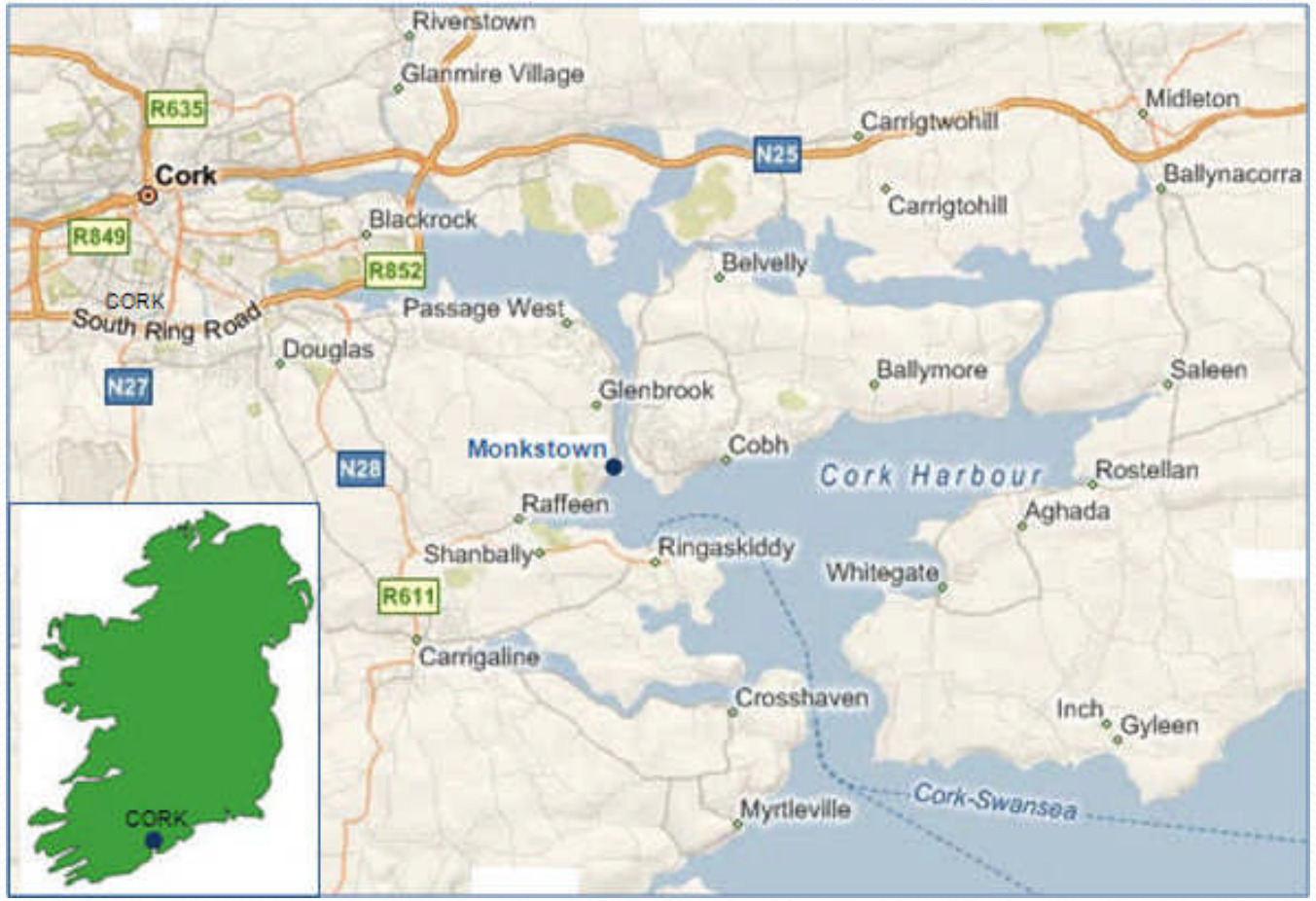
Residue Monitoring in Bovine Herds adjoining Industrial clusters in County Cork

Jim Buckley, MVB, MVM, MRCVS (Former CVO, Cork County Council)

4th December, 2013

Area Map


Riverstown
Glanmire Village
R635
Cork
R849
Blackrock
R852
CORK
South Ring Road
Passage West
Douglas
N27
Glenbrook
Monkstown
N28
Cobh
Cork Harbour
Raffeen
Shanbally
Ringaskiddy
R611
Carrigaline
Crosshaven
Myrtleville
Cork-Swansea
Inch
Gyleen
Whitegate
Aghada
Rostellan
Ballymore
Saleen
Belvelly
Carrigtwohill
N25
Midleton
Ballynacorra
Carrigtohill
CORK

Surveillance Programme

- Baseline Data
- Herd Health
- Productivity
- Tissue Residues

[Buckley & Larkin 1998, Buckley et al 2007]

Sentinel

- A biological monitor species that accumulates a pollutant in their tissue without significant adverse effects

- A sentinel is an animal that is used to measure pollution exposure (or effect) in a particular species as a measure of the ambient levels of potential pollutants in an area

[Beeby, 2001]

Biological Markers

- **Classified as:**
  - Markers of Susceptibility – inter-current disease, background metabolic disease
  - Markers of Effects – signals of tissue dysfunction, e.g. Liver enzymes, morbidity, mortality, clinical pathology & clinical findings
  - Makers of Exposure – residue levels in bovine milk, i.e. Dioxin / PCB levels

[**Crowley et al 2013 in-press**]

Public Concern – Residues – Persistent Organic Pollutants

- POPs – a Group of toxic chemicals
- Persistent in the environment
- Lipophillic – bioaccumulate in the food chain
- Transported long distances via air and water
- Micro-pollutants – exhibit toxic effects at very low concentrations
- Long latency period – years / decades

[O'Donovan et al 2010]

Dioxins – Regulation EC No. 1881/2006

- **PCDDs** – 75 polychlorinated dibenzo-p-dioxin congeners
- **PCDFs** - 135 polychlorinated dibenzofurans congeners, 17 are of toxicological concern (e.g. 2, 3, 4, 7, 8 TCDD – most toxic)
- **PCBs** – Polychlorinated biphenyls – a group of 209 congeners based on the biphenyl molecule
- **Dioxin-like PCBs** – 12 are similar to dioxins chemically and toxicologically

Dioxins – Production - Sources

- Not produced intentionally – no known use

- Main potential sources include:
  - Accidental burning
  - Traffic emissions
  - Backyard burning of domestic waste
  - Emissions from domestic heating
  - Emissions form industry, power generation and incinerators

[Ref: EPA 2012]

Biological & Ecological significance

- Toxic effects include endocrine dysfunction, immunotoxicity and carcinogenicity.
- Dioxins and PCBs are now ubiquitous and detectable in most environments world wide
- Trace quantities of dioxins and PCBs have been found in the atmosphere, soil, plants, wild / domestic animals and humans
- 90% of the non-occupations human intake of PCDDs / PCDFs and of dioxin-like PCBs is via ingestion
- Less than 10% of intake attributed to inhalation and other routes
- Human breast milk, dairy products & fish can be significant sources – eggs and meats to a lesser extent - as a result of feedstuff contamination

[EU Scientific Committee on Food, 2000, EPA 2012, Scientific Committee on Food, 2000, O'Donovan et al, 2010]

Dioxins in Cows' Milk

- Concentration in bovine milk is dependant on contamination of pasture or other feed material
- Dairy cattle:
  - have an average lifespan of 9 years in the region
  - Occupy an important position in the human foodchain – meat and milk
  - Are subject to local environmental pollution through ingestion / inhalation
- Bovine milk suitable matrix for risk of human exposure

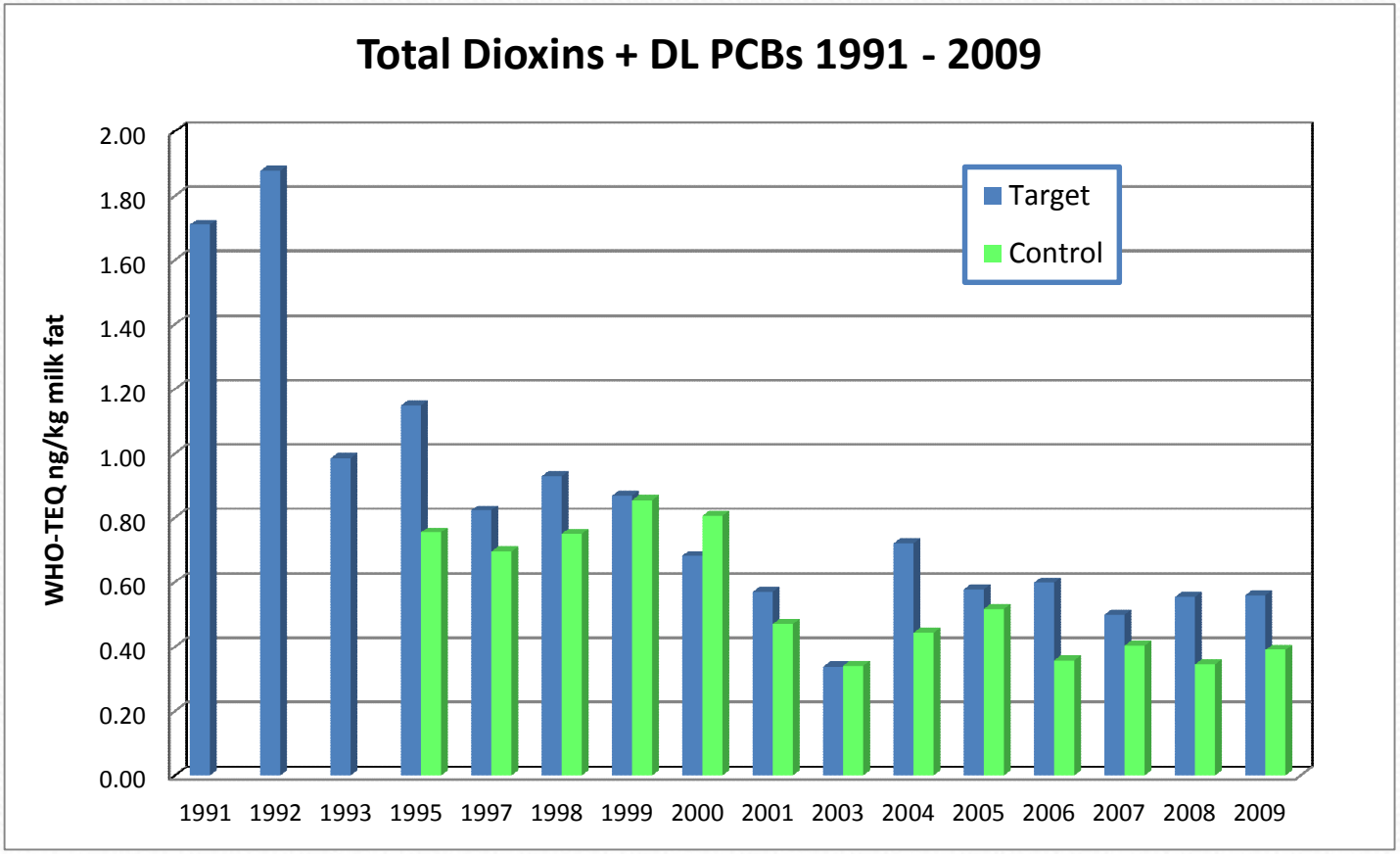
Objectives

- To determine the concentration of dioxins and dioxin-like PCBs in bovine milk samples from target and control herds in the South Cork Region
- To identify any temporal trends in these concentrations over time (2005-2010 and 1991-2004)
- To compare observed levels with data from similar studies

Laboratory Testing

- Milk fat extracted from prepared milk samples was examined for concentrations of dioxins, furans and PCBs using Isotope dilution methods, high performance gas chromotography (HPGC) and high resolution mass spectrometry (HRMS)
- Accredited laboratories, in line with DIN EN ISO-IEC 17025:2000 in Germany (1991 – 2005) and laboratories in compliance with Reg. EC No. 1883/2006 and EC No. 1181/2006 in the UK (2006 – 2010)
- Sample and trend analysis were facilitated and funded by the FSAI.

Results



[Ref Crowley et al 2013 in-press]

Dioxins, Dioxin-like PCBs and Marker PCBs 1991 - 2009

- Total WHO TEQ and DL-PCB TEQ in ng/kg fat ranged from 0.41 – 0.71 ng/kg fat total TEQ with an yearly average of 0.56 ng/kg fat TEQ
- The sum of Marker 6 PCBs ranged from 0.39 – 0.6 ug/kg fat with yearly averages of 0.51 and 0.49 ug/kg fat (2008 & 2009, respectively)
- Results for Control samples range from 0.29 – 0.41 ng/kg fat total TEQ with yearly averages of 0.35 and 0.39
- The sum of Marker 6 PCBs ranged from 0.29 – 0.47 ug/kg fat with yearly averages of 0.4 and 0.38 (2008 & 2009, respectively)

Residue Trends in Bovine Milk

- Total dioxin content in Target Herds was highest between 1991 & 1992 – peaked at a WHO-TEQ of 1.87 ng TEQ/kg milk fat
- Total dioxin decreased to approx. 0.85 ng TEQ/kg milk fat in the late 1990s
- Further decreases were evident throughout the 2000s and generally stabilised at or below 0.6 ng TEQ/kg milk fat, which is 10% of the recommended level (Reg. EC No. 1881/2006)
- Similar trends were evident in the Control Herds
- Total dioxin WHO/TEQ in both Target & Control milk have exhibited strong downward trends – approx. 45% overall

Comparative Studies

- The reduction in total dioxins in milk produced in the Cork Harbour area is similar to the trend observed in the UK and globally EU SCF, 2000 and also in Irish cows' milk
- A mean 33% decrease in dioxin levels nationally was noted between 1995 & 2004 (EPA 2005)
- Average values for total dioxins measured by EPA since 2000 were 0.44 and 0.35 WHO-TEQ ng/kg milk fat (Cork Harbour and adjacent areas)
- The results from this study are in line with those from other EPA surveys, both locally and nationally

Conclusion

- The observed fall in PCDD/Fs and, in particular, PCBs in Target and Control bovine milk between 1991 and 2001, may be attributed to:
  - Regulations banning burning slack and bituminous coal in the designated area of Cork
  - The introduction of unleaded petrol and improved energy efficiencies
  - The introduction of the integrated pollution control IPC licensing system (EPA 1993)
  - Significant investment by industry in stack infrastructure (scrubbers, disposal of fly ash etc)

Acknowledgements

- Special thanks to ;
  - Participating Dairy Farmers,
  - Veterinary Practitioners,
  - Agricola Processing (Fermoy),
  - Teagasc Agricultural Advisors
  - Clinical Pathology Lab (UCD, Belfield, Dublin 4)
  - DAFM Regional Veterinary Laboratory, Model Farm Road, Cork
  - FSAI (Dr Christina Tlustos)
  - EPA , Licensing & Enforcement Section (Mr Peter Cunningham)

References

- Beeby, A. (2001). What do sentinels stand for? *Environmental Pollution*, 112, 285-298.
- Buckley, J., Larkin, H. (1998). Health surveillance of cattle in the vicinity of a chemical industrial complex. *Veterinary Record*, 143, 323-326.
- Buckley, J., O'Donovan, J.V., Berry, D.P., O'Mahony,P., O'Farrell,K.J. (2007). Comparison of production and calving data for 10 Irish dairy herds in the vicinity of an industrial chemical complex and 10 dairy herds in rural, non-industrialised areas. *Veterinary Record,* 161, 841-845.
- EC (European Commisssion). (2006). Reg. 1881/2006
- EPA (2012). (Concannon, C.) Dioxin levels in the Irish environment. Ninth Assessment (Summer 2011) based on levels in cows' milk. EPA, Wexford, Ireland.
- European Union Scientific Committee on Food (EU, SCF). (2000). Opinion of the SCF on the risk assessment of dioxin and dioxin-like PCBs in food. http://europa.eu.int/comm/foods/fs/sc/scf/index_en.html
- O'Donovan, J.V., O'Farrell, K.J., O'Mahoney, P., Buckley, J.F. (2010). Temporal trends in dioxin, furan and polychlorinated biphenyl concentrations in bovine milk from farms adjacent to industrial and chemical installations over a 15 year period. *The Veterinary Journal*, 190, 117-121.
- O'Farrell, K.J., MacCarthy, D.D., Crinion, R.A.P. and Sherington,J. (1986). Metabolic Profiles of Dairy Cows. 1. The effects of season, nitrogen level and stocking rate. *Irish Veterinary Journal*, 40, 42-52.
- Animal Health Surveillance of Dairy Herds in the Vicinity of a large chemical industrial complex in the Cork Harbour region, 2005/10 (2013), Crowley D., Buckley J, Keohane C, Larkin H, O'Farrell KJ, Berry D, Tlustos C, Sayers R