Environment Canada Environnement Canada

Canada

An Overview of Canadian Water Quality Guidelines

USEPA Expert Meeting
Washington DC

Doug Spry
Science and Technology Branch
14 Sep 2015

I was asked to discuss…

1) What Canada has done so far in terms of aquatic life criteria

2) The methodology that Canada uses
   - Two protocols 1991, 2007

3) Challenges that Canada has had to deal with in developing national criteria

Factors that led us to where we are now…

- The **Science** of course, but also
- **Governance**
  - Canada as a Federation
    - Ten provinces, three territories, federal government
    - Provinces and Territories are the managers of their Water Resources
    - Some jurisdictions use only the national water quality guidelines, others may combine with their own
  - Canadian Council of Minsters of the Environment (CCME)
    - "CCME is the primary minister-led intergovernmental forum for collective action on environmental issues of national and international concern." – www.ccme.ca/en/about/index.html
    - "CCME is supported financially and in kind by the environment departments of the [Canadian] governments"
    - Consensus-based decision-making

Factors con't

- **Policy**

  Science can inform, but not resolve, some decision points

  - Biological data requirements (how much data?)
  - Acceptable effect level: no effect or some low effect?
  - Multiple species?, multiple endpoints (survival, growth, reproduction)?
  - Protection goals (differ between US and Canada)
    - Intended Level of Protection and Margin of Safety
  - **Adoption/implementation of the Canadian Water Quality Guideline is voluntary**
    - no regulatory authority until incorporated into statutory consent documents (or regulatory tools)

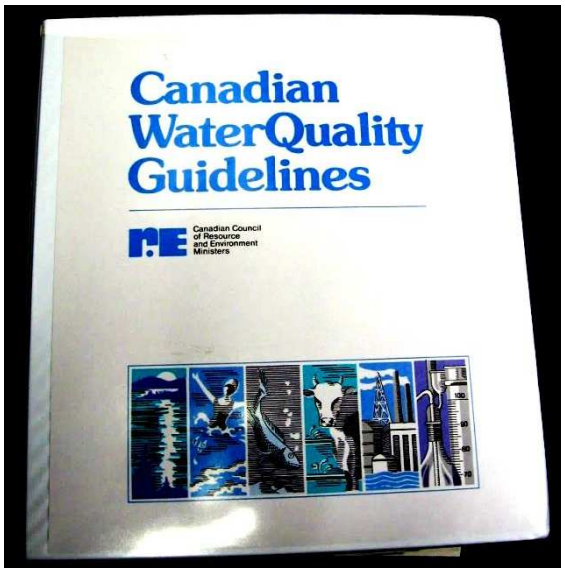
- **Borrowing** ideas/data from others (US, Australia, European Union, etc.)

A Sidebar on Terminology…

- The 1987 Canadian Water Quality Guidelines defined the following:
- **Criteria:** scientific data evaluated to derive the recommended limits for water uses.
- **Water quality guideline:** numerical concentration or narrative statement recommended to support and maintain a designated water use.
- **Water quality objective:** a numerical concentration or narrative statement which has been established to support and protect the designated uses of water ***at a specified site*** [italics added]
- **Water quality standard**: an objective that is recognized in enforceable environmental control laws of a level of government.

History

- **1987**: CCREM published the ***Canadian Water Quality Guidelines*** binder
  - 6 Chapters,
  - 4 Appendices

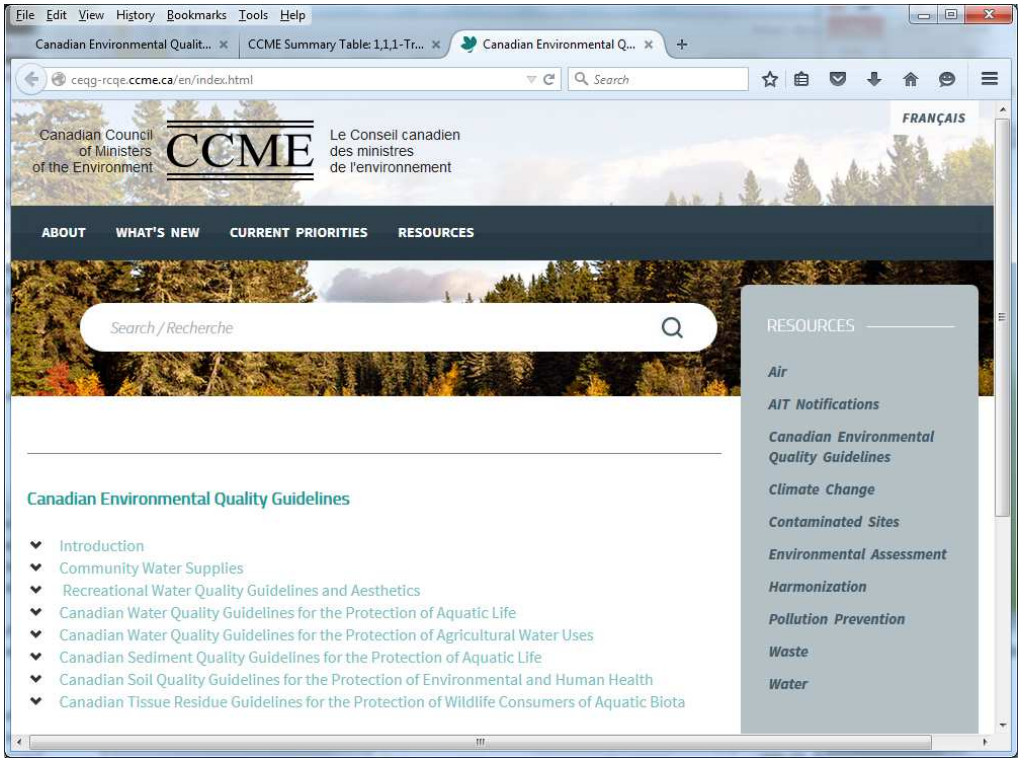


- Regarding Aquatic Life, the Guidelines laid out 6 policies, 2 of which:
  1. All ecosystem components to be considered. **Tentative guidelines preferable to no guidelines**
  2. **Guiding Principle** was enunciated.

Guidelines “are set at such values as to protect all forms of aquatic life and all aspects of the aquatic life cycles. The clear intention is to protect all life stages during indefinite exposure to the water.

History con’t

- **1989 - 1997**: Appendices V to XXIII
- **1991 -** Appendix IX - Protocol for the derivation of CWQGs
  - Chronic guidelines from chronic data
  - Critical toxicity value / SF
- **1999** - Publication of the suite of Canadian Environmental Quality Guidelines
  - Over 550 guidelines for over 220 substances



Revision to Protocol

- Why?

  The existing CTV / SF had been protective for decades, but we wanted to:

  - Incorporate newer science
  - Use all acceptable data in dataset
  - Statistical evaluation of result
    - confidence limits can be generated
  - Similar to other International methods
  - No arbitrary safety factor
  - Encourage new data generation

Revision to protocol, con't

- Started just after the 1999 suite was published
  - Developed by "Protocol Subgroup" of CCME Water Quality Task Group
  - British Columbia, Alberta, Ontario, Quebec, Environment Canada
  - Extensive consultation and review, internally, nationally internationally
  - Officially approved Summer 2007
  - Published on the CCME Website 2008
- Old guideline values will stand until updated

What was new in the 2007 protocol

- Expanded derivation methodologies (data quantity) and increased range of guideline types
  - Species sensitivity distribution (=Type A)
  - New short-term (acute - lethal) exposure (spills, transient event)
  - Better accounting for toxicity modifying factors
- Changes to endpoints and species
  - non-Canadian species, if appropriate surrogate
  - data quality and quantity influence how the guideline is calculated - Type A & B
- The **Guiding Principle** will be maintained for long-term exposure, *but not for short-term exposure*!

Steps in Guideline Derivation

- **Data Compilation and Evaluation**
  - Klimisch-type evaluation (1°, 2°, 3°=unacceptable)
  - Incorporation of Exposure & Toxicity Modifying Factors (ETMFs; e.g. pH, temp., DOM, hardness)
- **Guideline Value Determination**
  - Type A (SSD) or B1 / B2 (CTV/SF) determined by data quantity and quality
  - Guidance for specific water chemistry/conditions
- **Guideline Review and Approval**
  - Peer, Task Group, public reviews
  - CCME approval
  - Publication – CCME website

Minimum Toxicity Data Requirements for CWQG

Taxonomic Group	Exposure Duration	Freshwater		Marine	
		A and B1	B2	A and B1	B2
Fish	Long-Term & Short-Term	**3 spp** 1 salmonid 1 non-salmonid	**2 spp** 1 salmonid 1 non-salmonid	**3 spp** 1 temperate	**2 spp** 1 temperate
Aquatic Invertebrates	Long-Term & Short-Term	**3** spp 1 planktonic crustacean	**2 spp** 1 planktonic crustacean	**2 spp** 1 temperate	**2 spp**
Aquatic Plants	Long-Term	**1 sp** If phytotoxic, require 3	**Not required** If phytotoxic, require 2	**1 temperate** If phytotoxic, require 3 **(2 for B1)**	**Not required** If phytotoxic, require 2
	Short-Term	**Not required** If phytotoxic, require 2		**1 temperate** If phytotoxic, require 2	

Data hierarchy – Long-term data

Mix of hypothesis testing and regression endpoints

Most preferred

Least preferred

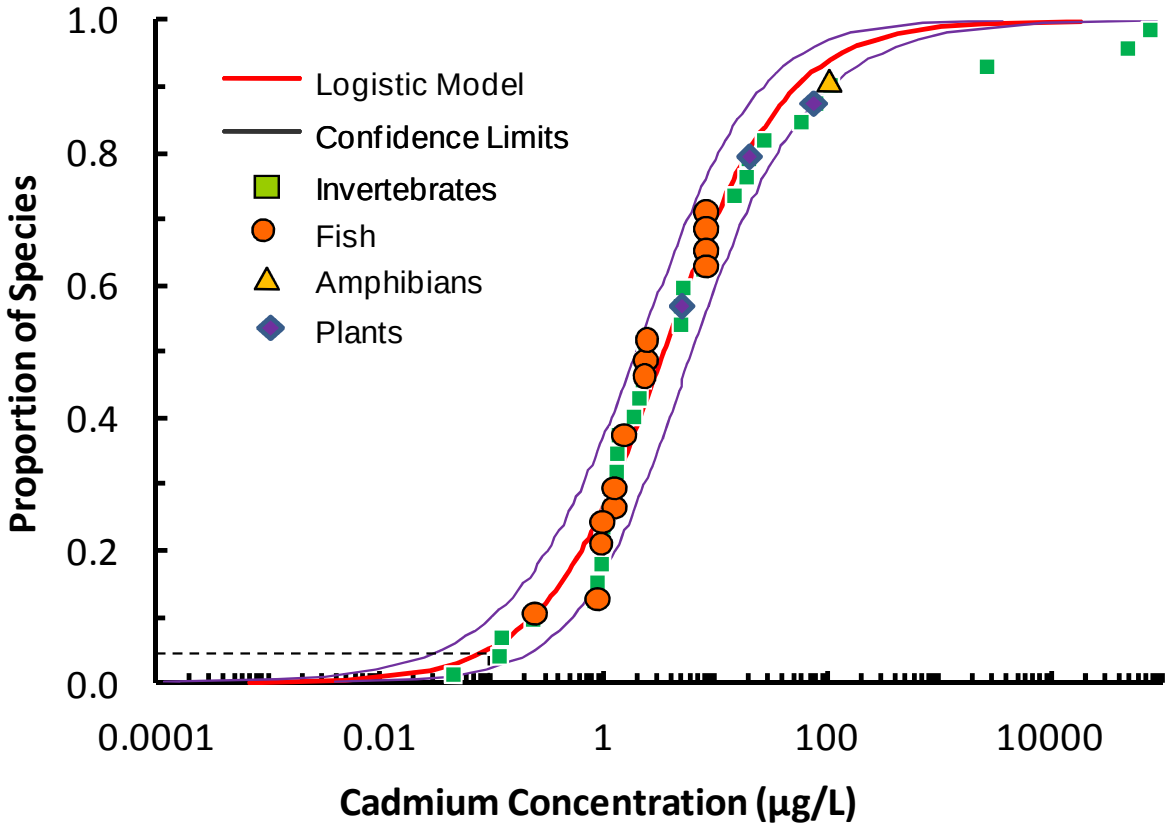
Type A:	Type B1 and B2:
No-effects threshold data	**Low-effects threshold data**
Most appropriate ECx/ICx	Most appropriate ECx/ICx
EC10/IC10	EC15-25/IC15-25
EC11-25/IC11-25	LOEC
MATC	MATC
NOEC	EC26-49/IC26-49
LOEC	Non-lethal EC50/IC50
EC26-49/IC26-49	LC50
non-lethal EC50/IC50	

Type-A (SSD) Derivation Process

- Data compiled, assessed, and entered into “SSD Master”
- Several curves are fitted using the most appropriate distribution and several models
  - currently 5: Normal, Logistic, Extreme value, Weibull, Gumbel, but not limited
- One species, one vote (one point on the curve)
- Best-fitting model curve is selected for guideline determination:
  - Statistical requirement: Model curve must pass “goodness of fit” test ($p < 0.05$) and visual inspection
  - If either toxicological or statistical requirement is not met, the next tier derivation method (Type B approach) will be used
- CWQG is the concentration corresponding to the 5th percentile of Y-axis (Hazard Concentration 5%ile)

SSD for Cadmium

"Primarily and preferentially" "no effects" data
- here normalized to 50 mg/L hardness

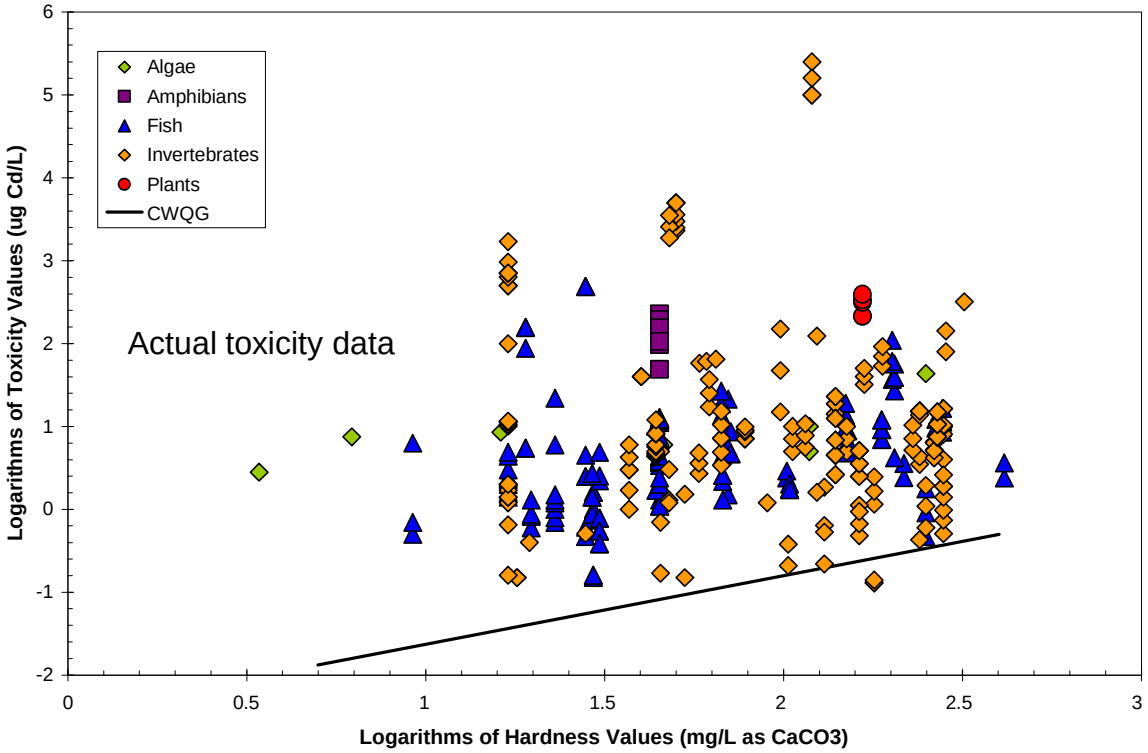


Type-A Derivation Process, con't

- Final considerations:
  - Endpoint for Species at Risk in Canada below HC5?
    - If so, then that No Effect endpoint becomes the WQG
  - Severe lethal endpoint at or below HC5?
  - Multiple endpoints for same taxon clustered at lower end of curve?

Evaluate protectiveness of the HC5

- Plot actual data or for MLR, simple hazard ratios of entire dataset (1 or 2 data) (endpoint conc / HC5)
- Ratio <1 indicates that HC5 may not be protective
- Examine and adjust lower if needed



Seven years of experience with the “new protocol”

- We (CCME) ended up in a different place than I expected.
  - We started with an effects curve and the 5th %ile of the lower confidence interval. We ended up not using the CI as safety factor
- Small datasets result in SSDs with wider confidence intervals (CIs used for Goodness of Fit assessment rather than as a “safety factor”)
- Addition of new data to small data sets has had unpredicted results
- Limited experience with EDCs or BLM yet but…Federally we are looking at these and also multiple linear regression

Experience with the new protocol con't

- Often difficult to obtain the necessary toxicity data to develop a robust SSDs
- Geometric means – guidance could be better
- We landed on "one species one vote", perhaps without better testing the other alternatives
- Every WQ Guideline derivation poses unique challenges
- Expert judgement is still required in data assessment and selection (potential downside, "gaming" is possible)
- More protocol guidance needed in some areas, too rigid in others
- We have, in essence, provided open source methodology; others outside government have developed and published guidelines.
- CCME has a "contributed guidelines" process

Setting priorities for chemicals

- CCME Water Quality Project Team has a process for setting priorities for WQG development
- Universe of chemicals potentially includes all substances (23,000 chemicals on the DSL for starters)
- Increasingly top down. Responsive to broad and varied policy needs
- Increasingly, monitoring and analytical methods need to be in place to support WQG development (from a WQG perspective)
- Currently working on silver (just published), zinc, manganese, carbamazepine

Challenges

- The consensus-based decision process continues to make it difficult/lengthy to adopt new science
- Similarly, making changes to policy is difficult/takes time
  - is the Guiding Principle realistic or aspirational?
- Margin notes in my copy of the protocol
  - Unresolved issues like surrogate species
- Getting the data necessary to develop guidelines, especially for “emerging concern” substances is difficult
- Setting priorities for WQG development is more removed from technical experts
- Diminishing resources

Advice/Observations

- Where we ended up was quite a bit different from where I expected.
- Educate yourselves and your clients and provide training *before* you get too far down the road (better uptake)
- Do good science but keep it accessible
- Document! Document! Document!

  'I know that you believe you understand what you think I said, but I'm not sure you realize that what you heard is not what I meant.'

  - Robert McCloskey

  - We are still discussing critical issues that weren't resolved at the beginning
  - This will help ensure transparency

Tim Fletcher ON

Isabelle Guay QC

Uwe Schneider ret.

Narender Nagpal BC

Intrinsik

Kelly Potter EC

Thank you !

Philippa Cureton EC

Susan Roe EC

Samantha Howe EC

Barry Zajdlik

Jonathan Hill EC

Tamzin El-Fityani EC

Joanne Little AB

Monica Nowierski ON

And thanks to all those who did the work!

Richard Casey AB

Marc Demers EC

And all the others who contributed

Sushil Dixit EC

doug.spry@ec.gc.ca

National Guidelines and Standards Office

Science and Technology Branch

Environment Canada