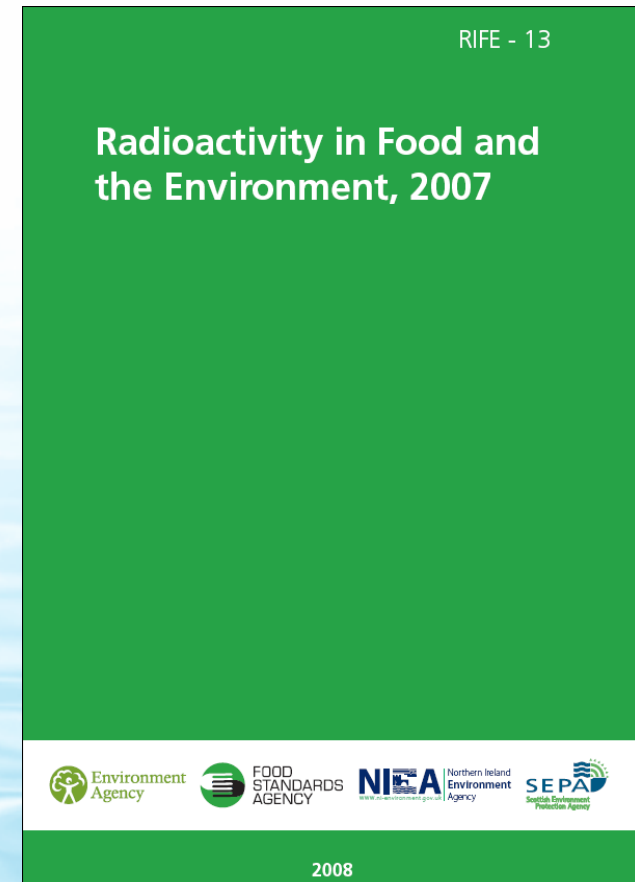
Centre for Environment, Fisheries and Aquaculture Science

Lowestoft, UK



Cefas

- ~ 2000 environmental samples collected per year
- ~ 10000 analyses by gamma spectroscopy and radiochemistry
- ~ 150 HTO/OBT analyses
- Produce annual RIFE report



Recent research projects

- Human body retention of OBT
 - J Hunt and T Bailey
- Polonium-210 transfer factor experiments
 - J Hunt and H Rumney
- Technetium-99 in Irish Sea sediments
 - K Leonard and D McCubbin

Tritium in British coastal waters

- Discharges of tritium
- Monitoring results
 - seawater
 - biota
- Concentration factor – enhancement?

Tritium analysis at Cefas

- Total tritium – biota oxidised with chromic acid
 - distilled
 - liquid scintillation

Tritium analysis at Cefas

- Total tritium – biota oxidised with chromic acid
 - distilled
 - liquid scintillation
- Organically-bound tritium – sample dried at 40°C
 - residue oxidised
 - distilled
 - counted

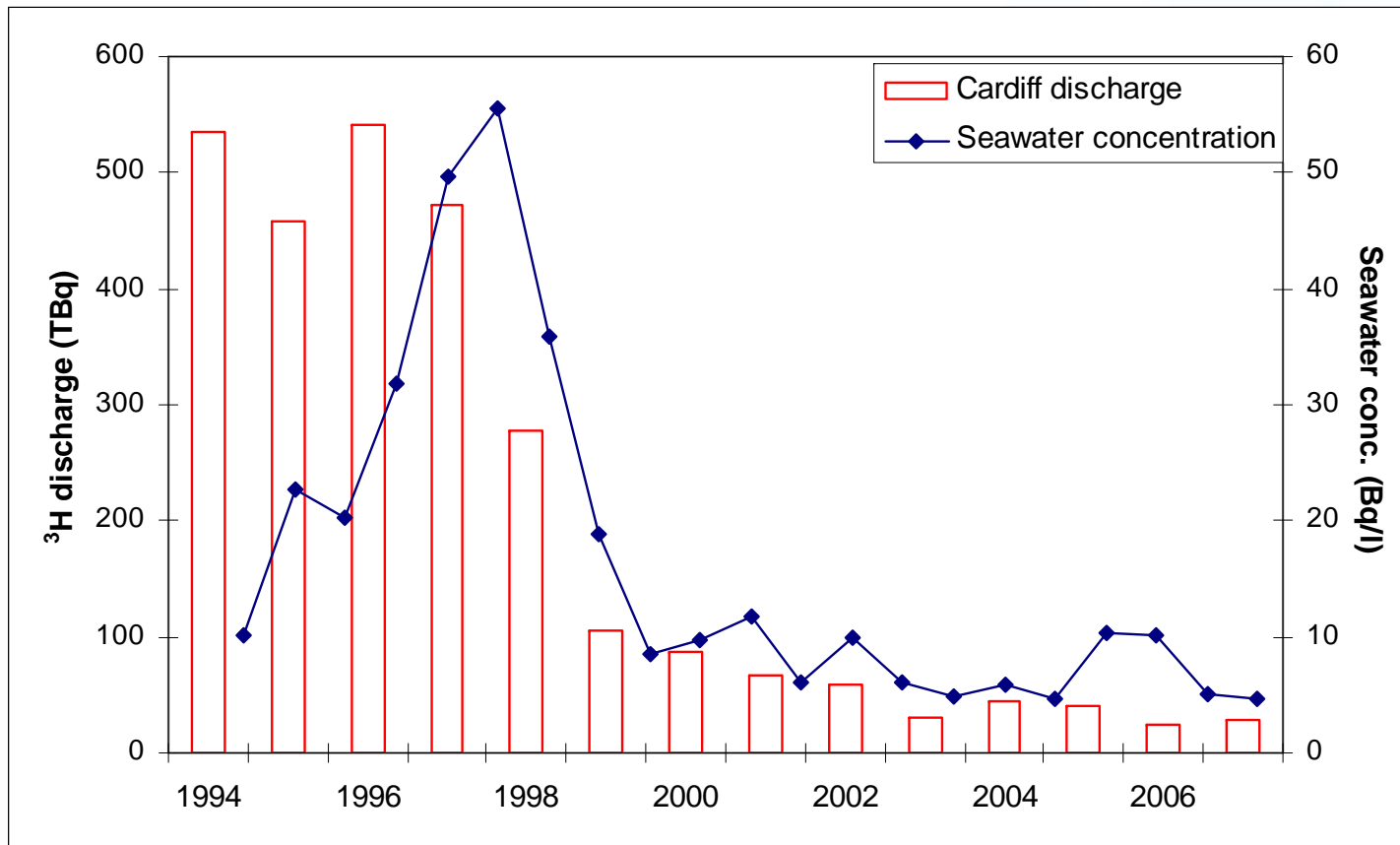
UK sites of interest

- Cardiff
- Sellafield
- AGRs
- monitoring programme includes tritium analysis



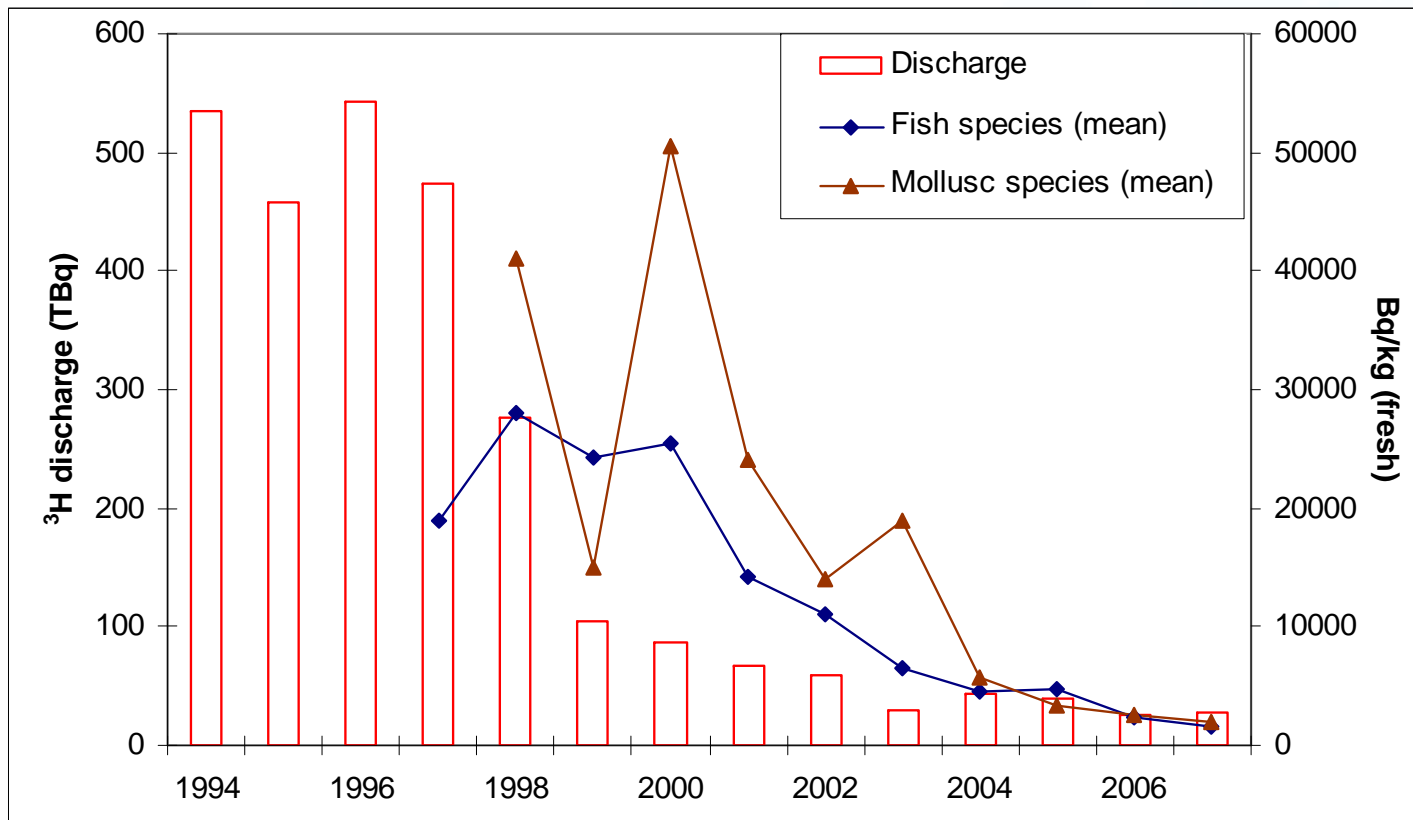
Cardiff – seawater

- Peak discharge of >800 TBq in mid-1980s
- Seawater concentrations responded well to lower inputs



Cardiff – biota (total tritium)

- Routine monitoring for tritium commenced in 1997
- 'Special' monitoring suggests >100000 Bq/kg in fish



Cardiff overview

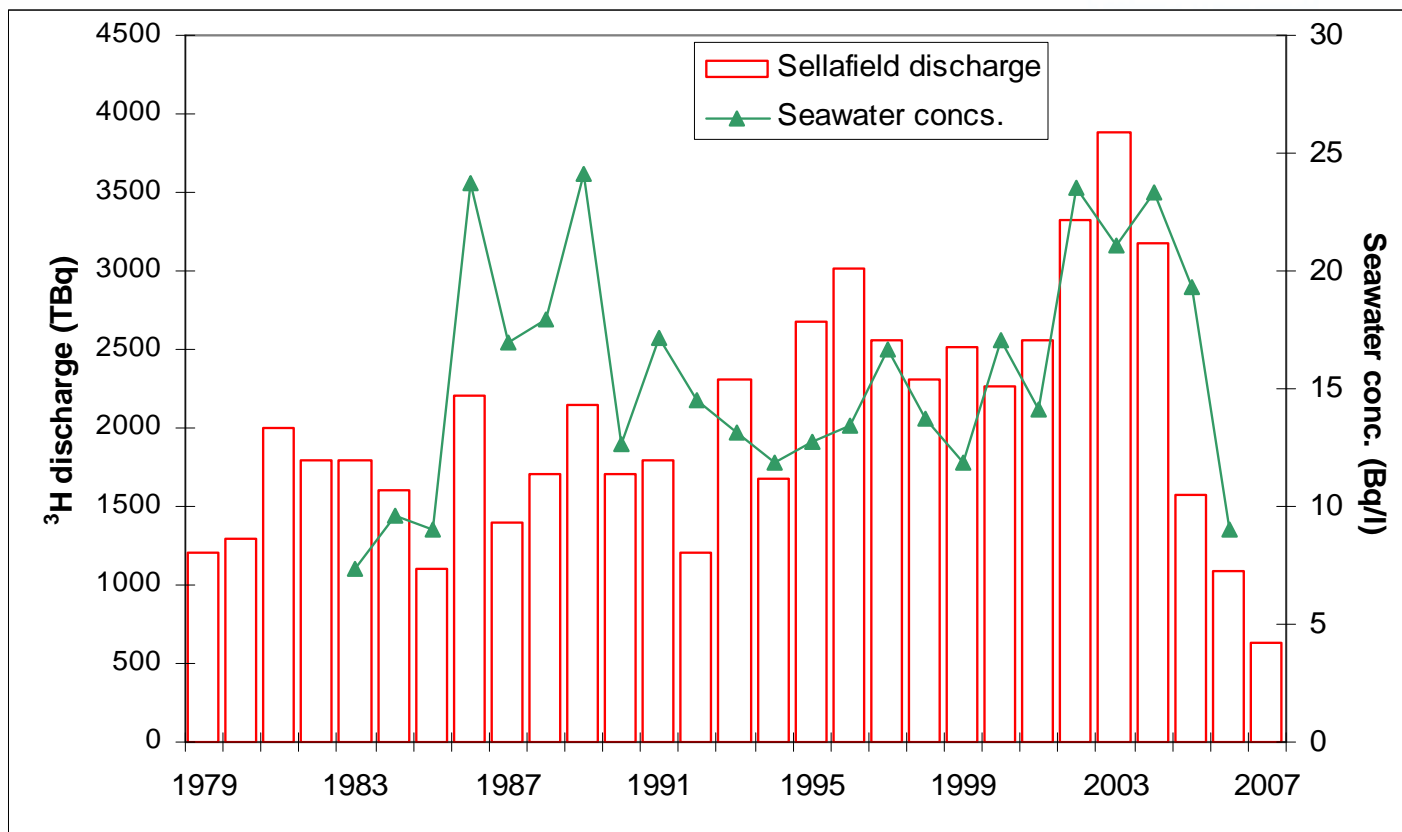
- Proportion of discharge from Cardiff was organic chemicals – OBT (~30%?)
 - i.e. amino acids, lipids, carbohydrates

Cardiff overview

- Proportion of discharge from Cardiff was organic chemicals – OBT (~30%?)
 - i.e. amino acids, lipids, carbohydrates
- High concentrations in fish and shellfish
 - Mean ~ 20 – 30000 Bq/kg in late 1990s
 - Individual samples above 50000 Bq/kg
 - Currently ~ 1500 Bq/kg
 - ~ 90-95% OBT

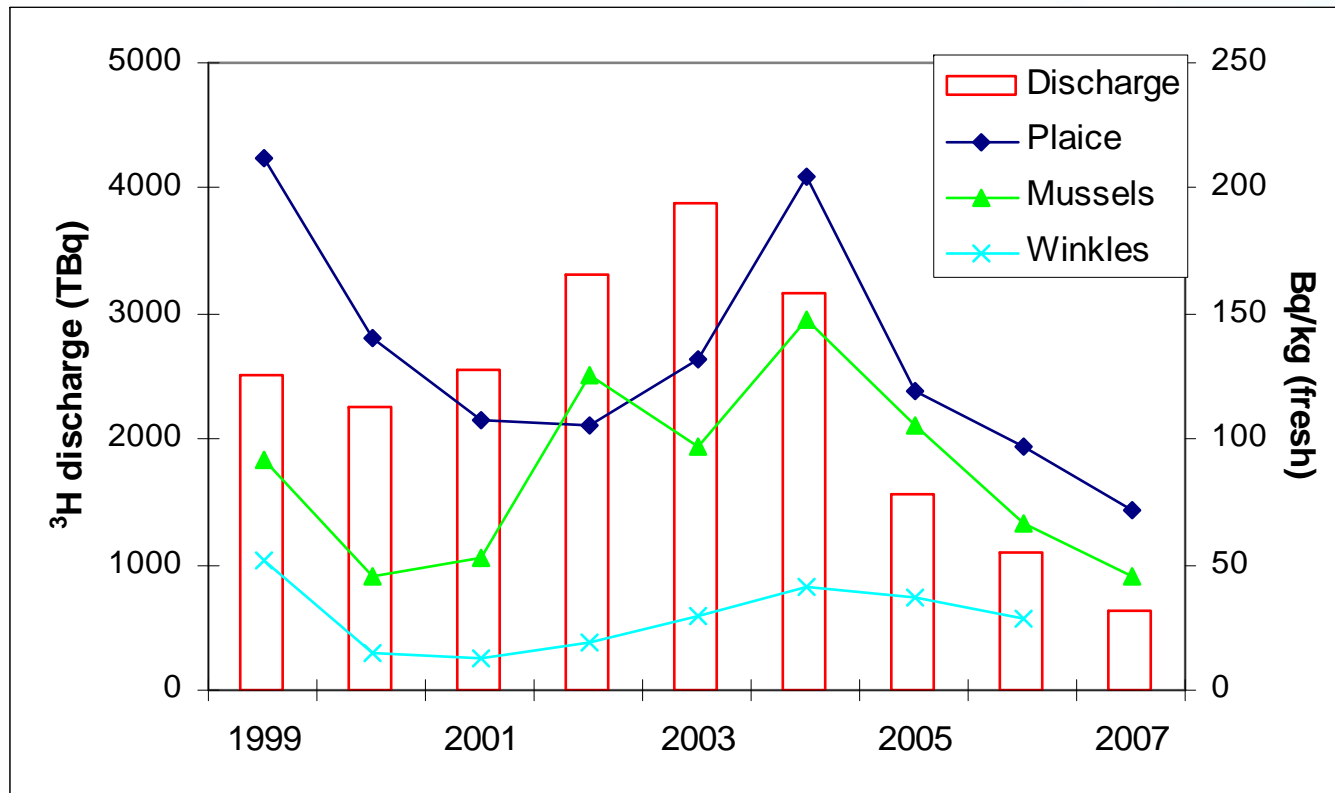
Sellafield – seawater

- Tritium discharges – relatively high - ~2000 TBq per year
- Mean seawater concentrations – ~10 – 20 Bq per litre



Sellafield - biota (total tritium)

- Lower concentrations despite greater discharges
- Apparent relationship with discharge



Sellafield overview

- Mean concentrations in biota generally above levels in seawater
 - ~ 50 – 150 Bq/kg
 - Seawater measurements range from below detection to > 100 Bq per litre

Sellafield overview

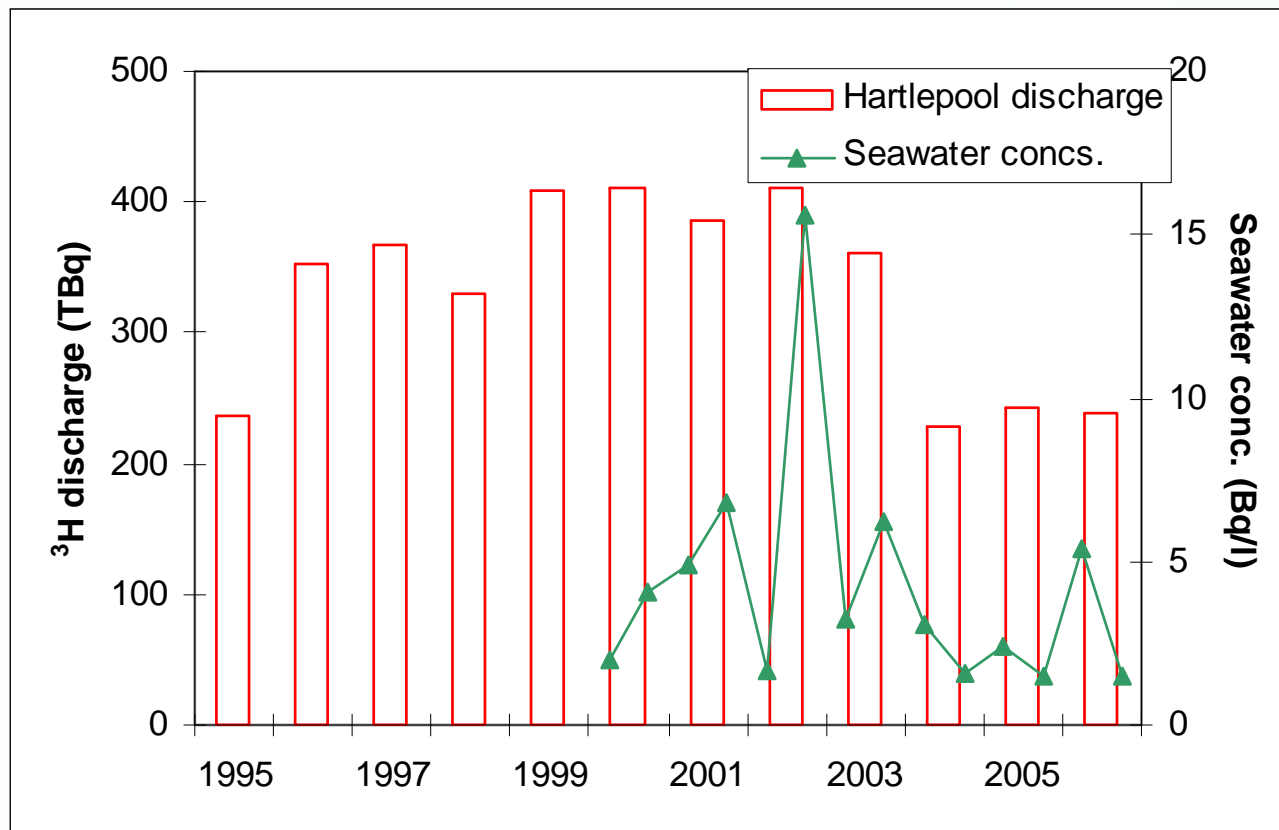
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Sellafield overview

- Mean concentrations in biota generally above concentration in seawater
 - ~ 50 – 150 Bq/kg
 - seawater measurements range from below detection to > 100 Bq per litre
- Fish/shellfish levels much lower than Cardiff
- ~80-90% OBT

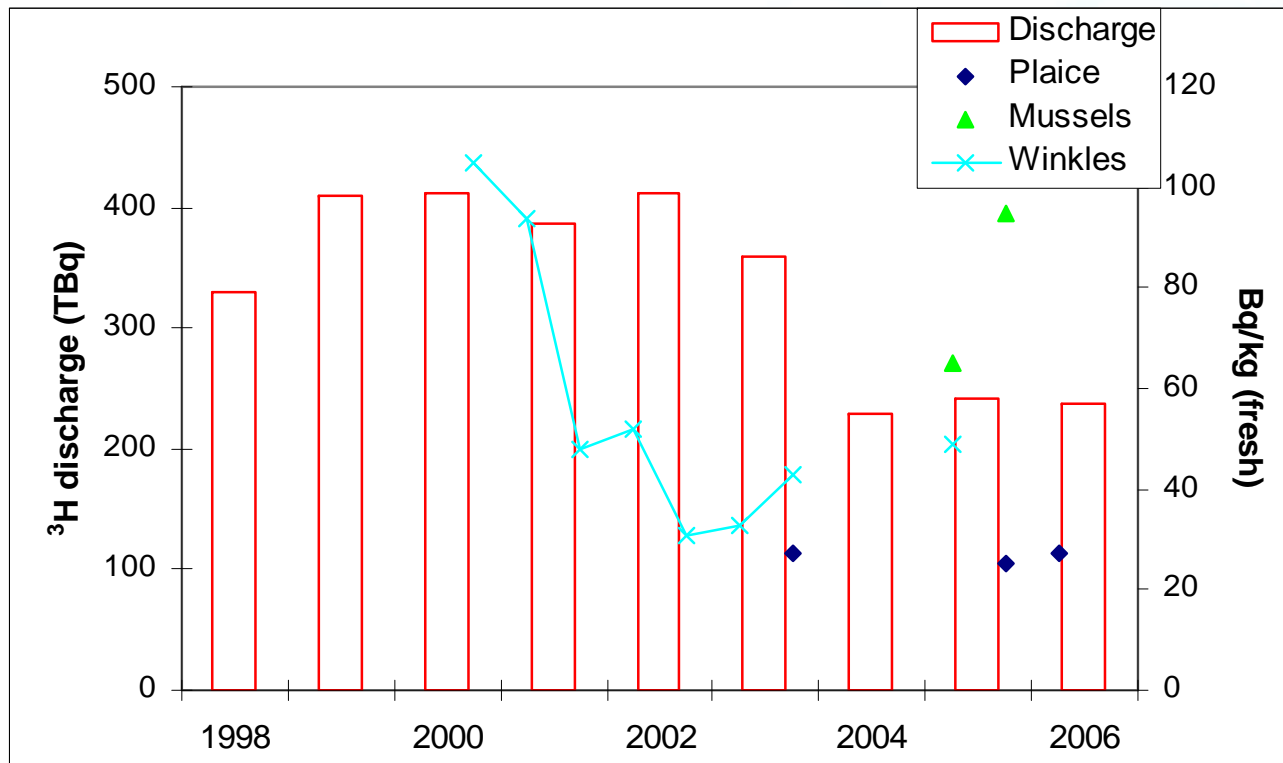
Hartlepool - seawater

- Discharges fairly constant - ~ 300 TBq per year
- Seawater concentrations - ~ 5 Bq per litre



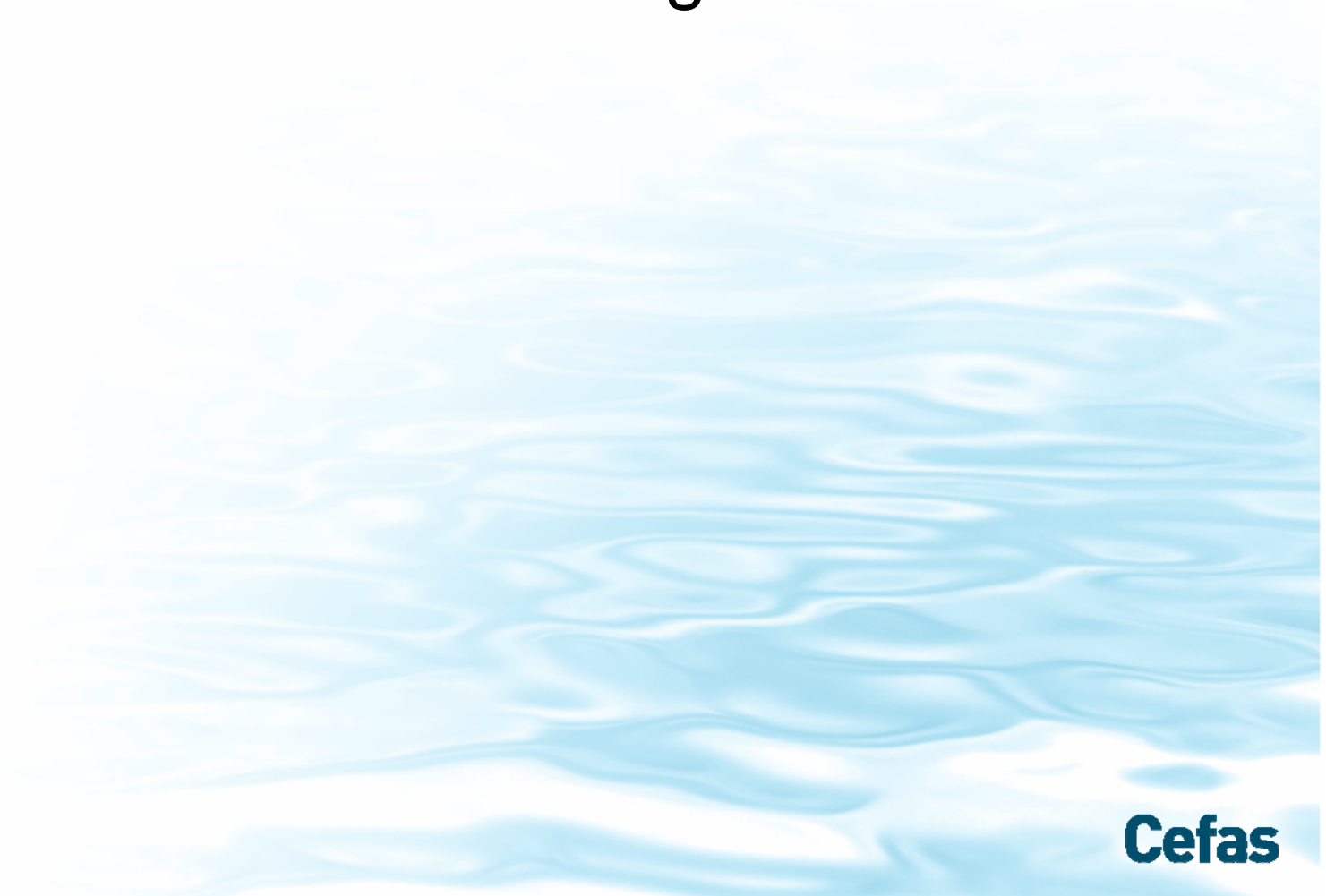
Hartlepool – biota (total tritium)

- Few samples above detection limit
- No discernible trend



Hartlepool overview

- Evidence of tritium discharge in seawater



Hartlepool overview

- Evidence of tritium discharge in seawater
- Levels in biota close to detection limits

Hartlepool overview

- Evidence of tritium discharge in seawater
- Levels in biota close to detection limits
- ~70% OBT in mussels
~90% OBT in winkles

Concentration factor (CF)

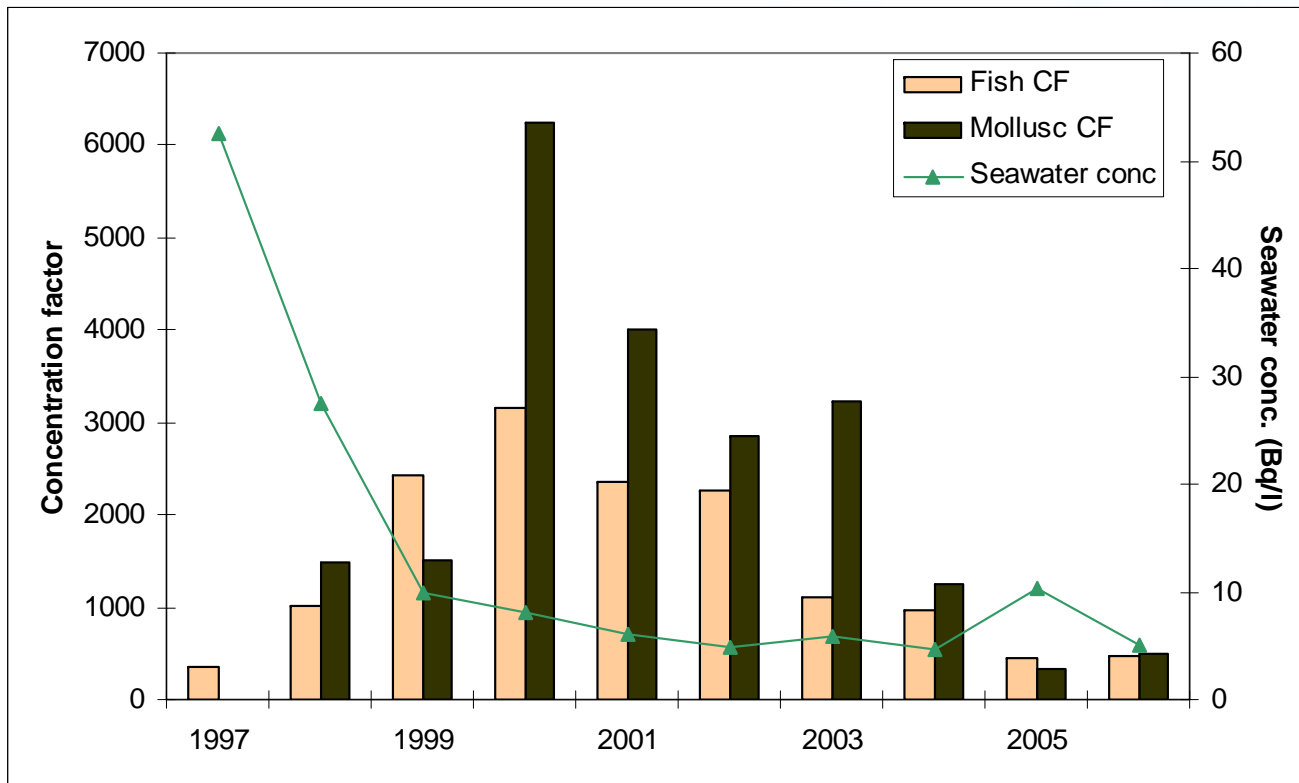
- Usual definition:

$$CF = \frac{\textit{Concentration}(\textit{biota})}{\textit{Concentration}(\textit{water})}$$

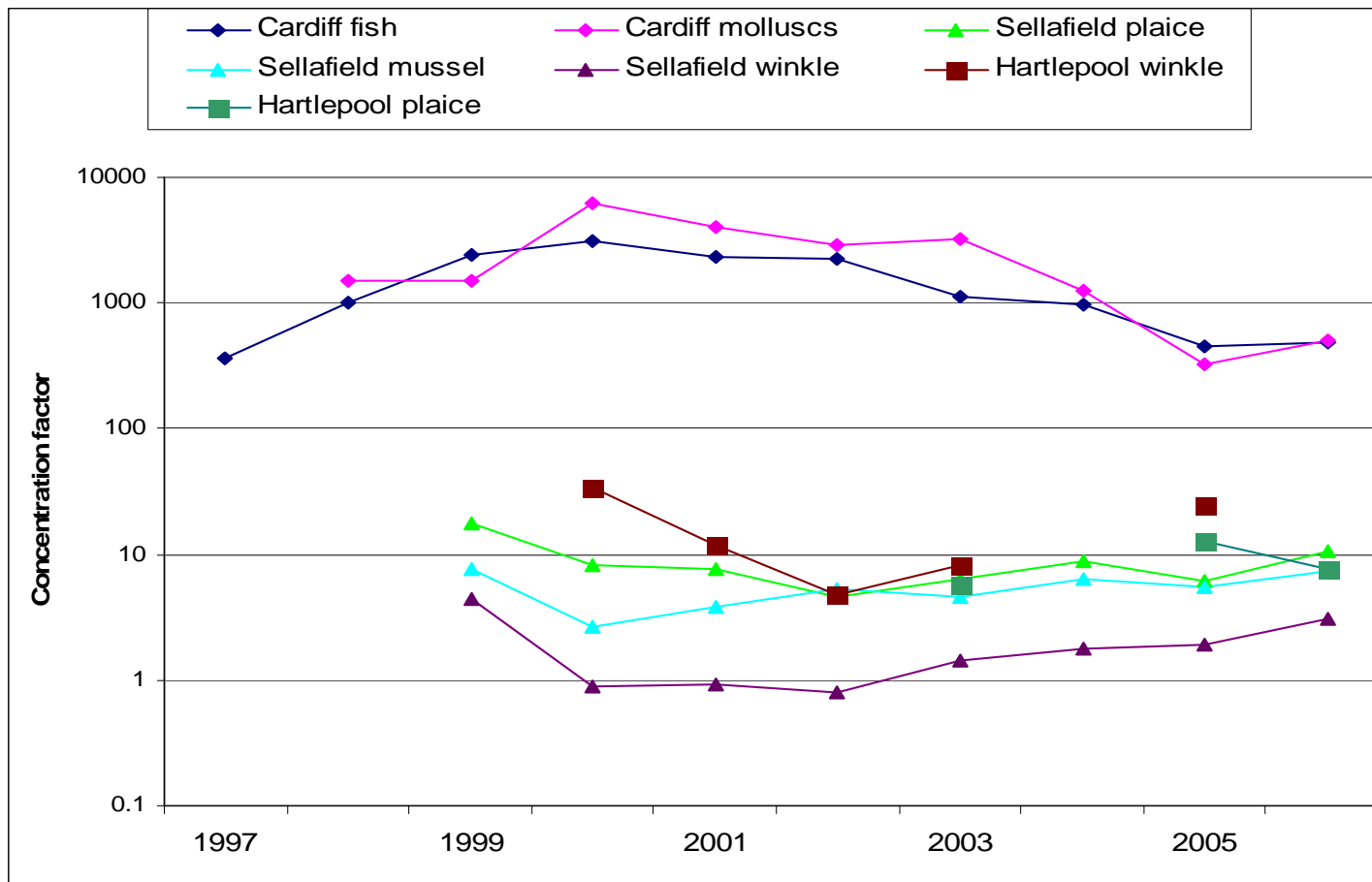
- Useful for observing trends
- CF for hydrogen → 1

CF trend – Cardiff

- Apparent CF up to 6000
- Currently ~ 500 in both fish and molluscs



Sellafield and Hartlepool CFs much lower - ~10



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HTO → OBT

e.g. Williams et al. 2001. J. Radiological Protection **21**(4);
McCubbin et al. 2001. Marine Pollution Bulletin **42**(10)

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HTO → OBT

- Observed result:

CF ~300 – 6000

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- Direct to sea
- Why are Sellafield and Hartlepool CFs >1 ?
 - Possible formation of organic complexes prior to discharge
 - Possible formation of organic complexes in marine environment (e.g. Turner *et al.* 2009 *J. Environ. Rad.* **100**(10))

Uncertainties in determining 'enhancement'

- High limit of detection by current analytic method
- CF method assumes equilibrium
- Composition of effluent
- Different methods and measurements

Finally -

- Better understanding:
 - Improve detection limits
 - Controlled lab experiments
 - Composition of effluent

Thank you