Australian Government
Department of the Environment and Energy
Supervising Scientist

Australian & New Zealand
GUIDELINES FOR FRESH & MARINE WATER QUALITY

Deriving water quality guideline values and using weight of evidence in water quality assessments

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Acknowledgments

GV derivation method

- Michael Warne, Graeme Batley, Jenny Stauber, David Fox, John Chapman, Chris Hickey

Weight of evidence guidance

- Chris Humphrey, Graeme Batley, Ross Smith, John Bennett

Coordination

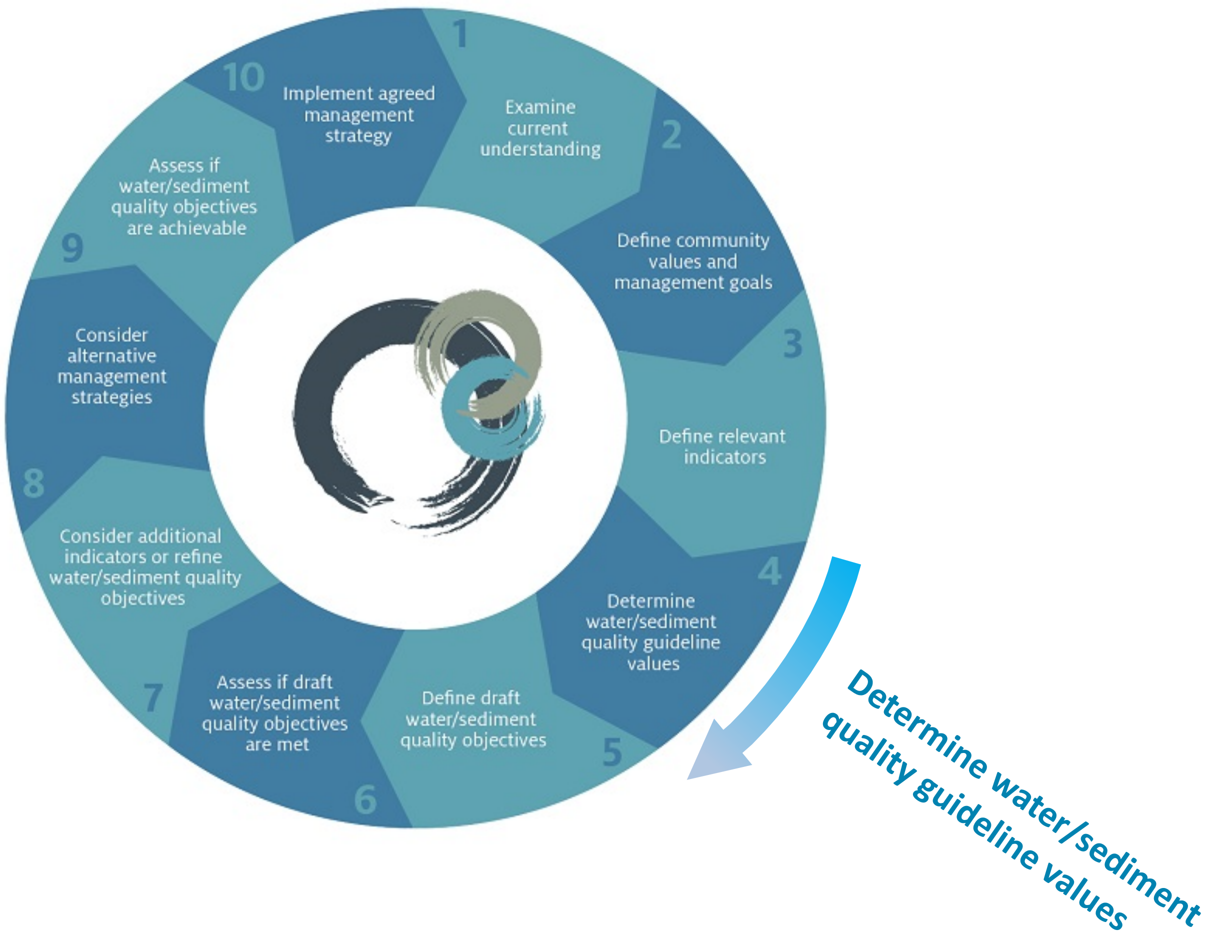
- Angela Slade
- Department of Agriculture and Water Resources

Australian & New Zealand
GUIDELINES FOR FRESH & MARINE WATER QUALITY

Outline

1. Guideline values
2. Revised method for deriving toxicant default guideline values
3. Other approaches for deriving guideline values
4. Using weight of evidence in water quality assessment
5. Concluding message

2. Guideline values



Guideline values

Definitions

Guideline Value (GV) (≈ Predicted no-effect concentration; PNEC)

- *A measurable quantity of a water quality indicator below which there is considered to be a low risk of unacceptable effects occurring to the aquatic ecosystem (or human health)*

Site-specific GV

- *A guideline value that is relevant to the specific location or conditions that are the focus of a given assessment or issue*

(Sub)catchment GVs

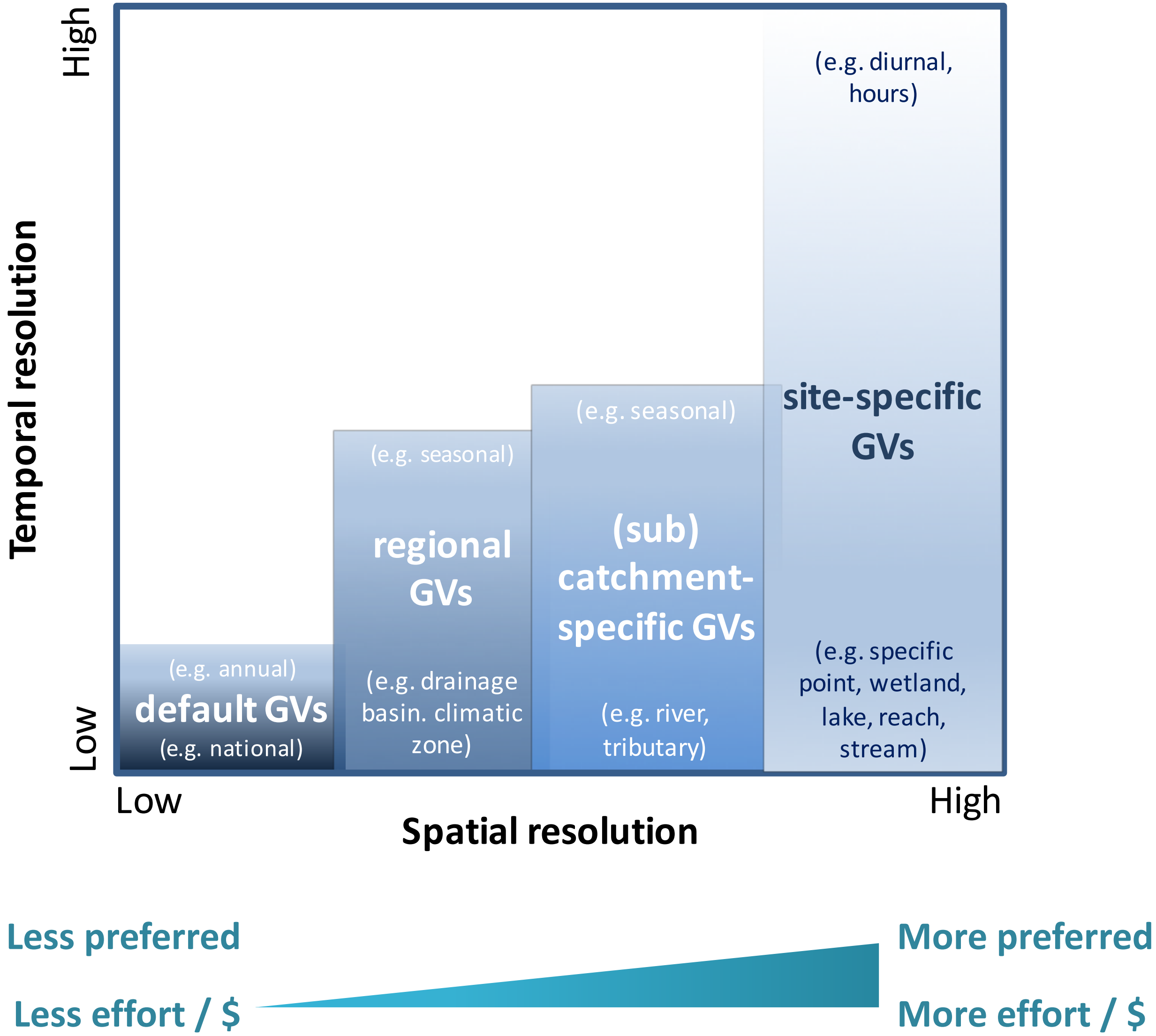
Regional GVs

Default GV (DGV – *or 'generic' GV*)

- *A generic guideline value recommended for application in the absence of a more specific guideline value (e.g. site-specific)*

Guideline values

Scale



Guideline values

DGVs for toxicants in 2000 (in Australia and New Zealand)

- Toxicant DGVs a key component of the 2000 Water Quality Guidelines (notwithstanding emphasis on preference for site-specific GVs over national DGVs)
- Adopted species sensitivity distribution (SSD) approach to deriving DGVs
    - Burrlioz 1.0
- Enormous effort to attempt to derive GVs for >250 toxicants (f'water & marine)

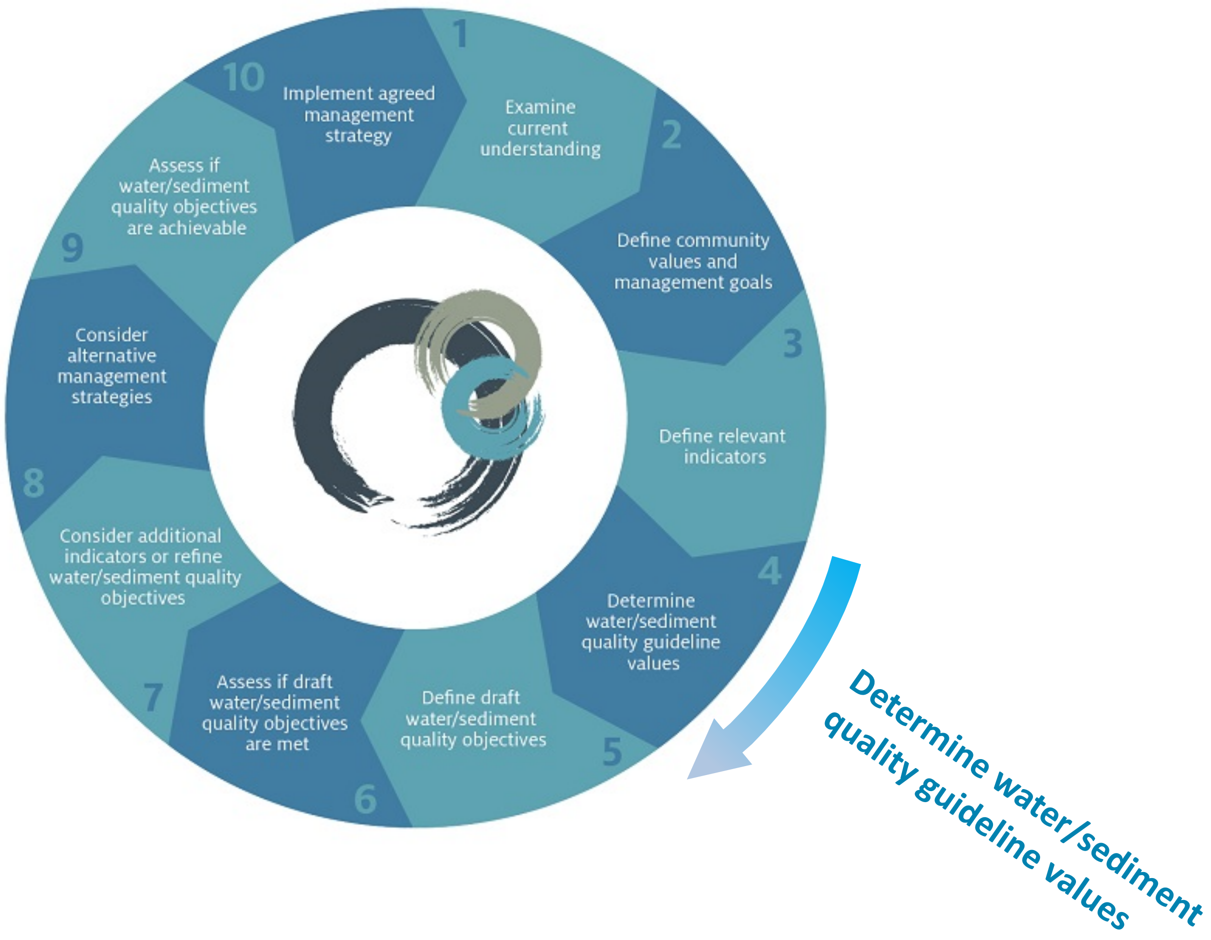
Table 3.4.1 Trigger values for toxicants at alternative levels of protection. Values in grey shading are the trigger values applying to typical *slightly–moderately disturbed systems*; see table 3.4.2 and Section 3.4.2.4 for guidance on applying these levels to different ecosystem conditions.

Chemical		Trigger values for freshwater (μgL^{-1})				Trigger values for marine water (μgL^{-1})			
		Level of protection (% species)				Level of protection (% species)			
		99%	95%	90%	80%	99%	95%	90%	80%
METALS & METALLOIDS									
Aluminium	pH >6.5	27	55	80	150	ID	ID	ID	ID
Aluminium	pH <6.5	ID	ID	ID	ID	ID	ID	ID	ID

- BUT >70% low reliability (Assessment factor method)

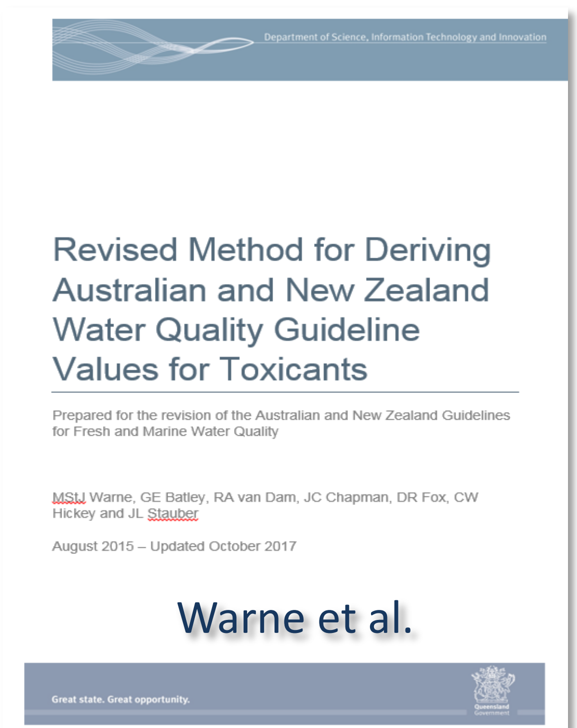
- No GVs updated post-2000 – even erroneous ones!

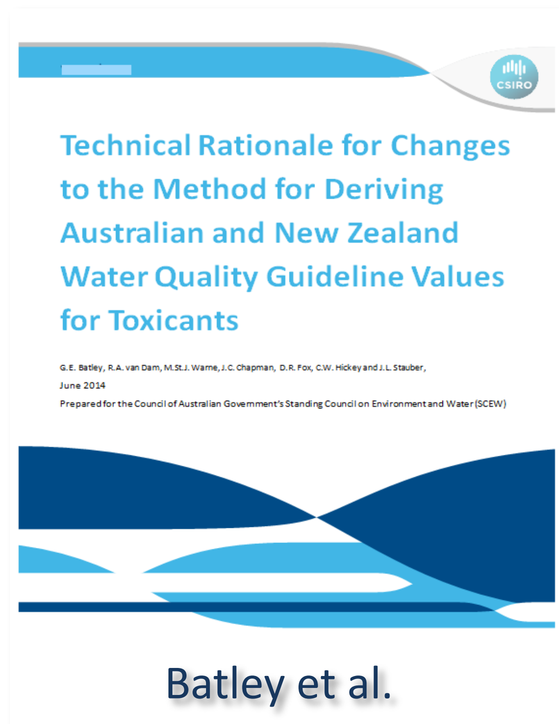
3. Deriving toxicant guideline values
(Warne et al. 2018)



Deriving toxicant GVs

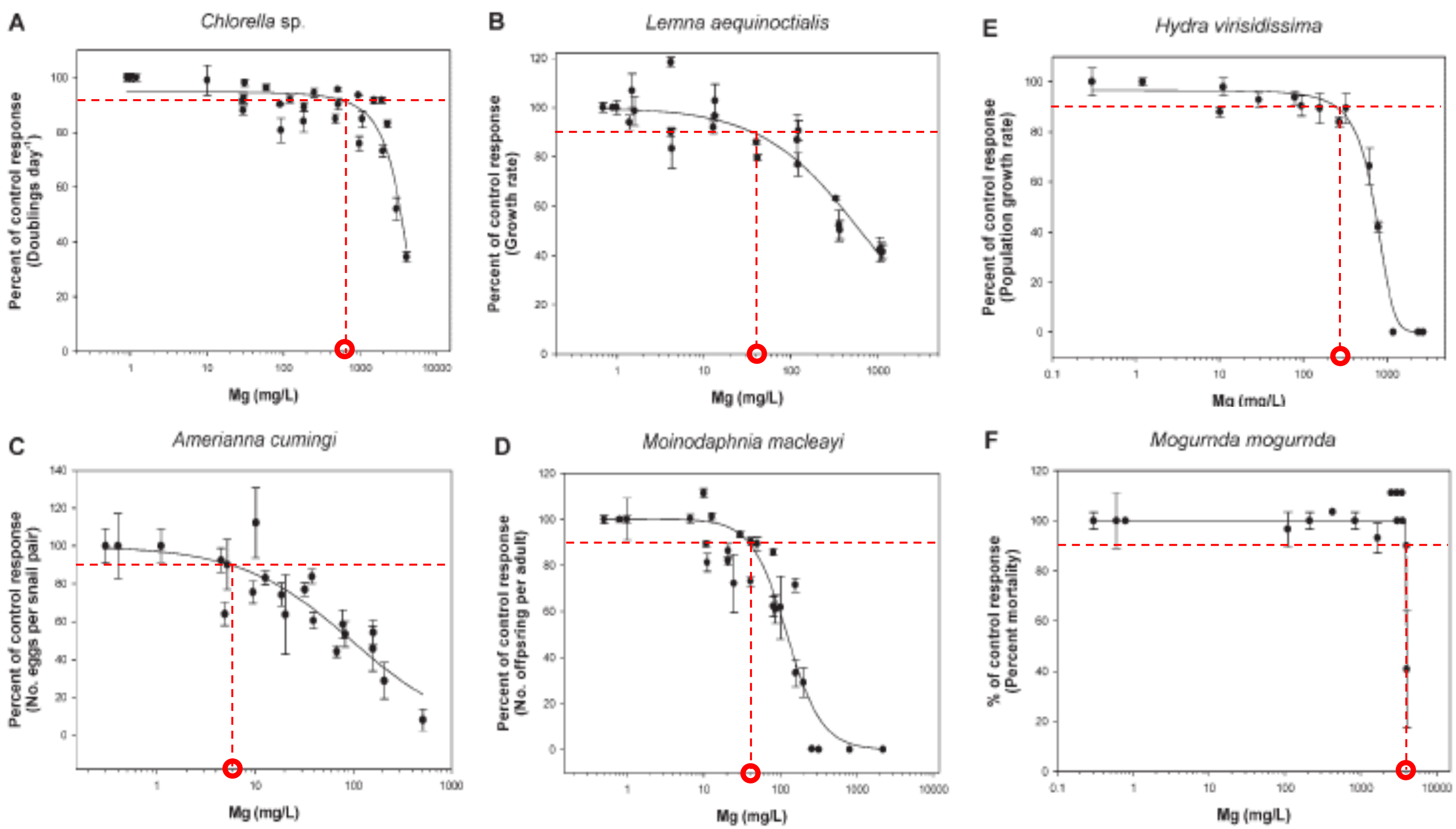
- Critical to have a technically robust approach for deriving default and site-specific GVs
- Opportunity to update the ANZECC/ARMCANZ (2000) SSD-based methodology AND use it to derive/revise some DGVs





Deriving toxicant GVs – at a glance (using lab data)

1. Generate/acquire appropriate* toxicity estimates (e.g. EC10s) from lab-based toxicity (concentration-response) experiments

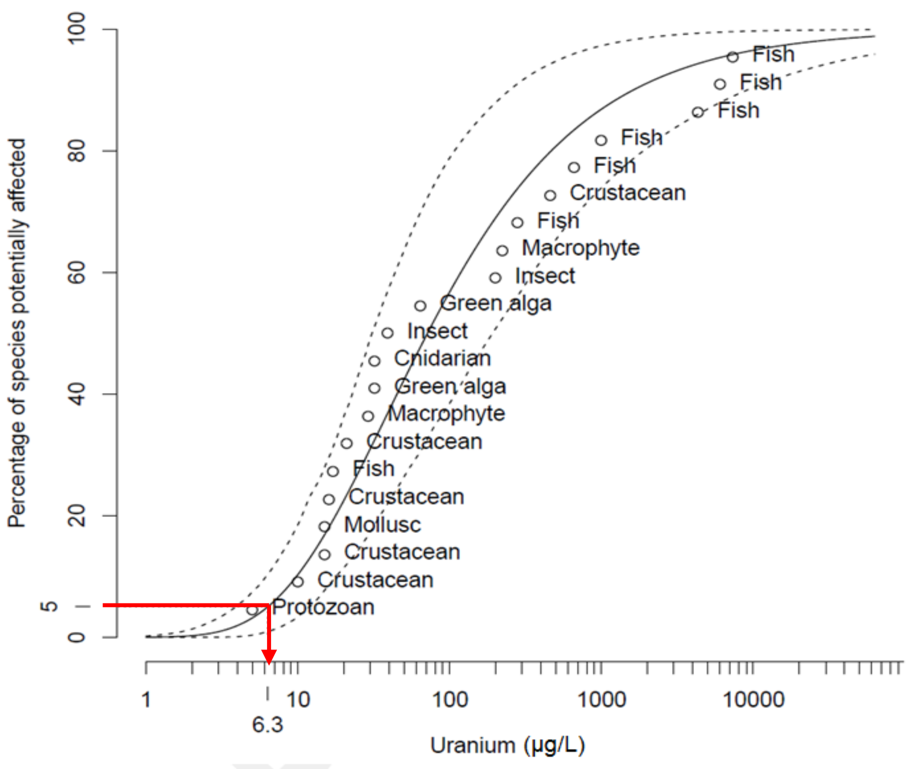


* Appropriate = acceptable type, quality, etc..

Deriving toxicant GVs – at a glance (using lab data)

2. If sufficient toxicity data*, collate data, consolidate to one value per species, plot as a cumulative frequency distribution, and fit a statistical model (species sensitivity distribution – SSD)

3. Interpolate/extrapolate concentration predicted to protect x% of species (e.g. 5th centile = concentration to protect at least 95% of species)

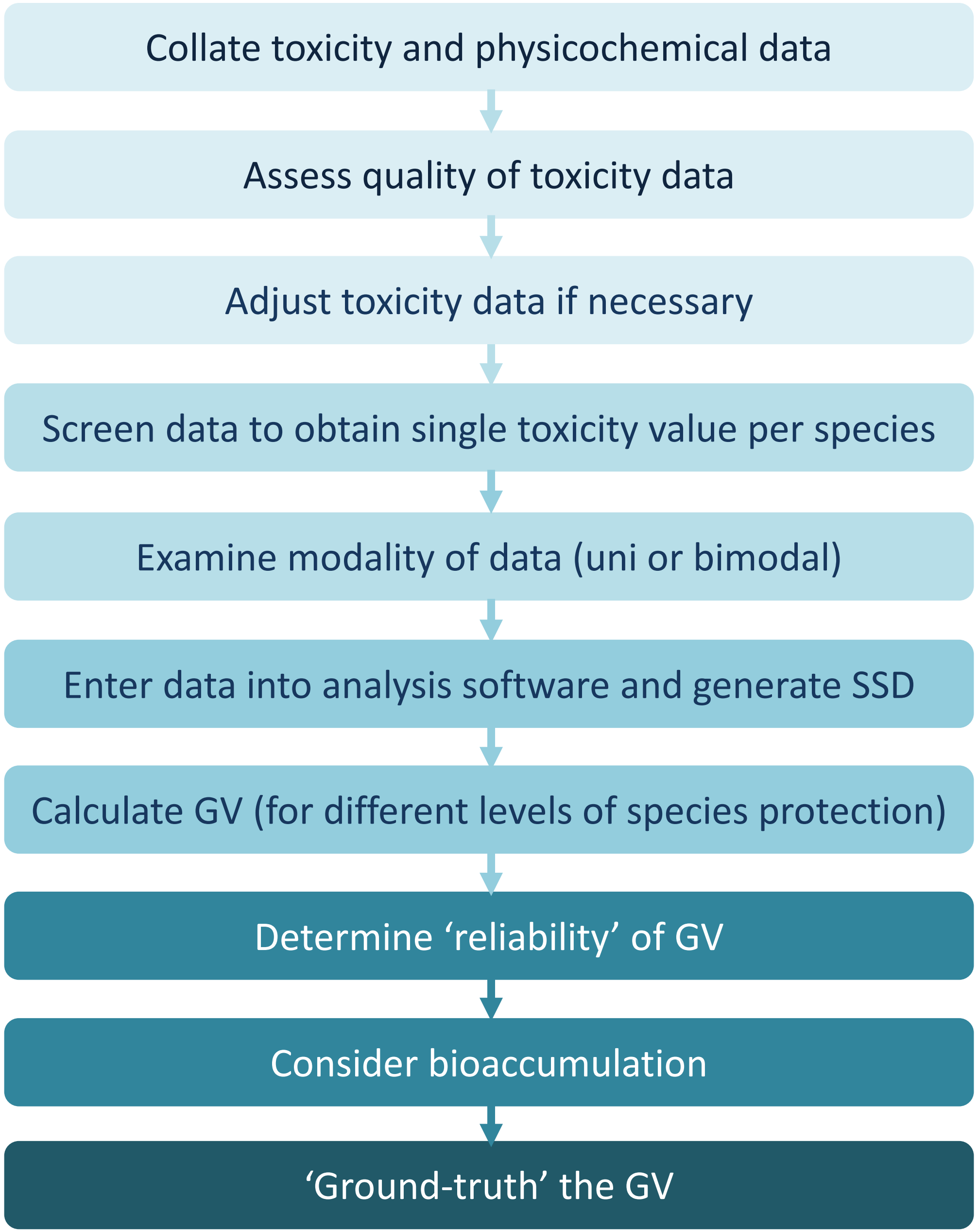


* Sufficient (in Aust/NZ) = Data for ≥ 5 species for ≥4 taxonomic groups for SSD method.

Deriving toxicant GVs – revised method

The process

(in more detail)



Deriving toxicant GVs – revised method

Key aspects

1. Updated classifications for acute and chronic toxicity tests
2. Broadened acceptable sources of data
3. Non-traditional endpoints admissible if ecological relevance can be demonstrated
4. Updated hierarchy of acceptable toxicity estimates
5. Ability to combine chronic and acute (converted to chronic) data
6. More flexibility in decisions – best professional judgment
7. Species sensitivity distribution-fitting – revised approach and software
8. Revised GV Reliability classification

Deriving toxicant GVs – revised method

Acute and chronic toxicity classifications

TOXICITY TEST	LIFE STAGE[a]	RELEVANT ENDPOINTS[b]	TEST DURATION
Acute			
Fish and amphibians	Adults/juveniles	All[c]	<21 d
	Embryos/larvae	All	<7 d
Macroinvertebrates[d]	Adults/juveniles	All	<14 d
	Embryos/larvae	All (except fertilisation, larval development/ metamorphosis)	<7 d
	Embryos/larvae	Larval development/ metamorphosis	<48 h
Microinvertebrates[e]	Adults/juveniles/larvae	All (except fertilisation and larval development – see microinvertebrate chronic)	<7 d
Macrophytes	Mature	All	<7 d
Macroalgae	Mature	Lethality and growth	<7 d
Microalgae	Not applicable	All	≤24 h
Microorganisms	Not applicable	All	≤24 h
Chronic			
Fish and amphibians	Adults/ juveniles	All[f]	≥21 d
	Embryos/larvae/eggs	All	≥7 d
Macroinvertebrates	Adults/juveniles/larvae	All (except reproduction, larval development/metamorphosis)	≥14 d
	Adults/juveniles/larvae	Reproduction	≥14 d (or at least 3 broods for large cladocerans)
	Larvae	Larval development/ metamorphosis	≥48 h
	Embryos	Fertilisation	≥1 h
Microinvertebrates	Adults/juveniles/larvae	Reproduction	≥7 d (or at least 3 broods for small cladocerans)
	Adults/juveniles/larvae	Lethality/immobilisation	≥7 d
	Larvae	Development	≥48 h
	Embryo	Fertilisation	≥1 h
Macrophytes	Mature	All	≥7d
Macroalgae	Mature	All	≥7 d
	Early life stages	Lethality	≥7 d
	Early life stages	Development	≥48 h
	Early life stages	Fertilisation	≥1 h
Microalgae	Not applicable	All	>24 h
Microorganisms	Not applicable	All	>24 h

[a] The life stage at the start of the toxicity test. [b] Endpoints need to be ecologically relevant – see the section - Acceptable test endpoints. [c] For acute tests, "All" refers to all ecologically relevant endpoints for a particular life stage of a particular species. [d] Macroinvertebrates include invertebrates where adults are ≥2 mm long (e.g. decapods, echinoderms, molluscs, annelids, corals, amphipods, larger cladocerans (such as *Daphnia magna*, *Daphnia carinata* and *Daphnia pulex*) and insect larvae of similar sizes with life cycles markedly longer than most microinvertebrates. [e] Microinvertebrates are operationally defined here as invertebrate species where full grown adults are typically <2 mm in length with relatively short life cycles. Examples of invertebrates that meet this criterion are some cladocerans (e.g. *Ceriodaphnia dubia* and *Moina australiensis*), copepods, conchostracans, rotifer, acari, bryozoa, and hydra. Large cladocerans such as *Daphnia magna* or *Daphnia pulex* are macroinvertebrates. [f] For chronic tests, "All" encompasses all ecologically relevant endpoints measured in both single and multi-generation tests.

Deriving toxicant GVs – revised method

Updated hierarchy of acceptable toxicity estimates

- Chronic no/low effect data – NEC, EC/IC/LCx where $x \leq 10$, BEC10, EC/IC/LC15-20, NOEC

If too few or none of these:

  - Chronic effect data (e.g. EC50) converted to chronic no/low effect data
  - Acute data converted to chronic no/low effect data

- Can combine chronic and (converted) acute data if necessary

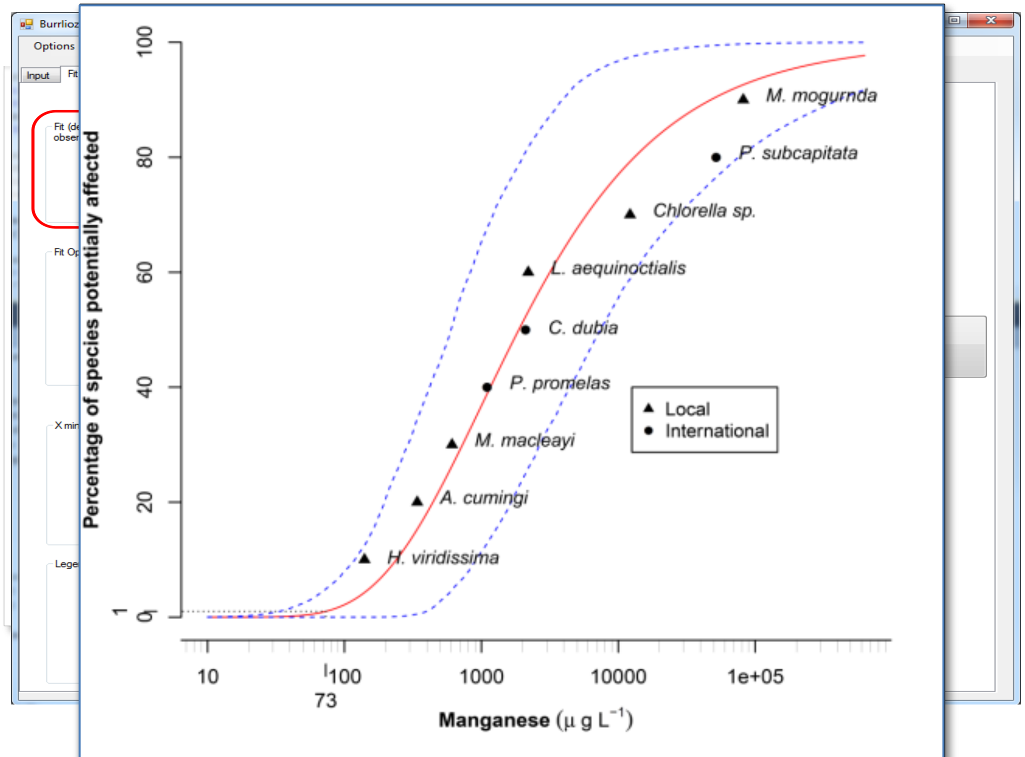
Greater flexibility in decision making

- Sensible decision making to suit the situation and prevent nonsensical outcomes
- Within the existing 'rules', recognise need for best professional judgement, including:
  - Acute and chronic toxicity test classifications
  - Age of toxicity data
  - inclusion of "<" and ">" values
  - Data quality
  - Data selection when multiple data for a single species
  - Data modality
- Justification for all decisions needs to be documented

Deriving toxicant GVs – revised method

Species sensitivity distribution fitting & Burrlioz 2.0

- Fits log-logistic distribution when n < 8 and Burr Type III when n ≥ 8.
- Calculation of 95% confidence limits (CLs)
- GV and '% species protected' calculators
- Improved graphics functionality
  - Labels and legends
  - Graphics export function
  - Plot 95% CLs
- Produces a Burrlioz analysis report



https://research.csiro.au/software/burrlioz/

Deriving toxicant GVs – revised method

Revised GV reliability classification scheme

- Based on i. type of data, ii. sample size and iii. 'fit' of SSD to data

DATA TYPE	SAMPLE SIZE	ADEQUACY OF FIT IN SSD	RELIABILITY
Chronic	≥15 (Preferred)	Good	Very high
		Poor	Moderate
	8 – 14 (Good)	Good	High
		Poor	Moderate
	5 – 7 (Adequate)	Good	Moderate
		Poor	Low
Combined chronic and converted acute or Combined chronic fresh and chronic marine	≥15	Good	Moderate
		Poor	Low
	8 – 14	Good	Moderate
		Poor	Low
	5 – 7	Good	Moderate
		Poor	Low
Converted acute (chronic equivalent)	≥15	Good	Moderate
		Poor	Low
	8 – 14	Good	Moderate
		Poor	Low
	5 – 7	Good	Low
		Poor	Very low

- Assessment factor-based GVs – 'unknown' reliability

Deriving toxicant GVs – revised DGVs

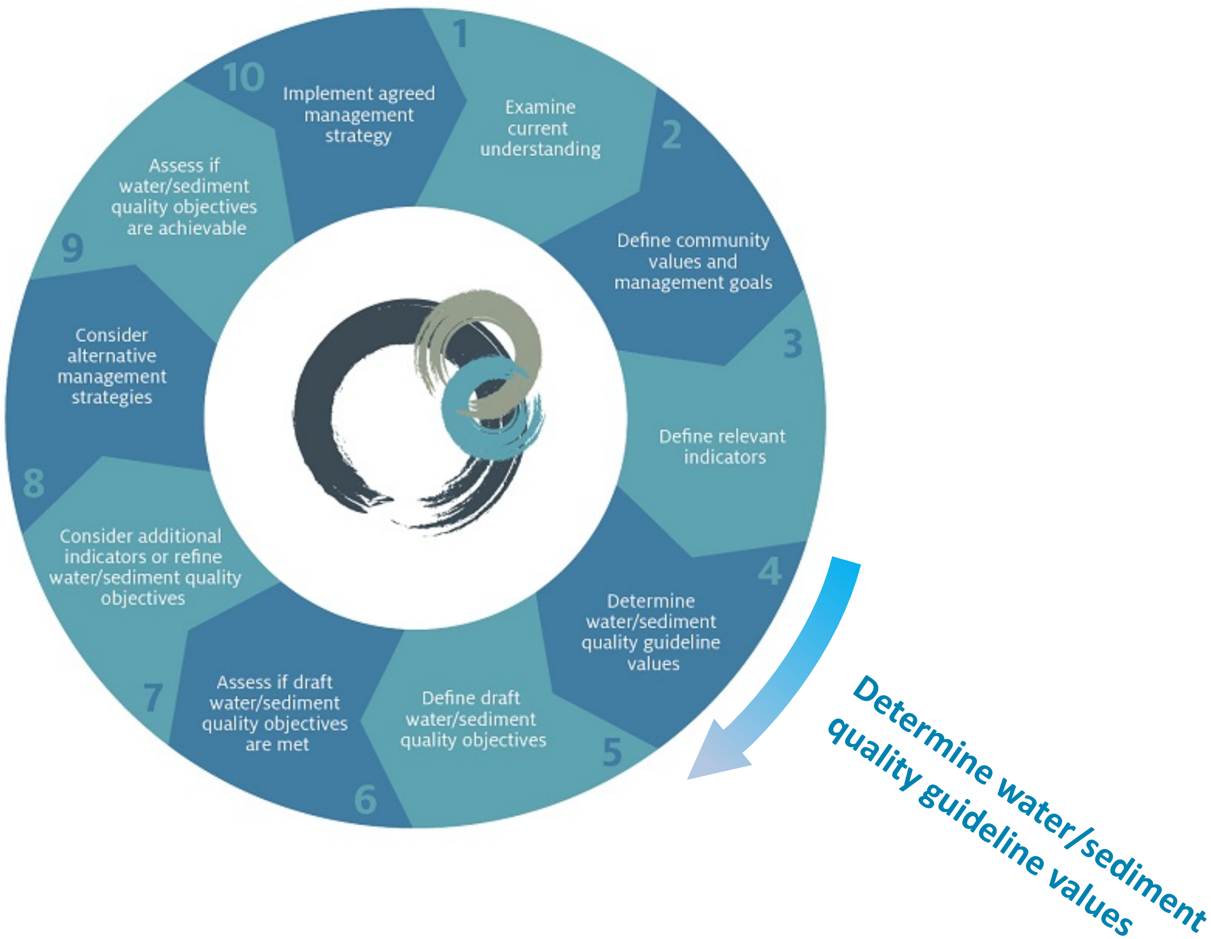
- Selection based on jurisdictional priorities
- Screened, ranked and prioritised → "Top 50" toxicants

Toxicant	Type	Fresh/Marine
Manganese	Metal	Marine
Boron	Metal	Fresh
Chromium (Cr III)	Metal	Fresh
Iron	Metal	Fresh
Iron	Metal	Marine
Nitrate	Non-met inorg	Fresh
Chlorine	Non-met inorg	Marine
Ammonia	Non-met inorg	Fresh
Fluoride	Non-met inorg	Fresh
Bisphenol-A	Indust Chem	Marine
Bisphenol-A	Indust Chem	Fresh
Triclosan	Indust Chem	Fresh
PFOS	Indust Chem	Fresh
PFOA	Indust Chem	Fresh
Dioxins	Indust Chem	Fresh

Toxicant	Type	Fresh/Marine
Glyphosate	Pesticide	Fresh
MCPA	Pesticide	Fresh
Metsulfuron-methyl	Pesticide	Fresh
Paraquat	Pesticide	Fresh
Picloram	Pesticide	Fresh
Metalochlor	Pesticide	Fresh
Simazine	Pesticide	Fresh
Simazine	Pesticide	Marine
2,4-D	Pesticide	Fresh
Fipronil	Pesticide	Fresh
Mancozeb	Pesticide	Fresh
Permethrin	Pesticide	Fresh
Sulfometuron	Pesticide	Fresh
α-cypermethrin	Pesticide	Fresh

+ copper and zinc (fresh)

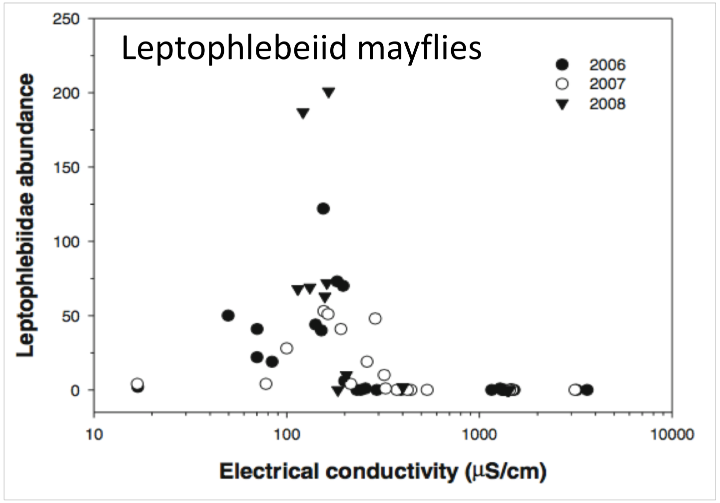
3. Other approaches for deriving guideline values

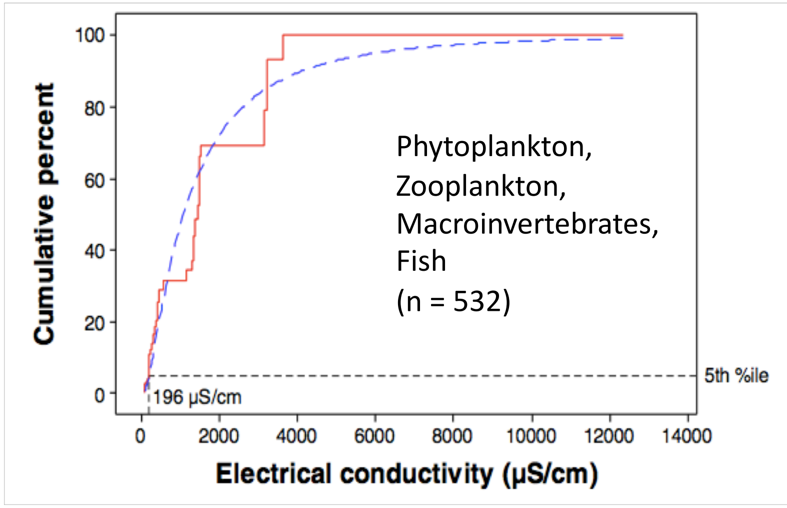


Other approaches for deriving toxicant GVs

- Bioavailability models
  - Biotic ligand models
  - Multiple linear regression models
- Referential approach
- Field or semi-field (mesocosm) data
- Multiple lines of evidence

Field-based GV for EC



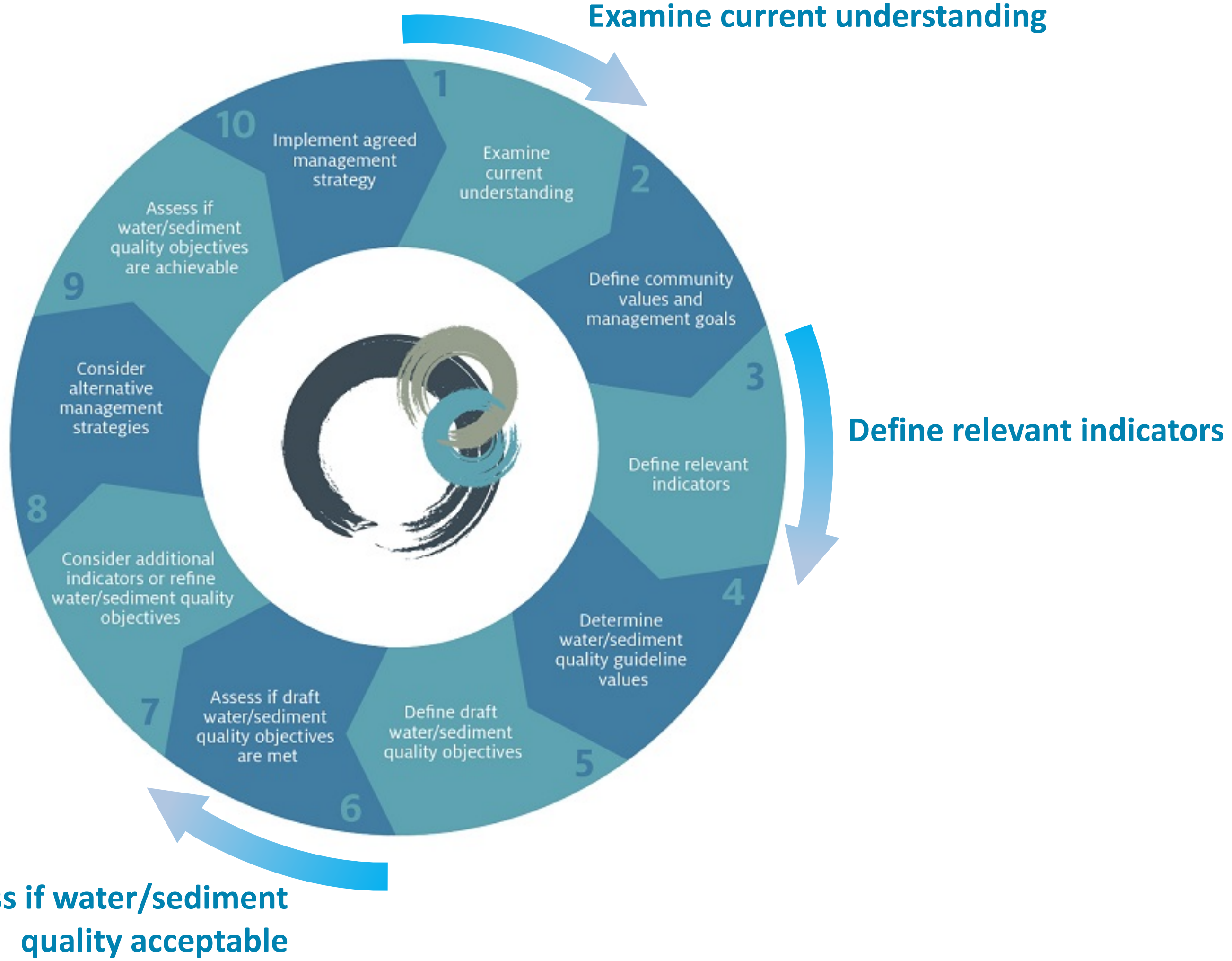


van Dam et al. (2014)

Line of evidence and response	Conditions	Candidate GVs (mg/L)
Laboratory		
Sub-lethal toxicity, 6 local species	Short-term: chronic 72-144 h exposures; Mg:Ca <9:1	**2.5**
Mesocosms	Mid-term and sustained: chronic 4-8 week exposures; Mg:Ca <20:1	
Zooplankton: 4 weeks: Similarity		2.4
Zooplankton: 4 weeks: Taxa number		**2.3**
Chlorophyll a concentration: 4 weeks		1.5
Chlorophyll a concentration: 8 weeks		2.7
Billabong macroinvertebrates	Long-term and sustained: average of antecedent wet and dry seasons median contaminant values; Mg:Ca ~3.5:1	
GTB similarity		5.6
GTB taxa number		**3.9**
SSD: All sites		4.7
SSD: GTB		5.0
TITAN: All minesites, filtered		1.3
TITAN: All minesites, unfiltered		2.4

Humphrey et al. (in prep)

4. Using weight of evidence in water quality assessment



Weight of evidence in WQ assessment

Introduction – what, why, etc.?

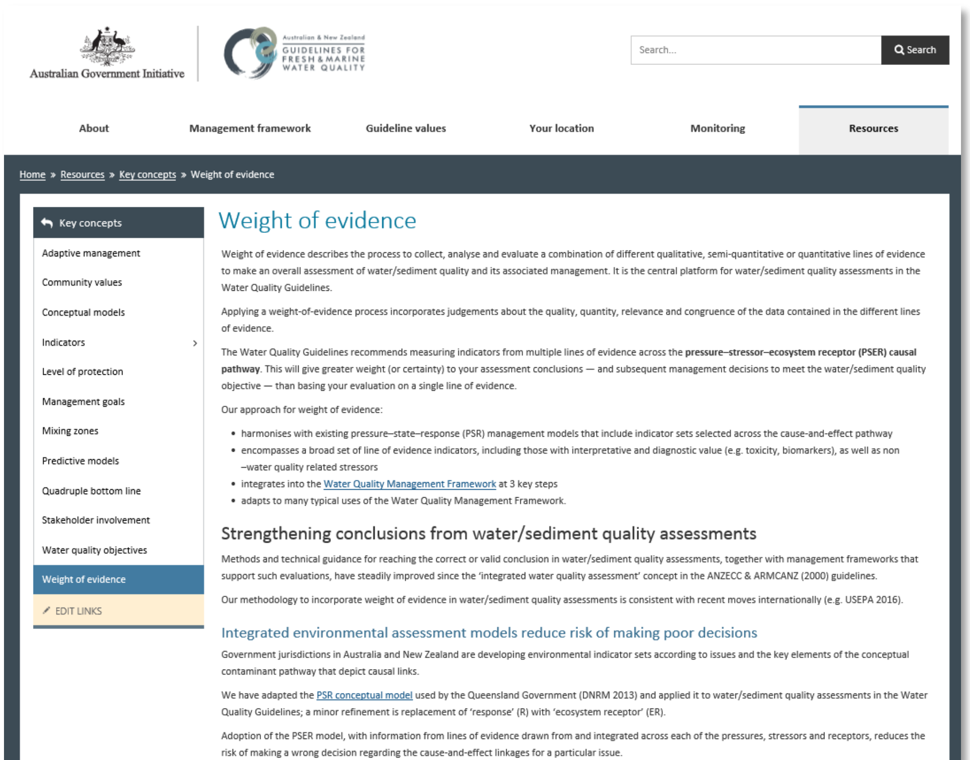
- Assessing water quality against a GV is often insufficient on its own to enable sufficient confidence in conclusions
  - Examining multiple lines of evidence is often more appropriate
- Weight of evidence
  - A process to collect, analyse and evaluate a combination of different (qualitative, semi-quantitative or quantitative) lines of evidence to make an overall assessment of water/sediment quality, to inform management decisions
  - Incorporates judgements about the quality, quantity, relevance and congruence of the data contained in the different lines of evidence
- WoE is a key platform for water/sediment quality assessments in the Aust/NZ Water Quality Guidelines
- Our guidance attempts to make WoE accessible and useful to water quality assessors, so is deliberately simple (and non-quantitative), but allows users to make it as complex as they need it to be

Weight of evidence in WQ assessment

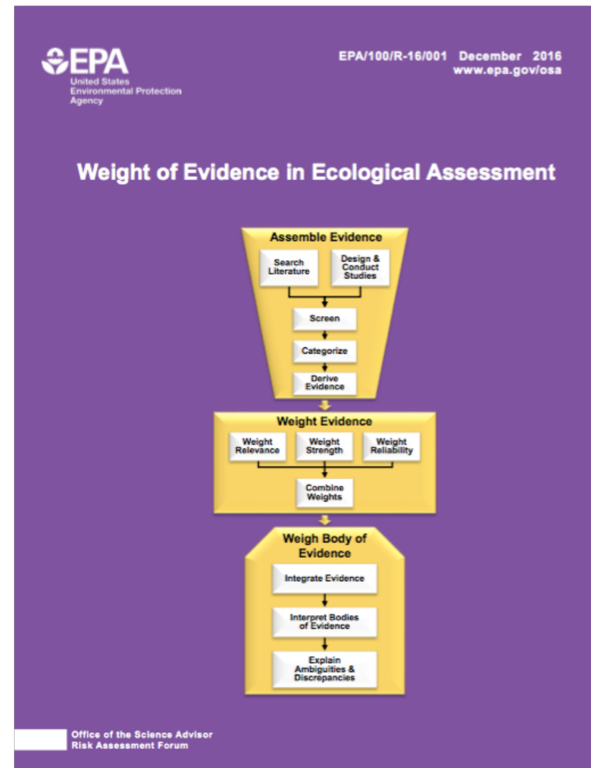
Introduction – what, why, etc.?

➢ Key information sources

Aust & NZ governments (2018)



USEPA (2016)



https://www.youtube.com/watch?v=ikReHM_tVS4

Weight of evidence in WQ assessment

Introduction – what, why, etc.?

➢ Key information sources

Aust & NZ governments (2018)

Australian Government Initiative | Australian & New Zealand GUIDELINES FOR FRESH & MARINE WATER QUALITY

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Home » Resources » Key concepts » Weight of evidence

Key concepts
- Adaptive management
- Community values
- Conceptual models
- Indicators
- Level of protection
- Management goals
- Mixing zones
- Predictive models
- Quadruple bottom line
- Stakeholder involvement
- Water quality objectives
- Weight of evidence

EDIT LINKS

Weight of evidence

Weight of evidence describes the process to collect, analyse and evaluate a combination of different qualitative, semi-quantitative or quantitative lines of evidence to make an overall assessment of water/sediment quality and its associated management. It is the central platform for water/sediment quality assessments in the Water Quality Guidelines.

Applying a weight-of-evidence process incorporates judgements about the quality, quantity, relevance and congruence of the data contained in the different lines of evidence.

The Water Quality Guidelines recommends measuring indicators from multiple lines of evidence across the **pressure–stressor–ecosystem receptor (PSER) causal pathway**. This will give greater weight (or certainty) to your assessment conclusions — and subsequent management decisions to meet the water/sediment quality objective — than basing your evaluation on a single line of evidence.

Our approach for weight of evidence:

- harmonises with existing pressure–state–response (PSR) management models that include indicator sets selected across the cause-and-effect pathway
- encompasses a broad set of line of evidence indicators, including those with interpretative and diagnostic value (e.g. toxicity, biomarkers), as well as non–water quality related stressors
- integrates into the Water Quality Management Framework at 3 key steps
- adapts to many typical uses of the Water Quality Management Framework.

Strengthening conclusions from water/sediment quality assessments

Methods and technical guidance for reaching the correct or valid conclusion in water/sediment quality assessments, together with management frameworks that support such evaluations, have steadily improved since the 'integrated water quality assessment' concept in the ANZECC & ARMCANZ (2000) guidelines.

Our methodology to incorporate weight of evidence in water/sediment quality assessments is consistent with recent moves internationally (e.g. USEPA 2016).

Integrated environmental assessment models reduce risk of making poor decisions

Government jurisdictions in Australia and New Zealand are developing environmental indicator sets according to issues and the key elements of the conceptual contaminant pathway that depict causal links.

We have adapted the PSR conceptual model used by the Queensland Government (DNRM 2013) and applied it to water/sediment quality assessments in the Water Quality Guidelines; a minor refinement is replacement of 'response' (R) with 'ecosystem receptor' (ER).

Adoption of the PSER model, with information from lines of evidence drawn from and integrated across each of the pressures, stressors and receptors, reduces the risk of making a wrong decision regarding the cause-and-effect linkages for a particular issue.

Suter et al. (2017a, b)

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Health & Ecological Risk Assessment

A Weight of Evidence Framework for Environmental Assessments: Inferring Qualities

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https://www.youtube.com/watch?v=ikReHM_tVS4

Weight of evidence in WQ assessment

The basics

- Links to a **pressure – stressor – ecosystem receptor (PSER)** causal pathway conceptualisation of water quality issues

- Encourages selecting, measuring, evaluating and integrating a broad set indicators across the PSER causal pathway elements

- Introduces users to (amongst other things):
  - Properties of evidence (relevance, reliability, strength)
  - Characteristics of causation (time order, co-occurrence, etc..)
  - “Weighting” and “weighing”

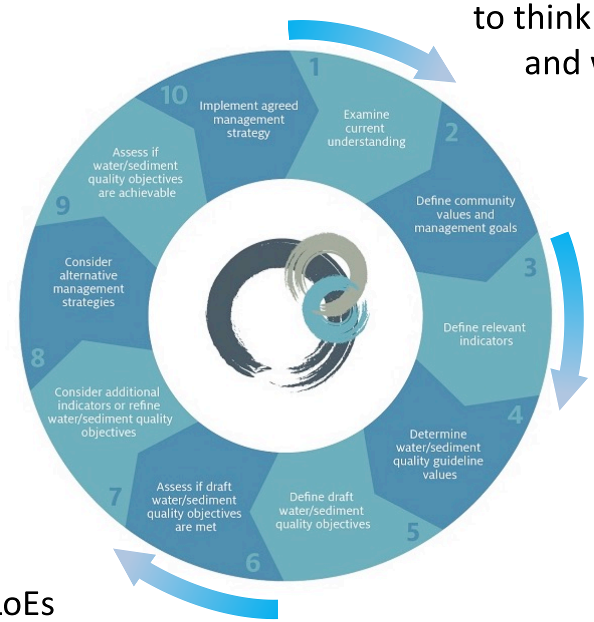
- Emphasises benefits of considering the WoE process at the ***outset*** of the WQ assessment

Weight of evidence in WQ assessment

The basics

➢ Explicitly integrated into the WQMF at:

Step 1 – Formulating the problem in a PSER conceptual model, and starting to think about the issues and what might need to be measured

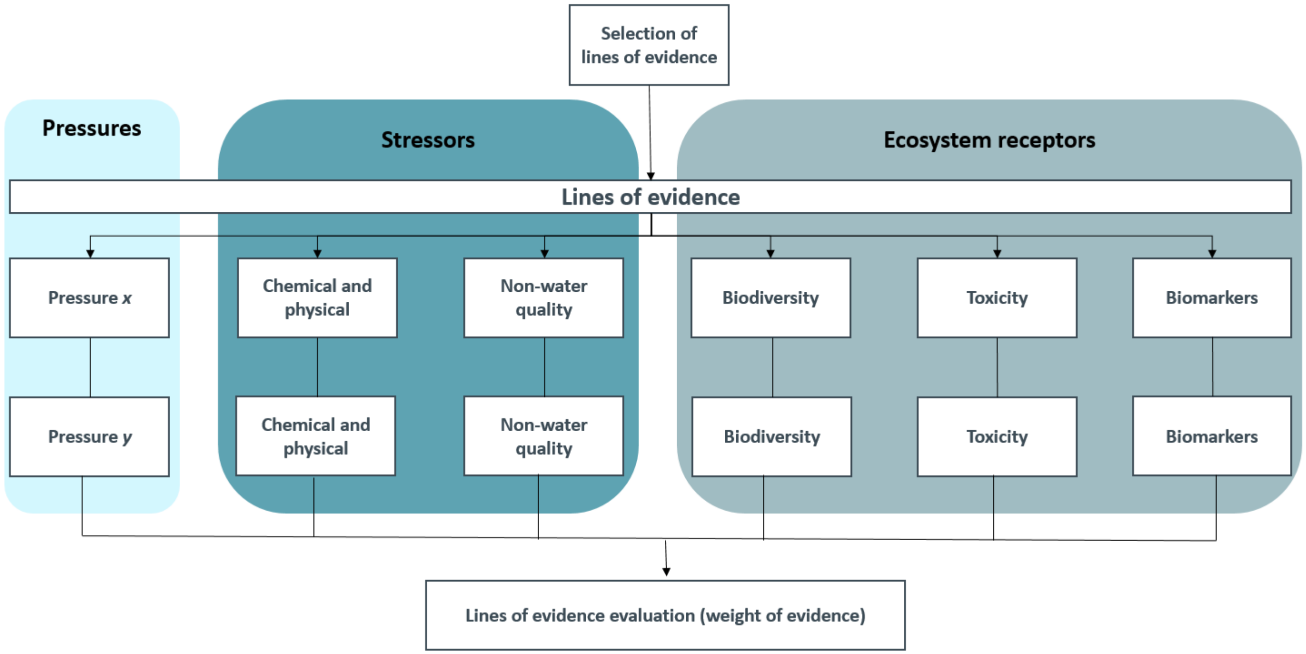


Step 3 – Selecting lines of evidence (LoEs) and associated indicators across the PSER elements

Step 6 – Combining LoEs in a WoE-based evaluation to draw conclusions about ambient water/sediment quality

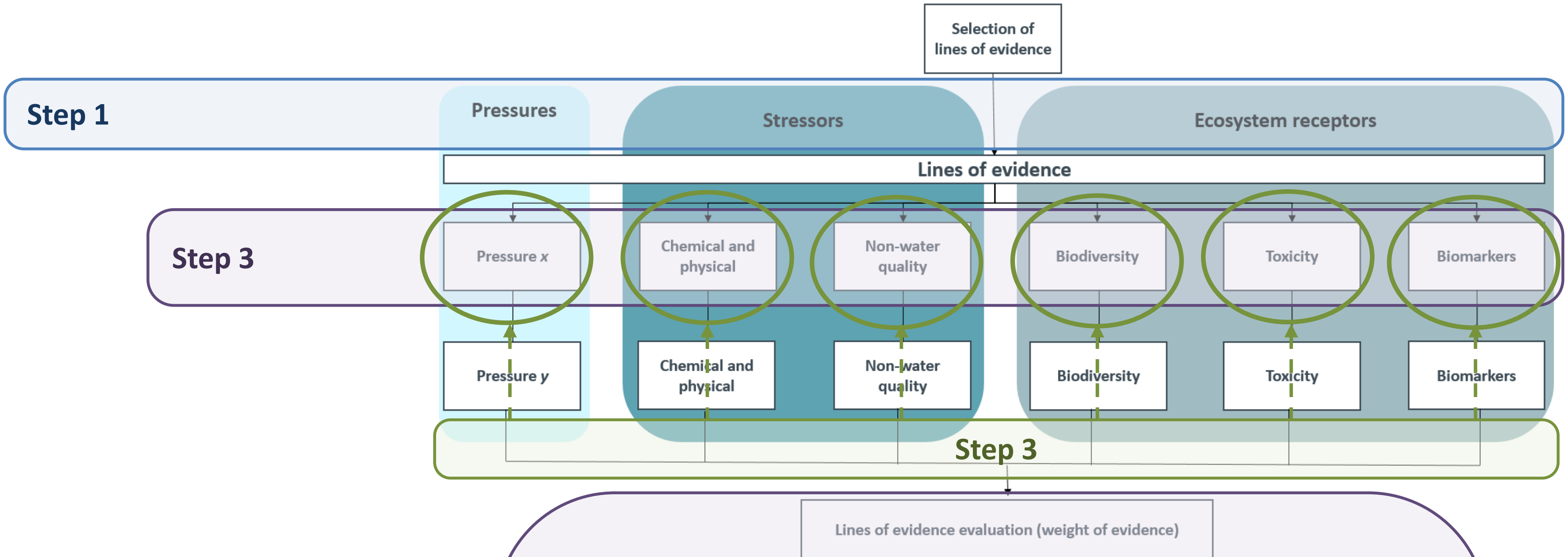
Weight of evidence in WQ assessment

WoE and the PSER model



Weight of evidence in WQ assessment

WoE and the PSER model



WoE evaluation (Step 6)

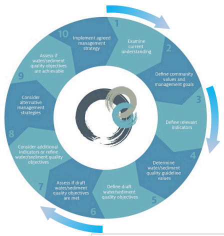
Typically want to know about:

Condition – *Is it being protected? Is there a change?*

Causality – *What is causing it?*

Weight of evidence in WQ assessment

Type and quality of evidence as an up-front consideration



Step 3 – Selecting lines of evidence (LoEs) and associated indicators

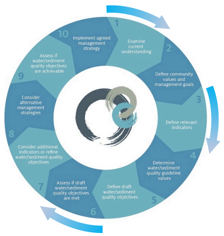
Example matrix for quality of the body of evidence for investigating an unexpected event

Pressure	Stressor		Ecosystem receptor				
	Line of evidence					Quality of evidence	Comment
Pressure 1	Chemical & physical	Other non-WQ-related	Biodiversity	Toxicity	Biomarkers		
	✓					Generally low	Contaminant might not be detected due to transient nature. No cause-effect data to link contaminant to observed response.
				✓		Low to moderate	Source of toxicity not measured. No toxicity may indicate a (missed) pulse but if persistent in the system greater likelihood of inferring a water–quality related stressor.
			✓			Low to moderate	No response indicates no long-term effect. Response correlating with a putative (spatial) disturbance gradient increases inference. Lack of pressure and stressor information limits conclusions. Effect could be due to unmeasured toxicant pulse.
✓		✓				Moderate to high when combined with evidence from other lines of evidence	Measures of the pressure (or surrogates) responsible may correlate with such 'events'. Other evidence of stress could be important (e.g. weather, overfishing, freshwater inputs to marine systems, engineering works, heavy rainfall, unusual temperatures).
	✓			✓		Moderate	Identification of potential toxicant but no indication of long-term ecosystem effects.
	✓			✓		Moderate	Potential cause-and-effect information but limited if contaminant not bioavailable or transient (pulse). Other effects may be contributing to biodiversity response. Need to check all pressures and stressors.
	✓		✓	✓		High	Contaminant has potential to cause ecosystem harm. May not be conclusive if contaminant transient.
	✓		✓	✓	✓	High	Bioaccumulation adds evidence of potential toxicant(s).
	✓	✓	✓	✓	✓	High	For fish kills, pathological assessments are also usual and assist with identification of the cause from among various candidates.

➢ F

Weight of evidence in WQ assessment

WoE-based evaluation

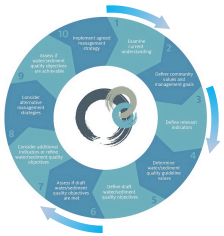


Step 6 – Evaluating LoEs in a WoE evaluation to draw conclusions about ambient water/ sediment quality

- Provision of generic interpretive guidance for different combinations of responses amongst LoEs (the body of evidence)
- For each 'typical use', user presented with:
  - (i) Possible interpretations of findings based on the responses recorded for the various LoEs
    - Greater number of aligned responses (e.g. effect v no effect) provides greater strength of evidence
  - (ii) Options to be more (semi)quantitative/complex
- Option (via Step 7) to add other LoEs if necessary

Weight of evidence in WQ assessment

WoE-based evaluation – high level interpretive guidance



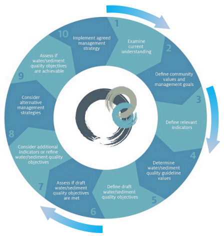
Step 6 – Evaluating LoEs in a WoE evaluation to draw conclusions about ambient water/ sediment quality

Interpretations for likely combinations of line of evidence responses assessed in relation to guideline values and reference-site data

Line of evidence				Interpretation
Stressor	Ecosystem receptor			
Chemistry	*Toxicity*	*Bioaccumulation*	*Biodiversity*	
✘	✘	✘	✘	No exceeded guideline values and no effects on the ecosystem
✓	✘	✘	✘	Measured contaminants are not bioavailable, or are present at non-toxic levels
✘	✓	✘	✘	Toxic effects due to unmeasured contaminants or an unidentified stressor
✓	✘	✓	✘	Contaminants exceeding guideline values and bioaccumulating but not toxic
✓	✘	✘	✓	Toxicity not seen using the test organisms but effects are still seen on biodiversity (toxicity testing may not have been representative of sensitive taxa or did not reflect higher-level ecosystem responses)
✘	✘	✘	✓	Unmeasured contaminants or other factors (e.g. another stressor) contributing to ecological effects.
✓	✓	✘	✘	Some resistance to effects on biodiversity (ecosystem resilience overwhelming toxicity to some species), or test species not representative of receiving ecosystem sensitivity
✘	✓	✘	✓	Unmeasured or cumulative effects of contaminants or stressors are toxic and affecting ecosystem health.
✓	✓	✓	✘	Measured contaminants are toxic and accumulating but no significant ecological effects are observed (mitigating processes occurring, or ecosystem may have acquired tolerance)
✓	✓	✓	✓	Strong evidence of water-quality-related impact

Weight of evidence in WQ assessment

WoE-based evaluation – semi-quantitative approaches



Step 6 – Evaluating LoEs in a WoE evaluation to draw conclusions about ambient water/ sediment quality

Table 19 Proposed scoring system for lines of evidence in a sediment quality weight-of-evidence assessment

Line of evidence	Indicator type	Score 3	Score 2	Score 1
Chemical and physical	Sediment chemistry	Concentration > SQGV-high	Concentration > GV, < SQGV-high	Concentration < GV
	Pore water chemistry	Concentration > WQGV-HC10[a]	Concentration > WQGV-HC5[a], < WQGV-HC10	Concentration < WQGV-HC5
	Toxicity	≥ 50% effect vs control	20–50% effect vs control	< 20% effect vs control
Biomarkers	Bioaccumulation	Significantly different ($p < 0.05$) and > 3 × control[b]	Significantly different ($p < 0.05$) and ≤ 3× control	Not significantly different from control
Biodiversity	Biodiversity	Significant and high effects on abundance or diversity	Significant but moderate effects on abundance or diversity	No significant effects on abundance or diversity

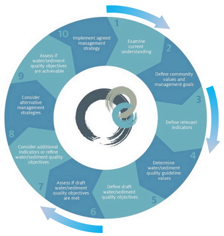
GV = guideline value, SQGV = sediment quality guideline value, WQGV = water quality guideline

a. HC5 and HC10 are the guideline values for 90% and 95% species protection, respectively.

b. For essential substances that are well regulated, significant difference from control/reference will be the most important characteristic to consider.

Weight of evidence in WQ assessment

WoE-based evaluation – semi-quantitative approaches



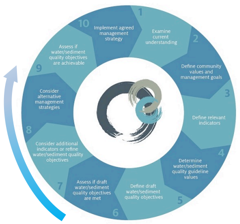
Step 6 – Evaluating LoEs in a WoE evaluation to draw conclusions about ambient water/ sediment quality

Table 21 Weight-of-evidence scores and assessments for 14 examples of contaminated sediments using a semi-quantitative approach to assess different lines of evidence (LOEs) for a single pressure within an ecosystem

Example	Chemical and Physical LOE	Toxicity LOE	Biodiversity LOE	Biomarkers LOE	Score	Overall assessment
A	3	3	3	2 or 3	3	Significant adverse effects from sediment contamination
B	3	3	2	2 or 3	3	Significant adverse effects from sediment contamination
C	2 or 3	3	2	2	3	Significant adverse effects from sediment contamination
D	2 or 3	2	2	1 or 2	2	Possible adverse effects from sediment contamination
E	2	2 or 3	2	1or 2	2	Possible adverse effects from sediment contamination
F	2	2	2 or 3	1 or 2	2	Possible adverse effects from sediment contamination
G	2 or 3	2 or 3	1	2 or 3	2	Toxic chemical stressing system but resistance may have developed at community level
H	1	2 or 3	2 or 3	1	2	Unmeasured toxic chemicals causing effects on communities is possible
I	1	2 or 3	1	1	2	Unmeasured physical or chemical causes of toxicity
J	2 or 3	1	2 or 3	1	2	Chemicals are not bioavailable or community change may not be due to chemicals
K	1	1	2 or 3	1	1	Changes probably not due to measured contaminants
L	1 or 2	1	1	1 or 2	1	No adverse effects
M	1	1	1	1	1	No adverse effects
N	2 or 3	1	1	1	1	Contaminants unavailable

Weight of evidence in WQ assessment

Links back to management decisions



Depending on WoE-based WQ assessment outcomes:

Step 7 – Option to consider selection of additional or alternative indicators or LoEs, or further refinement of the GVs

Step 8 – Option to consider alternative management strategies to improve water/sediment quality

Step 10 – Communicate and implement decisions based on assessment, and monitor, using multiple lines of evidence if needed

5. Concluding message

- Risk-based assessment and management of water quality in Australia and New Zealand has been strengthened by:
  - Improved DGV derivation method
  - New guidance on other approaches for deriving (site-specific) GVs
  - Formalisation of the use of a weight of evidence process for assessing water quality
  - Integration of these, and other features, in an effective management framework that helps guide sound water quality assessment and associated decision making to protect or improve water quality

Thank you!

www.waterquality.gov.au/anz-guidelines

(live by March 2018)