Chapter 1
Introduction and Approach

1-1.0 Introduction

The goal of this project is to develop a methodology for derivation of pesticide water quality criteria for the protection of aquatic life in the Sacramento River and San Joaquin River basins. The surface waters of these basins receive pesticide inputs in runoff and drainage from agriculture, silviculture, and residential and industrial storm water (CVRWQCB 2004). The term pesticide is defined by the Central Valley Regional Water Quality Control Board (CVRWQCB 2004) as (1) any substance, or mixture of substances which is intended to be used for defoliating plants, regulating plant growth, or for preventing, destroying, repelling, or mitigating any pest, which may infest or be detrimental to vegetation, man, animals, or households, or be present in any agricultural or nonagricultural environment whatsoever, or (2) any spray adjuvant, or (3) any breakdown products of these materials that threaten beneficial uses.

The project will be accomplished in three phases. Phase I was a comparison and evaluation of existing criteria derivation methodologies from around the world (TenBrook & Tjeerdema 2006, TenBrook *et al.* 2009). This is a report of Phase II, in which the Phase I review serves as a basis for selecting elements of methodologies, or entire methodologies, for further evaluation for possible incorporation into, or adoption as, the new methodology. Phase III will be to apply the new methodology to derive criteria for up to five pesticides including diazinon and chlorpyrifos, two organophosphate insecticides of particular concern in the Sacramento River watershed due to listings under 303(d) of the federal Clean Water Act (CWA; CVRWQCB 2002).

1-1.1 Project Goals

The development of this methodology was part of a larger project with the Central Valley Regional Water Quality Control Board (CVRWQCB, Contract 05-100-0150-0). Therefore the protection goal (section 2-1.1) of the method is derived from California water policy. The CVRWQCB requested that the proposed numeric criteria of the pesticide (in total or dissolved form) that when attained should not "produce detrimental physiological responses in aquatic life," as required by the current narrative toxicity objective. The criteria should identify the allowed maximum pesticide concentration, the duration of exposure, and the allowable frequency of excursion, if any, above the maximum.

Additionally, the project scope of work requires that the new method should have a procedure for deriving criteria based on short-term (1 day or less) and long-term (4 days or more) exposures, which requires that both acute and chronic criteria be derived by the new method. Criteria need to also be expressed in a manner that is compatible with typical monitoring programs required to assess compliance. The CVRWQCB indicated

that most monitoring programs will collect daily grab sample for a site or a composite sample that represents a single day.

This project focused on the Sacramento and San Joaquin River watersheds of the California Central Valley and this ecosystem is referred to in several instances. The resulting method, however, is generally appropriate for any freshwater ecosystem in the Unites States. Additionally, simple modifications could be made to adapt this method for saltwater criteria or other geographic areas.

1-2.0 Approach to methodology development

The review of existing methodologies in the Phase I report for this project (TenBrook & Tjeerdema 2006, TenBrook *et al.* 2009) provides the basis for development of a new methodology. If the review in Phase I had revealed a single methodology that contained all the features deemed important to derivation of robust, protective criteria, then that methodology could simply be adopted for use by the CVRWQCB. Such was not the case and thus, the new methodology will consist of a combination of features from existing methodologies with refinements based on recent research in aquatic ecotoxicology and environmental risk assessment. Table 1.1 provides an overview of the major methodologies reviewed in Phase I (reproduced from Table 2, TenBrook & Tjeerdema 2006, TenBrook *et al.* 2009), and Table 1.2 provides a summary of the differences between them (reproduced from Table 4, TenBrook & Tjeerdema 2006, TenBrook *et al.* 2009). In this Phase II report, methodology components and ecological risk assessment techniques identified in Phase I are selected for the new methodology. Selection is based partially on the review conducted in Phase I, and partially on further evaluation to determine which have the strongest scientific basis, combined with practicability, for use in the new methodology.

1-3.0 Notes about numeric criteria

As discussed in the Phase I report (TenBrook & Tjeerdema 2006, TenBrook *et al.* 2009) water quality criteria are referred to by different terms and are used for different purposes depending upon how they are derived. For this project, numeric criteria are science-based values, which are intended to protect aquatic life from adverse effects of pesticides, without consideration of defined water body uses, societal values, economics, or other non-scientific considerations. This corresponds to what the USEPA calls a numeric criterion and it is the derivation of this type of number that is the subject of this report.

Methods will be presented for derivation of numeric criteria from data sets of any size. The limitations of those numbers will be discussed qualitatively, and, where possible, quantitatively, but no categorization will be made as to what the values should be used for, as that decision lies in the realm of policy.

Table 1.1 Overview of major methodologies

Method Title	Source	Year	Country	Criterion	Criterion description
Guidelines for deriving numerical national water quality criteria for the protection of aquatic organisms and their uses	USEPA	1985	United States	CMC: criterion maximum concentration	Used for setting water quality standards, setting discharge limits, and other regulatory programs; for protection from short-term exposure
				CCC: criterion continuous concentration	Used for setting water quality standards, setting discharge limits, and other regulatory programs; for protection from long-term exposure
A protocol for the derivation of water quality guidelines for the protection of aquatic life	CCME	1999	Canada	Guidelines	Single maximum which is not to be exceeded
Australian and New Zealand guidelines for fresh and marine water quality.	ANZECC & ARMCANZ	2000	Australia/ New Zealand	HRTV: high reliability trigger value	Derived from $\geq$ 1 multispecies or $\geq$ 5 single-species chronic data; not a mandatory standard; exceedance triggers further investigation
				MRTV: medium reliability trigger value	Derived from $\geq$ 5 acute data; not a mandatory standard; exceedance triggers further investigation
				LRTV: low reliability trigger value	Derived from < 5 acute or chronic data; not used as a guideline value
Guidance document on deriving environmental risk limits in The Netherlands	RIVM	2001	The Netherlands	NC: negligible concentration	Used to set environmental quality standards (EQS); EQS may or may not be legally binding
				MPC: maximum permissible concentration	Used to set environmental quality standards (EQS); EQS may or may not be legally binding
				SRC_{ECO}: ecosystem serious risk concentration	Used to set environmental quality standards (EQS); EQS may or may not be legally binding
Water quality guidance for the Great Lakes system	USEPA	2003	United States	Tier I CMC	Adopted into water quality standards or used to implement narrative criteria; for protection from short-term exposure
				Tier I CCC	Adopted into water quality standards or used to implement narrative criteria; for protection from long-term exposure
				Tier II CMC	Used only for implementation of narrative criteria; for protection from short-term exposure
				Tier II CCC	Used only for implementation of narrative criteria; for protection from long-term exposure
Technical guidance document on risk assessment É. Part II. Environmental Risk Assessment.	ECB	2003	European Union	PNEC: predicted no effect concentration	Used in risk assessment

Table 1.2 Overview of similarities and differences between key elements of six major criteria derivation methodologies.

	Data used directly for derivation					SSD method[1]							AF method[2]		Criteria Considerations										
Method	Sources	Evaluation criteria	QSARs allowed	Multispecies data	Endpoints not linked to SGR[3]	Log Triangular	Log-normal	Burr family/best fit	Minimum number of data required	Minimum number of taxa required	Uncertainty quantified	All data used	Minimum number of data required	Minimum number of taxa required	Acute	Chronic	Magnitude	Duration	Frequency	Bioaccumulation	Additivity	Non-additivity	Bioavailability	Water quality	TES[4]
USEPA (1985)		✓			R[5]	✓			8	8					✓	✓	✓	✓	✓	✓			✓	✓	
CCME (1999)		✓			S[6]								6-9	5		✓	✓								
ANZEC/ ARMCANZ (2000)		✓	✓	✓				✓	5	5	✓	✓	1	1		✓	✓			✓			✓	✓	✓
RIVM (2001)	✓	✓	✓				✓		4	4	✓	✓	1	1		✓	✓			✓				✓	
USEPA (2003)		✓				✓			8	8			1	1	✓	✓	✓	✓	✓				✓	✓	✓
ECB (2003)		✓		✓				✓	10	8	✓	✓	1	1		✓	✓			✓					

[1] Species sensitivity distribution method
[2] Assessment factor method
[3] Survival/Growth/Reproduction
[4] Threatened and Endangered Species
[5] R = Rarely
[6] S = Secondary data only

1-4.0 References

ANZECC & ARMCANZ. 2000. Australian and New Zealand guidelines for fresh and marine water quality. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource management Council of Australia and New Zealand, Canberra, Australia.

CCME. 1999. A protocol for the derivation of water quality guidelines for the protection of aquatic life. Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment, Ottawa.

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