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SANTA CRUZ

**POLICIES & POLITICS OF AGRICULTURAL NONPOINT
SOURCE POLLUTION CONTROL IN THE E.U., U.S. AND
CALIFORNIA**

A dissertation submitted in partial satisfaction
of the requirements for the degree of

DOCTOR OF PHILOSOPHY

in

ENVIRONMENTAL STUDIES

by

Ann Gleason Drevno

June 2016

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Vice Provost and Dean of Graduate Studies

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ABSTRACT

POLICIES & POLITICS OF AGRICULTURAL NONPOINT SOURCE POLLUTION CONTROL IN THE E.U., U.S. AND CALIFORNIA

by

Ann Gleason Drevno

Much of modern-day agriculture relies heavily on fertilizers and pesticides to increase yields, yet when applied in excess or without proper control mechanisms these inputs can wreak havoc on local waterways. This dissertation analyzes policy approaches implemented in Europe, the U.S. and California to abate discharges from farms. The research utilizes a mixed methods approach, integrating qualitative, quantitative and spatial analyses, to investigate regulatory tools, governance structures, policy outcomes, and stakeholder opinions relating to water pollution from agriculture. The dissertation is comprised of four interrelated parts. The first part assesses the range of regulatory approaches employed to control agricultural nonpoint source pollution in the United States and the European Union. Findings suggest that transitioning from the voluntary control mechanisms to more effective instruments based on measurable water quality performance relies predominantly on three factors: (1) more robust quality monitoring data and models; (2) local participation; and (3) political will. Identifying obstacles to and successes of national and international agricultural water pollution policies set the context for delving deeper into this regulatory problem on a regional level. The second, third, and fourth parts of this

doctoral research focus on the primary regulatory mechanism for agricultural discharges in California's Central Coast Region: The Conditional Agricultural Waiver. One of these parts uses the policy tool framework to assess the overall effectiveness of the Conditional Agricultural Waiver and its associated monitoring programs. Research results show that while the regional policy represented a small step forward in implementing appropriate control mechanisms for agricultural pollution, the significance of monitoring programs greatly limited the policy's success. Another part of this dissertation surveyed 1,000 growers and their opinions on water quality practices and regulations. Results corroborate with prior research—growers' trust in the majority of regional agricultural groups was closely correlated with communication. However, trust in the Regional Board did not correspond to the relatively high contact frequency with the regulatory agency, most likely due to a divergence of interests and institutional distance. This study also confirms anecdotes of declining trust between farmers and the Regional Board over the course of the two Ag Waivers. A final part of the dissertation focuses on specific provisions aimed at controlling two pesticides in the region. Results from this chapter indicate that the 2012 Central Coast Conditional Agricultural Waiver was a contributing factor in successfully reducing the use of diazinon and chlorpyrifos, but several unintended consequences, such as continued presence of the pollutants in waterways, remain unsettled.

DEDICATION

For my family

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acknowledge the support of these organizations as well as the 230 growers who took part in the survey.

Finally, this work would not have been accomplished without the loving support of my family. Peter, true to form, has been a patient partner through the rollercoaster of stresses and triumphs during my graduate studies. It was his flexibility and willingness to shape his life and career to support my graduate endeavors that made this dissertation and having children while writing it possible. To our daughter, Ella, who reminds me daily of the importance to laugh, play and take writing breaks, and our son, who has patiently been awaiting his birth until just after the delivery of this dissertation. To my parents, Janet and Ramsay, who instilled the values of environmental stewardship and political engagement through our nightly dinner table conversations as well as in their high school classrooms. To my siblings and two of my best friends, Mary and Joey, who constantly inspire and encourage me. And to both sets of grandparents, whose help with childcare and their nurturing support of both their granddaughter and me offered the mental space to fully commit to my studies.

The second chapter of this dissertation is an adaptation of the following previously published material:

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The third chapter of this dissertation is an adaptation of the following previously published material:

Drevno, A. 2016. Governing Water Quality in California's Central Coast: The Case of the Conditional Agricultural Waiver. *Journal of Science, Policy and Management*, 8(1).

Chapter 1: Introduction

Across the United States, state and regional water quality agencies are increasingly forced to take action to control nonpoint source contamination from agriculture. California, often at the forefront of implementing policies to protect the environment, is in an especially dire situation and is ramping up efforts at pollution mitigation. Examples of statewide and regional endeavors include the University of California Center for Watershed Sciences' report to the California Legislature on nitrate in drinking water ("The Harter Report"), the Central Valley Regional Water Quality Control Board's Irrigated Lands Regulatory Program, the Central Valley SALTS program, the Climate Action Reserve's nitrogen reduction protocol, and the Central Coast Regional Water Quality Control Board's renewal process for the Conditional Agricultural Waiver (Rosenstock et al., 2013). The latter is the focus of this dissertation.

California's agricultural pollution has been exacerbated by the most severe drought on record followed by El Niño rains as well as historically lax agricultural water quality regulations. The state's unprecedented four-year drought has led to serious water supply and water pollution problems. There is substantially less water: The state has lost roughly 11 trillion gallons from the drought (NASA, 2014), resulting in the literal sinking of farmland (Goldenberg, 2015). And there is even less clean water: More than half of all waters have some degree of contamination (Anderson et al., 2011), and between 2006 and 2010, rivers, streams and lakes in

California saw a 170% increase in toxicity (EPA, 2010). Agriculture is the largest contributing source of water pollution in the state. New studies are showing that the unabating drought is increasing the concentration of pollutants in water resources (Belitz et al., 2015), and that while the predicted 2016 El Niño is expected to bring drought improvement, it is likely to exacerbate water pollution issues by increasing water runoff and accompanying contaminants (UC Irvine, 2015).

The brunt of health problems related to agricultural water pollution has fallen on the most vulnerable, marginalized populations, with nutrients and pesticides being the primary constituents of concern. In California, over 2 million people, mostly low-income, minority farmworkers are at risk of drinking nitrate-contaminated water due in large part to agricultural pollution (Harter et al., 2012). Schools in Central Valley's farmland have found such high concentrations of pollutants that they have cut off their drinking fountains to students. Nitrate-contaminated drinking water from agricultural fertilizers is a well-known risk factor for "blue baby syndrome," a potentially fatal blood disorder resulting in reduced oxygen-carrying capacity of hemoglobin (Knobeloch et al. 2000). Because these communities are among the poorest in the state, many lack the resources or technical capacity to maintain safe drinking water supplies (Harter et al., 2012).

Pesticides are another major concern due to their more obscure impact on human health and water resources than their nutrient and sediment pollutant counterparts. Two organophosphate pesticides in particular, chlorpyrifos and diazinon, have been identified as sources of water column toxicity in California.

Exposure to these pesticides has been linked to neurobehavioral deficiencies, ADHD, lung damage, and in utero health effects to babies (Bouchard et al., 2010, Furlong et al., 2006, Raanan et al., 2015).

Despite their myriad threats to human and ecological health, fertilizers and pest control agents are indispensable farming tools, supporting growers' livelihoods and the state's agricultural economy. Nutrient fertilizers, both in naturally derived and inorganic (chemical) forms, are necessary for crop growth and development (Rosenstock et al., 2013). The use of inorganic nitrogen fertilizer on California farms has intensified over the past half century, from less than 200,000 tons in the 1950s to over 750,000 tons in recent years (Rosenstock et al., 2013). Many growers are also heavily reliant on pesticides as a crop insurance and protection mechanism. Pesticides and other integrated pest management strategies can lower the risk of pest outbreaks and decrease the incidence of pest damage on crops. According to the California Department of Pesticide Regulation, 194 million pounds of pesticide active ingredients were applied to California farms in 2013.

The ability of California's agricultural industry to continue to thrive economically and produce food for much of the world while not polluting waterways depends on the difficult task of balancing environmental needs with other competing concerns (OTA, 1995). Such a challenge underscores the importance of burgeoning academic discussions within the fields of environmental policy, political science, environmental economics and environmental science around choosing appropriate policy instruments (Salamon, 2002; OTA, 1995, Schneider and Ingrid, 1990; Horan

and Shortle, 2001; Shortle et al., 2012), whether those instruments have been implemented effectively and equitably (Press, 2015), how regulatory institutions are evolving to meet changing needs (Mahoney and Thelen, 2010; Salamon, 2002) and why particular policy goals are prioritized over others (Kingdon, 1995; Stone, 2002). These literatures will be discussed in more detail in the chapters that follow. Applied case study research on policy mechanisms to control California's agricultural water pollution is well positioned to contribute valuable insights to these bodies of work.

This dissertation uses mixed social scientific methodologies to investigate regulatory tools, governance structures, policy outcomes, and stakeholder participation relating to water pollution from agriculture in California's Central Coast. Following this introductory chapter, the remaining four chapters are divided into four interrelated themes and questions:

Chapter 2: The State of Affairs in U.S. and E.U. Agricultural Pollution Regulation

***Question:** What characterizes different approaches to agricultural nonpoint source pollution regulation employed in the United States and European Union?*

Drawing from environmental policy and environmental economics literature as well as case studies from the U.S. and Europe, this chapter aims to survey the range of regulatory instruments used to address commonly occurring challenges related to agricultural nonpoint source policies throughout the U.S. and E.U.

Identifying obstacles as well as successful control mechanisms to managing farm

runoff that are widespread nationally and internationally sets the context for delving deeper into this policy problem on a regional level.

Chapter 3: A Closer Look at California's Central Coast Ag Pollution Control

***Questions:** What factors shape water quality policy decision-making in the Central Coast? How effective is the Conditional Agricultural Waiver program?*

Chapters 3 through 5 are focused on the primary regulatory mechanism for agricultural discharges in California's Central Coast Region: The Conditional Agricultural Waiver. The Central Coast is one of the most appropriate and desirable places to conduct this research because it is one of the highest valued agricultural areas in California and the U.S., (EDD, 2011); yet has the highest percentage of toxic waterbodies in the state (CCRWQCB, 2011). Additionally, the political context of California's Central Coast—a strong agricultural lobby, active conservation and environmental justice organizations, Regional Board budgetary and staff constraints, and contradictory food safety and water quality goals—makes the region particularly interesting and appealing to study from a policy standpoint. Chapter 3 explores the complex process of negotiations, agendas and conditions at the heart of agricultural water quality policy-making, highlighting areas where the 2004 and 2012 Conditional Agricultural Waivers have succeeded in achieving its goals, as well as where they have fallen short.

Chapter 4: Growers' Opinion Survey of Central Coast Water Quality Mandates

Questions: *What have been growers' reactions to the 2004 and 2012*

Conditional Agricultural Waivers? How have growers' opinions and trust in the primary regulatory agency changed over time?

Participation and collaboration from regulated entities is what some scholars and practitioners believe to be at the heart of effective regulation and policy making.

Curiously, anecdotes from agricultural organizations show signs of decreased collaboration between regulators and growers, especially over the past eight years—between the adoption of the first and second Agricultural

Waiver. Chapter 4 reports and assesses the results from two surveys of over 230 growers on water quality management practices and opinions. The

first survey (2006) was conducted two years after the first Conditional

Agricultural Waiver was passed and the follow-up survey (2015) was conducted

two years after the updated Conditional Agricultural Waiver was passed and

modified. Results bring to bear the change of growers' opinions over time and in response to two different Agricultural Waivers (2004 and 2012), as well as other factors.

Chapter 5: Intended and Unintended Consequences of Pesticide Control in the Central Coast

Questions: *What causal factors drove the regional chlorpyrifos and diazinon*

decline, and how much of the decrease can be attributed to the 2012 Agricultural

Waiver? What conditions made the chlorpyrifos decline possible in the Central

Coast region, but not in other regions or California as a whole? What societal, environmental and regulatory implications have resulted from farmers' decisions to stop using both chemicals?

The final chapter looks in depth at specific pesticide-related provisions of the 2012 Central Coast Agricultural Waiver. The 2012 Waiver was successful at compelling farmers to stop using two pesticides of concerns, chlorpyrifos and diazinon, but other unintended consequences, such as water quality improvements and monitoring implications remain unsettled. Using several datasets on pesticide use, water pollution, organic production, survey responses, cropping patterns and policy documents, results assess the causes and effects of regulatory spotlighting two pesticides.

Goals

Employing a rich mixed-methods approach, including document review, historical analysis, interviews, surveys, spatial analysis, and descriptive statistics, this dissertation aims to contribute to scholarly discourse on effective agricultural water quality policy. It is my hope that this research offers valuable data and policy recommendations that are of direct use to other academics, agricultural operators, and regional water quality agencies.

Throughout the research process, from designing survey questions to choosing the best means to disseminate information, I collaborated with faculty, scientists, and regional agricultural and water quality networks to ensure that this work would be

applicable and relevant. For example, in developing my survey chapter (Chapter 4), I solicited feedback and received non-financial endorsements from four well-respected agricultural organizations for a survey sent out to over 1,000 growers on issues relating to water quality practices and regulations. Agencies that supported the survey included the Monterey County Farm Bureau, the University of California Extension, the Agriculture and Land Based Training Association, and the Agricultural Water Quality Agency. Each agency requested results from the survey, as well as a presentation to their organization. Additionally, I plan on distributing a two-page summary of results to all growers who participated in the survey.

Another part of this doctoral research that helped forge partnerships is through my work on Chapter 5. Data analysis in this chapter included spatial analysis of regional pesticide use over the past 13 years. In designing this chapter, I met with third-party monitoring agencies, G.I.S. technicians, and faculty members to ensure the highest quality data was used and that the research results would be of use to growers and policymakers. The spatial analysis of several pesticides known to be sources of water column and sediment toxicity in the region show the impacts, both negative and positive, of the primary regional agricultural water quality mandate that specifically targets two organophosphate pesticides. Results have already been distributed to Regional Water Quality Control Board staff members, who have passed them along to other networks and agencies.

Research results from this dissertation have been and will continue to be shared with academic audiences, agricultural operators, policymakers, water quality

agencies, and the general public in peer-reviewed publications, conference proceedings, reports, magazine articles, poster presentations, and oral presentations.

Links to all published research are posted on my graduate student website.

Throughout the data collection process, I maintained thorough records in both my notebooks and on electronic devices, and all stored electronic data have been backed up and preserved. Records of all interviews, survey questions and responses, datasets, and methodologies were retained to ensure reproducibility. I received exemption from IRB Review for both the interviews (IRB Protocol #HS1946) as well as the survey (IRB Protocol #HS2471) conducted in this research.

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Chapter 2: Policy Tools for Agricultural Nonpoint Source Water

Pollution Control in the U.S. and E.U.

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Summary

In the U.S. and Europe, agricultural nonpoint source pollution continues to be among the chief impediments to achieving water quality standards. While the implementation of technology-based water pollution control tools has resulted in evident point source pollution abatement, nonpoint sources continue to threaten surface water and groundwater. This chapter draws from environmental policy literature to identify regulatory tools and management approaches that specifically target agricultural NPS pollution and the factors that drive or impede their implementation and enforcement. The chapter utilizes policy tool frameworks to help characterize the widespread policy problem, distinguishing its unique set of hurdles from other environmental problems. Discussion of agricultural nonpoint source pollution management approaches is based on a thorough review of relevant environmental policy and environmental economic literature as well as case studies from the U.S. and Europe. Findings suggest that transitioning from the voluntary mechanisms to more effective instruments based on measurable water quality performance relies predominantly on three factors: (1) more robust quality monitoring data and models; (2) local participation; and (3) political will. This research provides important information for regional and national policy makers in areas where there is increasing pollution and regulatory mandates. Identifying conditions of effective

water quality policy is applicable and will be of direct use to agencies charged with pollution control.

Introduction

Agricultural nonpoint source pollution—runoff and leaching into nearby waterbodies from nutrients, pesticides and soil sediments—is the chief impediment to achieving water quality objectives throughout the U.S. and Europe. Discharges from agricultural nonpoint sources are inherently difficult to monitor because they are diffuse in nature. Consequentially, policymakers cannot employ the old standbys (i.e., emission-based performance standards) used to regulate point sources of pollution, which are emitted from an identifiable pipe or outfall. Instead, regional, state, and federal agencies have typically relied on voluntary, incentive-based approaches to manage nonpoint source pollution (NPS) (ELI, 1998). Such approaches have resulted in unsuccessful agriculture NPS control. In the U.S., agricultural pollution is the leading cause of pollution to rivers and lakes (EPA, 2010). And in Europe, agriculture contributes 50-80% of the total nitrogen and phosphorus loading to the region's freshwaters and seawaters (Lankoski and Ollikainen, 2013).

The inadequacies of current approaches have triggered academic and regulatory discussions about how to proceed with abating nonpoint sources (Saltman, 2001). These issues pose particularly challenging questions about appropriate regulatory tools, jurisdictional boundaries, funding needs, monitoring requirements,

pollution permit allocations and stakeholder collaboration. Drawing from environmental policy and environmental economics literature as well as case studies from the U.S. and Europe, the aim of this chapter is to assess agricultural NPS pollution management approaches and the factors that drive or impede their implementation and enforcement. The E.U.'s recent (2000) Water Framework Directive presents an opportunity to build on lessons of the earlier-promulgated 1972 U.S. Clean Water Act, while the U.S. can benefit from the implementation and enforcement of effective European water pollution controls. This research presents several policy tool frameworks to help characterize the widespread nonpoint source pollution problem in the U.S. and Europe, distinguishing its unique set of hurdles from other environmental policy problems. Findings suggest that controlling numerous diffuse sources of agricultural pollution requires an integrated approach that utilizes river basin management and a mix of policy instruments. Additionally, this chapter finds that transitioning from voluntary mechanisms to more effective instruments based on measurable water quality performance relies predominantly on three factors: (1) more robust quality monitoring data and models; (2) local participation; and (3) political will.

U.S. and E.U. Water Regulatory Background

Since the passage of revolutionary water quality policies in the 1970s, the U.S. and Europe have seen significant water quality improvements in point source discharges—defined as any discernible, confined and discrete conveyance. Over the

past 40 years, industrial pollution and discharges of organic wastes from urban areas and publicly owned treatment facilities have dropped substantially, and dissolved oxygen levels have increased downstream from point source pollution. This success can largely be attributed to the use of a transformative technology-based (or techniques-based as it is referred to in Europe) command-and-control approach, which employs standards to control pollutants at the point of discharge, setting uniform limitations based on the “Best Available Technology” (B.A.T.) for a given industry. Technology-based effluent limits have been enshrined in both the 1972 U.S. Clean Water Act and various European environmental policies.

The technology-based regulatory framework skillfully transformed water quality regulation for point sources into a remarkably more streamlined and simplified system with successful results; it unfortunately neglected the different and more difficult task of controlling nonpoint source (NPS) pollution. Instead, individual states in the U.S. and Member States/river basins in Europe have been entrusted with the monumental task of NPS pollution control.

The United States: Beyond Total Maximum Daily Loads (TMDLs) and the 1972 Clean Water Act

The 1972 Clean Water Act (CWA) and subsequent amendments largely shape present-day water quality policies (Shortle et al., 2012). During the drafting of the CWA, nonpoint source pollution was not perceived as serious of a problem as point source pollution (Saltman, 2001; Houck, 1999), and was only considered as an

afterthought (Andreen, 2004). Prior to 1972, the nation's general approach to water pollution was disjointed and highly variable—analogue to nonpoint source pollution regulation today. Control mechanisms were decentralized, which resulted in each state developing its own method of protecting water quality. While several states attempted to implement innovative water quality standards and discharge permits, the vast majority failed to improve water quality conditions. A fundamental weakness of relying on ambient standards was that states needed to prove which polluters impaired water quality and to what extent. This endeavor was extremely difficult given that the regulatory agencies possessed very little data about the location, volume, or composition of industrial discharges (Andreen, 2003a). Even if data were available, water agencies were often understaffed, under budgeted and had inadequate statutory authority. By the 1960s, many of the country's rivers and streams had reached such abominable conditions that a growing population of frustrated U.S. citizens turned to the federal government for help.

After years of delay and struggle, the U.S. was ready to formulate a comprehensive, unified regulatory structure, resulting in the 1972 Clean Water Act. The Act employed a command-and-control approach to implement technology-based standards, enforced by National Pollution Discharge Elimination System (NPDES) permits (CWA § 402). This approach, aimed at controlling pollutants at the point of discharge, set uniform limitations based on the best available technology pertaining to a particular industrial category. To implement and monitor performance, every point source was required to obtain a permit to discharge. Under this innovative system,

enforcement officials need only compare the permitted numerical limits with the permittee's discharge. Technology-based effluent limits have transformed U.S. water quality regulation into a remarkably more streamlined and simplified system with successful results (Andreen, 2003a).

In addition to the technology standards, the drafters of the Clean Water Act held on to the historic water quality-based approach, despite its observed inadequacies. In an attempt to bridge the gap between discharges and clean water (Saltman, 2001), dischargers were expected to comply with more stringent, individually-crafted effluent limitations based on water quality standards (Andreen, 2003b). This additional control tool is only implemented when technology-based controls are not sufficient in meeting beneficial uses. The process entails a few ostensibly straightforward steps: first, the state lists each impaired waterbody within its jurisdiction; second, the state designates a "beneficial use" (i.e., fishing, swimming, drinking) for each waterbody; third, a Total Maximum Daily Load or "TMDL" for each waterbody is calculated based on the designated beneficial use; and finally, a portion of the load is allocated to each point or nonpoint source.

However, the fundamental problem of TMDLs is that they must be translated into specific numerical discharge limitations for each source of pollution (Houck, 1999). This endeavor is often prohibitively expensive and extremely difficult given that every step of the regulatory process— from identifying and prioritizing impaired waterbodies to allocating emissions loads to measuring the program's success— suffers from insufficient and poor quality information (Whittemore and Ice, 2001).

Monitoring data are needed to assess, enforce, evaluate and use as a baseline for modeling efforts. The task of collecting these emissions data—identifying polluters that are difficult to pinpoint, monitoring discharges that are stochastic and virtually impossible to track, and connecting diffuse effluents back to their sources—is so problematic they have been stamped “unobservable” (Horan et al., 1998).

The paucity of information is often the result of another, more tangible limitation when implementing nonpoint source pollution abatement mechanisms: budgetary and administrative constraints. Funding the monitoring efforts as well as the staff time to adequately oversee water pollution control efforts is an obligatory, but often missing component in water management programs. Also, a lack of enforcement in areas where management practices are not protecting water quality remains a widespread problem throughout agricultural NPS programs (Houck, 1999). While individual river basins and states have varying water quality issues and employ slightly different approaches to abate nonpoint source pollution, each bears the burden of these similar hindrances.

Clearly, the challenges and complexities of nonpoint source water pollution are not amenable to technology and emission-based policy tools historically used. Current discussions on how to proceed with nonpoint source pollution abatement strangely and sadly mirror those occurring over forty years ago. In describing the difficulty of implementing water quality standards in the 1960s, Andreen (2003a) presents several questions still debated today: How should regulators allocate the capacity of a stream to a multitude of diffuse dischargers? Should the allocations be

recalculated every time there is a new or expanded discharge? What should be the boundaries of a receiving waterbody—an entire river system (since pollutants mix) or should each tributary be considered separately? Likewise, Houck (1999) describes the current state of U.S. nonpoint source pollution policy as: “slid[ing] back into the maw of a program that Congress all but rejected in 1972, among other things, its uncertain science and elaborate indirection.”

The European Union: Opportunities in the new Water Framework Directive

Similar to the U.S., the first surge of European water legislation began in the 1970s. This “first wave” was characterized by seven different Directives, which were initiated by individual Member States with little coordination with the larger E.U. community (Latacz-Lohmann and Hodge, 2003). During the late 1990s, mounting criticism on the fragmented state of water policy drove the European Commission to draft a single framework to manage water issues (European Commission, 2014).

The resulting legislation, the Water Frameworks Directive (WFD) (Directive 2000/60/EC), has been championed as “the most far-reaching piece of European environmental legislation to date” (Griffiths, 2002). Adopted in December 2000, the WFD replaced the seven prior “first wave” directives. Just as the Clean Water Act passes down authority to states in the U.S., the WFD gives each Member State and its river basins the same responsibility. Under this “second wave,” the WFD requires that River Basin Management Plans (RBMPs) be established and updated every six years. The RBMPs specify how environmental and water quality standards will be met,

allowing local authorities the flexibility to comply as they best see fit. The WFD mandates that all river basins must achieve “good” overall quality, and that more stringent standards need to be applied to a specific subset of water bodies used for drinking, bathing and protected areas. Two additional requirements of the WFD are economic analyses of water use and public participation in the policy implementation process. The E.U. chose management at the river basin level, a hydrological and geographical unit, rather than political boundaries, to encourage a more integrated approach to solving water quality problems (Moss, 2004).

Another distinguishing aspect of the WFD is its “combined approach,” which guides Member States’ choice of policy tools. Similar to the U.S. CWA approach, technology controls based on Emissions Limit Values, such as those embedded in the previous E.U. Integrated Pollution Prevention and Control (IPPC) Directive (Directive 96/61/EC and modifying directives), are implemented first. The IPPC works similarly to the U.S. NPDES permit system (CWA § 402), requiring all major industrial dischargers to obtain a permit and comply with specific discharge requirements. If these emissions and technology-based instruments are not sufficient in meeting water standards, then Environmental Quality Standards are employed.

The Water Framework Directive provides opportunities and challenges for all actors involved—Member States, European Commission, and candidate countries (European Commission, 2014). Under its ambitious goals and deadlines, Member States need to significantly alter their approach to water regulation (Griffiths, 2002). Transitioning from predominantly voluntary initiatives to comprehensive River Basin

Management Plans, the Directive has drawn international attention as a potential model for water quality improvement (Griffiths, 2002). Over a decade later, however, much work still needs to be done to bring the agricultural sector into compliance with the WFD.

Because each of the 50 states in the U.S. and each river basin in the 28 E.U. member states has devised its own plan to comply with water quality standards, hundreds of natural experiments of agriculture nonpoint source pollution control exist. The number of regulatory approaches is both impressive and discouraging: “Impressive because of the diversity and ubiquity of state legal mechanisms. Discouraging because of the inconsistent treatment of similar problems from one state to the next, and because of the significant gaps in coverage that still exist in many states” (ELI, 1998). Using a policy tool framework (Salamon, 2002), this chapter will explore the prospects for effectively governing agricultural nonpoint source pollution.

Policy Tool Framework

The task of selecting and implementing appropriate policy tools, even in all their abundance, is a challenging one for policymakers charged with nonpoint source pollution control (OTA, 1995). In choosing which tools will be used to address agricultural nonpoint source (NPS) water quality problems, authorities are faced with several tradeoffs and questions (Horan and Shortle, 2001), such as: *Who and what should be regulated? How will their compliance or performance be measured? What*

type of stimulus or policy tool will “best” motivate growers to change on-farm irrigation and nutrient management practices to reduce pollution runoff? How will policymakers balance water quality goals with economic and human health goals?

These questions, among others, are the subject of a growing body of policy implementation literature that examines important features of policy tools and the agencies and relationships on which they depend. Governments employ a number of policies, each of which involves a distinct set of policy tools (Salamon, 2002). The aim of a policy tool is to encourage an industry, institution or person to change their behavior in the interest of the environment or society. Policy tools have also been described as “nudges” from the government intended to alter someone’s actions (Thaler and Sunstein, 2008). The number of policy tools used in the public sector has proliferated in the last half-century (Schneider and Ingram, 1990; Salamon, 2002). Common tools include standards, taxes, regulation, vouchers, subsidies, and contracts. A diverse network of nonprofit, governmental and private organizations helps carry out implementation and compliance efforts. Characterizing policy tools within any regulatory program is not a simple task since tools often have multiple features, various organizational homes, and lack clear delineation (Salamon, 2002).

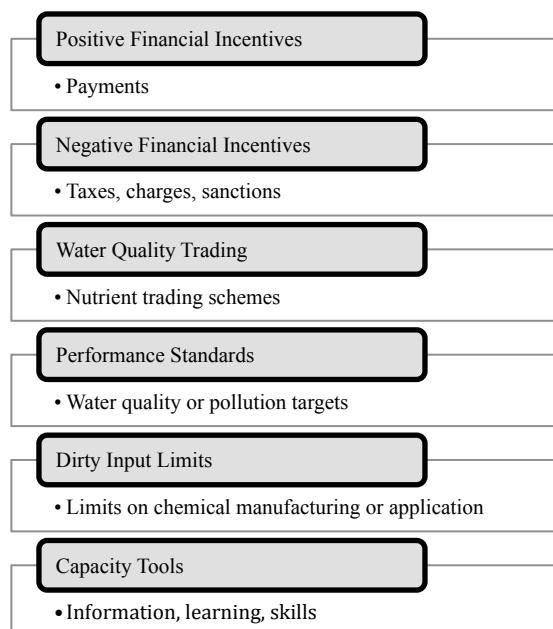
The multidimensionality of a tool complicates the task of comparison, explaining why tools have been sorted and analyzed in a number of different ways (Salamon, 2002). For example, Schneider and Ingram’s (1990) seminal paper asserts that behavioral assumptions of policy tools deserve more focus and research attention. They emphasize that an important and overlooked part of decision-making is *how*

regulatory instruments stimulate a regulated group to do something they might not have otherwise done. Another way that policy tools have been sorted and described is by the complex network of agencies on which tools depend. Using the concept of “networked governance,” Salamon (2002) highlights the burgeoning approach of relying on third-party agencies to provide public services. He shows that policy tools form the basis of the networked governance system, defining the actors and formalizing roles.

Many scholars have applied this framework to the environmental policy arena. In their book, *Sustainable Materials* (2012), authors Allwood and Cullen offer five groupings (five Es) based on the type of stimulus an environmental tool offers: encourage, enable, exemplify and engage, and enforce. The Office of Technology Assessment publication, *Environmental Policy Tools: A User’s Guide* (1995), provides yet another means of deciding

which instruments might help meet environmental goals. The OTA claims that an ideal instrument would be cost-effective and fair, place the least demands on government, provide assurance to the public that environmental goals will be met, use pollution prevention when possible, consider environmental equity and

Figure 2-1. Six Policy Tool Groupings



justice issues, be adaptable to change, and encourage technology innovation and diffusion. A final body of literature relevant to this chapter is that of environmental economics. Economics literature (Horan and Shortle, 2001; Shortle and Horan, 2005) has largely organized its analysis of nonpoint source pollution control instruments into three broad questions: Who to target? What to target? And with what stimulus?

Clearly, this framework offers a trusted and established means for assessing and comparing policy successes and failures. Drawing from a range of theoretical interpretations of the policy framework this chapter analyzes six groupings of tools (see Figure 3-1)—(1) positive financial incentives, (2) negative financial incentives, (3) water quality trading programs, (4) performance standards, (5) dirty input limits, and (6) capacity tools. Case studies from the literature are woven into the analysis.

Positive financial incentives: Pay the Polluter, Best Management Practices

For decades, local, state and federal agencies in the U.S. and Europe have relied heavily on voluntary financial incentive tools. Also called “Pay the Polluter” (PTP) initiatives (Shortle et al., 2012), financial and technical assistance are provided to farmers to motivate practices that reduce pollution. The basic assumption is that farmers will respond to positive payoffs by choosing activities that improve environmental conditions (Schneider and Ingram, 1990). The activities that might qualify for payments vary from Best Management Practices (BMPs) or technologies (i.e., installing a vegetative buffer strip or reducing fertilizer application rates) to environmental improvements (Weinberg and Claassen, 2006).

Ideally, financial incentives would be linked to environmental or water quality improvements, and payments would be made based on the extent of improvements (Weinberg and Claassen, 2006). However, due to the challenges of measuring the environmental gains resulting from agricultural practices, most incentive schemes simply target the implementation of Best Management Practices themselves (Weinberg and Claassen, 2006). A variety of BMPs have been identified and developed to reduce water pollution from agriculture. No single set of on-farm BMPs applies to all agricultural settings and for all purposes, but a wide range exists to best suit environmental and farm needs. Nationally recognized water pollution abatement schemes include the U.S. Environmental Protection Agency's "Core 4": conservation tillage, crop nutrient management, pest management, and conservation buffers. Other BMPs include irrigation water management and erosion and sediment control (EPA, 2012).

To choose the most appropriate BMP for a field or farm, information about current nutrient and water management practices, as well as local soil, climatic, and water quality conditions are needed. Tailoring BMPs to a specific site is perhaps the most effective means of improving nearby water bodies and has the added benefits of stakeholder participation. However, designing policies on a field-by-field basis can be prohibitively costly if reliant on expensive computer modeling technology; however, new technologies will continue to reduce their costs.

The two most distinguished financial incentive schemes pertaining to agricultural and water quality in the U.S.—USDA's Environmental Quality

Incentives Program (EQIP) and the Conservation Reserve Program (CRP)—use contracts to reward farmers for implementing conservation practices (EQIP) or for removing environmentally sensitive land from production (CRP). Incentivizing certain BMPs, such as land retirement, has the *possible*, but not certain, benefit of stopping or diminishing pollutants from entering into nearby water bodies.

Economic scholars contend that financial incentives could outperform other types of policy tools, such as effluent estimated emissions standards and estimated runoff incentives (Shortle and Horan, 2001). Incentives have the added benefits of encouraging technological innovation and providing flexibility to alter management practices. However, the lack of political will to tax or reallocate budgets to purchase sufficient water quality improvements make the success of this approach highly unlikely (Shortle et al., 2012). If financial incentives could be tied to performance with the use of modeling programs, it might bolster financial programs.

While such programs are popular among farmers, and while there have been local PTP success stories, the past four decades of experimenting with voluntary financial incentives in the U.S. and E.U. overwhelmingly indicates that the PTP approach should not be a stand-alone policy tool. In fact, there has been widespread interest in both scholarly circles and regulatory programs in moving away from voluntary incentive-based schemes towards enforceable requirements (Shortle et al., 2012). England is illustrative of this transition. Initially, in 1990, England responded to the E.U. Nitrate Directive (Directive 91/676/EC and modifications) with a voluntary contract system that compensated farmers for reducing nitrogen application

(Goodlass et al., 2001). Though moderately effective, reducing N inputs and leaching by about 20% (Goodlass et al., 2001), the country has decided to transition to the use of enforceable mandates on the type, quantity and timing of fertilizers in all Nitrate Vulnerable Zones (Latacz-Lohmann and Hodge, 2003). Mandated standards will be discussed further in the performance tool section, below.

Negative financial incentives: Taxes, Polluter Pays Principle

Situated on the opposite end of the continuum from Pay the Polluter approaches are negative financial incentive or disincentive schemes— sometimes referred to as Polluter Pays Principle (PPP) (Shortle et al., 2012, Horan and Shortle, 2001).

Negative financial incentives include charges, taxes, and sanctions. In the 1980s, a series of environmental economic papers reignited discussions about a particular type of financial disincentive tool—taxation—as a form of pollution control specifically for the use on nonpoint sources. Two separate bodies of work are distinguished based on what would be subject to tax. Griffin and Bromley (1982) and Shortle and Dunn's (1986) seminal pieces target *inputs*, while Segerson (1988) and subsequent scholars chose to focus on *ambient standards* as the base for modeling tax instruments.

Both taxation tools rely on the use of proxies, or models that estimate pollutant loadings. The ideal means to reduce pollutants through taxation, or any other tool, would be to control discharges directly. Since policymakers are unable to use pollution abatement tools that are directly tied to emissions, they must instead choose between constructs based on emission proxies or choose other tools that

circumvent emissions altogether (see Table 2-1). Economic scholars have written and researched prolifically on design models that predict the impact of a farm's discharges based on inputs or management practices. Unfortunately, no matter how complex or comprehensive such models are, they cannot fully capture the diversity of variables affecting the transport of pollutants from source to receiving water body (Winsten et al., 2011); and generally do not have the level of accuracy necessary for regulatory applications (Lemke and Baker, 2002). Tools based on models and proxies are considered "second-best" and less effective because of uncertainty that water quality improvements will be made (OTA, 1995).

A performance-based tax was successfully employed in the Netherlands under the E.U.'s Nitrate Directive. In 1998, the Dutch introduced an Input-Output manure management policy entitled the Minerals Accounting System (MINAS). Farmers were required to calculate their annual nutrient inputs (nitrogen and phosphorus brought onto the farm) and outputs (nutrients leaving farms). All net surpluses of nitrogen or phosphorus were subject to a hefty penalty—seven times the cost of fertilizer at the time (Harter et al., 2012). This performance-based tax tool proved to be effective in achieving its intended objective: One monitoring study showed that nitrogen surpluses in agricultural areas fell substantially as a result of its implementation (as cited in Harter et al., 2012). However, high transaction costs and prohibitively high penalties forced the Dutch to replace the nitrate tax with technology-based standards that limit the input of fertilizers (Goodlass et al., 2001; Winsten et al., 2011; Shortle et al., 2012; OECD, 2012a).

Simulated models and theoretical economic research corroborate the Netherlands' successful tax experience. When tested in a computer simulation, taxes have been shown to be one of, if not the most effective means of improving water quality. Yet which tax instrument is most cost-effective remains unsettled (see Horan and Shortle, 2001). In their study on optimal tax schemes for conserving water and reducing pollution, Dinar and Xepadadeas (2002) found that an instrument or two instruments that mix a tax on water use and a tax on emissions are most effective. They argue that this mixed tax tool need not monitor or regulate inputs because the external effects of inputs will be internalized through the tax on emissions. In their seminal paper on cost-effective tax instruments, Griffin and Bromley (1982) compared four pollution policies: input taxes, emission taxes, performance standards, and best management practices. They found that the four policies were equally efficient. A European case study in Southern England's Kennet Catchment, on the other hand, found a tax on nitrogen, an input-based tax, to be the most effective policy tool (Oshea and Wade, 2009). Other studies show that taxes based on emissions proxies are more cost-effective than taxes on inputs (see Shortle and Horan, 2005).

Taxes, whether input or emission-based, can be extremely effective if levied at high enough levels (Horan and Shortle, 2001). Nevertheless, taxes are arguably the most unpopular policy tool among the regulated group. Given the political clout of the American agricultural industry and high costs of modeling estimated emissions, taxation schemes have rarely been employed in the U.S., leaving few on-the-ground

cases to test their efficacy. When agricultural taxes are used, they are levied at such low rates that they offer little incentive to change behavior (as cited in Horan and Shortle, 2001).

Water Quality Trading (WQT)

Another type of market-based approach is water quality trading (WQT), advocated by both the U.S. Environmental Protection Agency and environmental economic scholars as one of the most cost-effective means of achieving water quality goals (Wainger and Shortle, 2013). Emissions trading (water or other media) provide individual dischargers a limited right to pollute and the option to trade those rights with others (Horan and Shortle, 2001). Trading programs became popular in the 1990s with the success of sulfur dioxide trading under the U.S. Clean Air Act's Acid Rain Program (OTA, 1995; Wainger and Shortle, 2013), which saved an estimated one billion U.S. dollars compared to traditional regulatory alternatives, and more recently the E.U.'s 2005 carbon dioxide Emissions Trading Scheme (OECD, 2012a).

Interest in WQT as a means to achieve water quality standards (i.e., TMDLs) in the U.S. was provoked in part by the success of other trading programs, but also by a series of citizen lawsuits in the 1980s pressing the U.S. EPA to clean impaired waters (Houck, 1999). Unfortunately, agricultural nonpoint sources pose significant technical challenges in water quality trading programs for several reasons. First, the entry of nonpoint source polluters into the trading market is commonly voluntary, not enforced. In the U.S. and Canada, point source dischargers (i.e., municipal and

industrial) must obtain permits to release emissions, whereas nonpoint source dischargers largely remain uninhibited by federal mandates (Shabman and Stephenson, 2007; OECD, 2012a). In these WQT programs, point sources trade with other point sources to avoid costly discharge reductions at their industrial facilities, and only a handful of nonpoint sources are involved on a voluntary basis (Horan and Shortle, 2001). On the limited occasions that the agricultural industry does engage in trading, farm nonpoint sources almost always assume the roll of “sellers” in the program, rather than “buyers” (Shabman and Stephenson, 2007). Under such circumstances, point source dischargers pay nonpoint sources to comply with water quality standards (Malone, 2002), creating a profit-making opportunity for agricultural pollution (OECD, 2012a)

This lopsided relationship between point and nonpoint sources highlights another related problem: the absence of a *fully capped* trading system. Though trading schemes show promise in transitioning the regulatory framework from individual discharge limits to river basin management based on group controls, for the system to realize its full potential, *all* dischargers—point and nonpoint—must participate (Shabman and Stephenson, 2007).

A further complication, both in partially- and fully-capped WQT systems, is that of accounting for differences in emission loads between point and nonpoint sources. WQT programs utilize a trading ratio (sometimes called an “uncertainty” ratio) to calculate how many units of estimated nonpoint source loadings should be traded with a unit of point source loadings (OECD, 2012a). Because of the

uncertainty of nonpoint source loadings, trading ratios are almost always set at 2:1 or greater to create a margin of safety (OECD, 2012a). In this scenario, point sources must purchase two units of estimated nonpoint reductions for every unit of excess emissions. Interestingly, a study on trading ratios found that political acceptability, rather than scientific information, determined ratio calculations (as cited in OECD, 2012a).

Despite the challenges, several notable successes have demonstrated that enforced group caps, emission allocations, and water quality standards can be met. For example, in 1995, farmers from the San Joaquin Valley, California implemented a tradable discharge permit system to enforce a regional cap on selenium discharges. The selenium program set a schedule of monthly and annual load limits, and imposed a penalty on violations of those limits (Young and Karkoski, 2000; OECD, 2012a). In Canada's Ontario basin, a phosphorus trading program was established in which point sources purchase agricultural offsets rather than update their facilities (Wainger and Shortle, 2013). A third-party, South Nation Conservation, acts a facilitator, collecting funds from point sources and financing phosphorus-reducing agricultural projects. It is estimated that the program has prevented 11,843 kg of phosphorus from reaching waterways (Wainger and Shortle, 2013).

Numerous other pilot trading projects show promise, but need a serious overhaul if they are to realize their full potential. One prominent example worth mentioning is the U.S.'s Chesapeake Bay Nutrient Trading program. In response to President Obama's executive order to clean up the Chesapeake Bay, the largest

estuary in North America, the six states contributing pollution to the Bay are in the national spotlight as they figure out how to achieve pollutant allocations. Currently, their plans to meet water quality requirements are falling short (Andreen, et al., 2011). Economic scholars contend that a nutrient trading plan could offer the most cost-effective means for complying with the looming TMDL. But, uncertainty about agricultural sources willingness to participate and what trading ratio is most appropriate as well as high transaction costs remain issues (Van Houtven et al., 2012).

Performance Tools

The most traditional form of command-and-control regulation is performance standards. Though often presented as an alternative to market-based approaches, performance standards can complement a tax or emissions-trading system, and can also be used alongside positive incentive schemes. In an incentive approach, if pollution exceeds a standard then a financial penalty or charge might be triggered, whereas if a farmer is well within compliance, the farmer might receive a positive payoff for their efforts. Standards can also be used in trading through pollution allowances with enforceable requirements (Shortle et al., 2012). And in a mandate scenario, standards are compulsory, and may or may not be accompanied with other motivating devices (Schneider and Ingram, 1990).

Theory and experience suggest that the most successful pollution prevention tools are performance-based (Shortle et al., 2012). Performance standards have successfully reduced point source water pollution—E.U.’s IPPC Directive (Directive

96/61/EC and modifying directives) and U.S.'s NPDES program (CWA § 402) and pollution of other media (i.e., air). Unfortunately, the same suite of challenges—the use of proxies, costs of monitoring and modeling, and uncertainty of environmental outcomes—face performance standards within the context of nonpoint source abatement. These perceived obstacles have largely precluded the use of performance tools for agricultural NPS control (Young and Karkoski, 2000). However, a growing body of literature expounds the benefits of using performance approaches for this industrial sector (Zarker and Kerr, 2008; Weinberg and Claassen, 2006).

Performance measures are used to encourage Best Management Practices (BMPs). Using models to predict the level of BMP performance can provide powerful decision-making data to farmers, helping them make appropriate management decisions (Winsten et al., 2011; Shortle et al., 2012). Performance modeling is most effective when conducted at the field-scale. For example, the Performance-Based Environmental Policies for Agriculture (PEPA) initiative found that the implementation of BMPs, such as changing row directions or installing buffer strips, reduces the risk of pollution to varying degrees depending on several on-farm factors (Winsten et al., 2011).

Allowing farmers to exercise site-specific knowledge in an individualized context highlights an important, laudable feature of performance-based approaches: flexibility (Shortle et al., 2012). Some suggests that practice-based tools, ones that mandate or incentivize the installation of certain BMPs, are not as cost-effective as their performance-based counterparts (Weinberg and Claassen, 2006). This is largely

due to the fact that performance-based instruments provide flexibility to choose the practices that will achieve water quality improvements at the lowest cost (Shortle et al., 2012).

Regulation further “upstream:” Dirty input limits, tools aimed at manufacturers

In the case of agricultural water pollution, farmers are the predominant actors targeted for compliance. While logical, since farmers’ management practices influence the amount of pollution that reach nearby water bodies, however it is worth noting that other actors involved in the pollution process could be targeted for regulation. For example, the control of pesticides has been managed by regulating the chemical manufacturer, imposing mandates or taxes on chemicals sold on the market (Shortle and Horan, 2005). This type of tool could be highly effective in reducing the amount of pesticides or fertilizers produced, sold, bought, applied and discharged into water bodies, creating a ripple effect through the whole production stream. Targeting actors further “upstream” is illustrative of what Driesen and Sinden (2009) call a the “dirty input limit” or “DIL.” Manufacturing companies are only one of several points along the production stream where the DIL approach could be effective; alternatively, pollutants could be controlled at the point of application. As suggested by the authors, the DIL approach is useful beyond the tool choice framework in that it provokes a new way of thinking about environmental regulation.

Capacity Tools

Among the least invasive (Horan and Shortle, 2001), but most important instruments for successful NPS management, capacity tools provide information and/or other resources to help farmers make decisions to achieve societal and environmental goals. Capacity tools are typically associated with voluntary initiatives rather than mandates (Schneider and Ingram, 1990). Because it can be difficult for farmers to detect the water quality impacts of their practices visually (Winsten et al., 2011), learning and capacity tools become an invaluable means of conveying information to farmers. Farmers' perceptions of the water quality problem and their role in contributing to pollution are one of the most influential factors in changing farming management practices (Winsten et al., 2011). In California, the Resource Conservation Districts, University of California Extension, and the University of California's Division of Agriculture and Natural Resources are examples of local government agencies providing capacity building services that include knowledge, skills, training and information in order to change on-farm behavior.

In summary, each policy tool possesses strengths and weaknesses, which need to be taken into consideration when developing more effective ways to control agricultural pollution. An integrated approach, one that utilizes a diversity of policy instruments to address water quality issues in agriculture, is required. River basin management plans (RBMPs), or the "watershed approach" as it is often referred to in the U.S., can more appropriately tailor their choice of policy tools to local conditions. Authority has been granted (by the E.U. to river basins and by the U.S. federal

government to states/watersheds) to achieve water quality objectives at the regional jurisdictional level. The success of these programs will largely depend on the wisdom and will of those regional governmental leaders (Andreen, 2004), as discussed below.

Table 2-1. Comparison of Selected Policy Tools: Lessons from the U.S. and E.U.

Tools Tied to Emissions					
	Type of Policy Tool	Product/Activity	Proxies used?	Political or practical obstacles?	Ability to raise revenue?
Taxes	<i>Input:</i> Charges on excess nutrient applications	Financial penalty	<i>Input:</i> Yes, estimated environmental impacts of excess inputs	Yes, taxes are unpopular	Yes
	<i>Ambient:</i> Charges on nutrient loadings		<i>Ambient:</i> Yes, modeled nutrient loading		
Traditional regulation	Performance Standards	Rule	Yes, restrictions on modeled nutrient loadings	Yes, difficult to set the correct standard	Perhaps, if penalty is imposed
Water Quality Trading	Market	Contract	Yes, estimated emissions trading	Yes, voluntary entry of NPS into trading market; partially-capped system; difficult to calculate trading ratio	Perhaps, permits could raise revenue; traditionally, allocations are free
					Examples
					Netherland's MINAS
					England's nitrogen program; Point source ex: E.U.'s IPPC and U.S.'s NPDES
					CA's selenium trading program; Canada's Ontario basin; U.S.'s Chesapeake Bay program

Tools Not Tied to Emissions						
Best Management Practices (BMPs)	Contract, Incentive, Standard	Practices	No, unless linked to environmental or water quality improvements	Somewhat, but usually politically acceptable	No	BMP examples: conservation tillage, nutrient management, pest management, buffers
Dirty Input Limit	Ban or Limits	Rule	Perhaps, if limits are based on estimated environmental impacts of excess inputs	Yes, not politically popular to limit production or use of fertilizers or chemicals	No	Point source ex: Pesticide regulation and Stormwater regulation
Financial Incentive	Incentive	Payment, Subsidy	No, unless linked to environmental or water quality improvements	Somewhat, lack of political will to tax/reallocate budgets to purchase sufficient water quality improvements	No	USDA's EQIP, U.S. CRP
Capacity	Learning and capacity	Info or resources	No	No, generally popular tool	No	RCDs; UC Extension, UC ANR
Source: adapted from Parry & Pizer, 2008; Horan & Shortle, 2001; Salamon, 2002						

Discussion

What are the major similarities and distinctions between different approaches to agricultural nonpoint source pollution regulation available in the U.S. and Europe? And, which are most effective? This chapter examined the defining characteristics and application of six policy tools, each of which have been proposed for agricultural pollution abatement. As noted in the introduction, the task of comparing tools is complicated by the multiple facets and dimensions embedded in each tool (Salamon, 2002). While research suggests that a mix of policy tools will outperform any one instrument (OECD, 2012b), clear strengths, weaknesses and unique traits distinguish tools from one another and should be taken into consideration when regulators choose means to meet environmental goals. Table 2-1 lists several categories by which to compare a select group of policy tools.

As the table illustrates, a number of key relationships are particularly important. Emphasis is placed on the difference between tools tied to emissions and those not tied to emissions. The clear benefit of tools tied to emissions is their ability to track and measure environmental improvements. However, therein lies these tools' biggest weakness: Reliance on proxies to predict the extent of environmental improvements. The information burdens needed to construct models that adequately predict the impact of a farm's discharges are so great that many practitioners and scholars have shrugged off the task as impossible. Encouragingly, a growing body of literature and scholarly discussions show prospect for improved computer simulation efforts. Until more robust models are designed with improved information,

policymakers will continue to rely on the second category of tools—those not tied to emissions. Tools untethered to specific pollution targets work by encouraging water quality improvements through incentives, contracts and/or information. These tools tend to be more politically favorable, but less effective by themselves, save one—the dirty input limit. While capacity tools can provide important information to farmers and best management practices *may* improve water quality, the DIL can prevent pollutants from ever reaching rivers and lakes, or even farms. With the U.S. pesticide and stormwater regulatory programs as models (Press, 2015), regulating inputs has the potential to achieve more than regulating emissions. But the DIL is not without obstacles, including heavy reliance on scarce information to set the appropriate limitations and political will to restrict chemical or fertilizer production and/or use.

Conclusion

Both the U.S. Clean Water Act and E.U. Water Framework Directive set out a framework to achieve clean water through the use of numeric water quality standards. Meeting these performance standards has been impeded by the challenge of nonpoint sources of pollution, especially from agriculture. The enormous task of regulating hundreds of thousands of small, diffuse, and diverse farm discharges has led to the perception that enforceable policies based on performance standards would be administratively cumbersome and economically inefficient (Young and Karkoski, 2000). Consequently, agricultural pollution control programs have relied on voluntary policy tools that incentivize inputs or practices, rather than environmental

results. These programs have, in effect, exempted nonpoint source industry dischargers from paying for their pollution, and more importantly, have failed to achieve clean water.

Transitioning from the voluntary mechanisms to more effective instruments based on measurable water quality performance relies predominantly on three factors: (1) more robust quality monitoring data and models; (2) local participation; and (3) political will. Computer simulation models that predict performance of Best Management Practices rely on ongoing water data as well as past and current land use and farm practices as baseline information (Weinberg and Claassen, 2006). A means for collecting these data needs to be thoughtfully integrated into programmatic design. Further, more empirical research and funding is necessary to test performance-based computer models with stochastic features, so that instruments are tried and ready when sufficient data from local water authorities become available. While monitoring and modeling remain expensive, new technologies will continue to reduce their costs.

Environmental regulation has historically relied on end-of-pipe, command-and-control instruments, leaving water quality agencies inexperienced in participatory, local forms of management (Moss, 2004). In conventional environmental regulation, enforcement officials need only compare the permitted numerical limits with the permittee's discharge, providing little incentive to involve stakeholders in the process. The new and more complex problems associated with nonpoint source pollution require a new governance approach, one that coordinates

with multiple managers (Salamon, 2002). Because no one-policy tool is appropriate for all crops and locations (Sheriff, 2005), local decision-making is crucial. Local control, at the river basin level, provides flexibility to design management practices that are individualized and cost-effective, as well as holds farmers accountable for the pollution they produce (Young and Karkoski, 2000). But participation also requires more work and a unique set of negotiation and collaboration skills (Goodin et al., 2006; Salamon, 2002). The U.S. Government Accountability Office (2013) study on the nation's water quality goals found that stakeholder participation was one of the top two factors inhibiting the achievement of water quality standards. Similarly, The European Commission's (2013) Scientific and Policy Report on the Water Framework Directive and Agriculture found that participation amongst farmers in monitoring and interpretation resulted in improved coordination.

The biggest hurdle is the lack of political will to implement water quality standards with mandatory controls (Malone, 2002). As one environmental policy expert stated, "true progress will require far more willingness to bring nonpoint source dischargers into the regulatory fold and much better information tying diffuse sources to water quality outcomes" (Press, 2015). If Europe and the U.S. are to achieve clean water, commitment and investment in enforceable measures are needed (ELI, 1998). By tying instruments to measurable environmental goals, performance tools can help in the transition (Shortle et al., 2012). U.S. and Europe have the means to address agricultural nonpoint sources of pollution, what is lacking is the motivation to do so.

The obstacles of addressing water pollution are fundamentally different and more difficult than they were 40 years ago (Andreen, 2004). Today, controlling numerous diffuse sources of pollution requires an integrated approach that utilizes river basin management and a mix of policy instruments. Unfortunately, no silver bullet exists to satisfy all regional contexts and agricultural water quality problems. Fortunately, policy makers have an array of policy tools to choose from and the advantage of learning from past regulatory programs, some successful, and some not, to improve water quality. This study finds that the widespread use of voluntary incentive-based approaches has failed to control agricultural pollution. Additionally, findings suggest an increasing necessity to move towards emissions and/or input limits-based policy tools tied to actual water quality improvements. Such a performance approach would benefit from well-researched BMPs that best suit farm and environmental needs.

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Chapter 3: Governing Water Quality in California's Central Coast: The Case of the Conditional Agricultural Waiver

Summary

Agricultural nonpoint source pollution is a persistent environmental and human health problem throughout California. Agriculture has impaired approximately 9,493 miles of streams and rivers and 513,130 acres of lakes in the state (SWRCB, 2010). And in California's Central Coast region, water quality has deteriorated over the past decade (CCRWQCB, 2011). Nonpoint source pollution is difficult to regulate because it is inherently diffuse: monitoring dispersed and dynamic discharges and connecting them back to their sources to identify what operation is polluting and to what extent is both expensive and complex. Despite these obstacles, policymakers are increasingly forced to tackle the monumental task of how to best regulate agricultural discharges.

This case study focuses on the primary water pollution control policy in one of California's highest valued agricultural areas: the Central Coast Conditional Agricultural Waiver (Ag Waiver). The Central Coast Regional Water Quality Control Board (Regional Board), which is granted authority from the State Water Resources Control Board (State Board) for protecting and restoring water quality within its jurisdiction, is under pressure, especially in light of a 2015 Superior Court ruling that directed the Regional Board to implement more stringent control measures for agricultural water pollution. Pressure on the Regional Board is exacerbated by regulatory budget constraints, interest groups, and by unanticipated events.

This chapter assesses the factors that influenced the development and implementation of the Ag Waiver policy process over the last decade and evaluates specific policy outcomes from this process. Results indicate that several complicated factors either drive or constrain improved water quality management and pollution control. In California's Central Coast, conditions that have weakened agricultural water pollution policies in the region include budgetary and staff constraints, the 2006 *E. coli* breakout, and the powerful agricultural lobby. On the other side, environmentalists, environmental justice groups, health organizations, scientific studies, S.B. 390, and the 2015 California Superior Court ruling have pushed the Regional Board to develop more comprehensive water quality protections.

The 2004 and 2012 Ag Waivers mark a significant step forward in water quality protections, but have fallen short of achieving water quality objectives. Several provisions could be strengthened or modified to better meet these goals, including: a more comprehensive monitoring and reporting program, enforcement of science-based management practices to control pollution at its source, and the development of strategies to increase the participation and cooperation with the regulated industry.

Introduction

Nonpoint source pollution, or pollution that comes from many diffuse sources, continues to contaminate California's waters (SWRCB, 2010). Agricultural nonpoint source pollution is the primary source of pollution in the state: Agriculture has

impaired approximately 9,493 miles of streams and rivers and 513,130 acres of lakes on the 303(d) list of waterbodies statewide (SWRCB, 2010). The 303(d) list is a section of the Clean Water Act mandating states and regions to review and report waterbodies and pollutants that exceed protective water quality standards.

Agricultural pollution in California's Central Coast has detrimentally affected aquatic life, including endemic fish populations and sea otters, the health of streams, and human sources of drinking water (Anderson et al., 2003; Anderson et al., 2006; Shimek, 2012a; Harter et al., 2012). Despite the growing evidence of agriculture's considerable contribution to water pollution, the agricultural industry has, in effect, been exempt from paying for its pollution, and more importantly, has failed to meet water quality standards. How to best manage and regulate nonpoint source agricultural water pollution remains a primary concern for policymakers and agricultural operators alike.

This case study focuses on the Conditional Agricultural Waiver in California's Central Coast, the primary water pollution control policy in one of the highest valued agricultural areas in the U.S. The Central Coast Regional Water Quality Control Board is under increasing pressure to improve water quality within its jurisdiction, especially with the added onus from a 2015 Superior Court ruling that directed the Regional Board to implement more stringent control measures for agricultural water pollution. Pressure on the Regional Board is exacerbated by regulatory budget constraints, interest groups, and by unanticipated events. Given these pressures,

choosing appropriate criteria by which to evaluate the success of California's primary agricultural water quality policies is complicated, but of critical importance.

This policy analysis explores the complex process of negotiations, agendas and conditions at the heart of policy-making, highlighting areas where the 2004 and 2012 Ag Waiver has succeeded in achieving its goals, as well as where it has fallen short. The analysis is divided into two parts. The first employs a within-case method of process tracing to assess the factors that acted as drivers or limitations to the policy process. Part two, uses six evaluative criteria to assess the effectiveness of specific outcomes, such as water quality improvements and the value of monitoring data.

Regulatory Background

The 1972 Clean Water Act employs a technology-based standards approach, whereby any discharger must obtain a permit (valid for five years) that contains the limits on what an individual or industry can discharge into a given water body as well as details their monitoring and reporting requirements, all these provisions are defined and enforced by the National Pollution Discharge Elimination System (NPDES) permit system (CWA § 402). This approach aims to control pollutants at the point of discharge by setting uniform discharge limitations based on the best available technology pertaining to a particular industrial category. The U.S. EPA grants states the primary responsibility of issuing NPDES permits, and monitoring and enforcing performance.

When the technology-based approach does not adequately control pollution, an additional control tool, water quality-based standards, is implemented. The EPA and states use a calculation, Total Maximum Daily Load (TMDL), to determine the maximum amount of a pollutant that a waterbody can receive while still meeting water quality standards. Water quality standards are set by designating a “beneficial use” (i.e., fishing, swimming, drinking) for each waterbody as well as the criteria to protect the designated use of that water. The TMDL calculation is a multi-step process: first, the state lists each impaired waterbody within its jurisdiction, called the “303(d) list”; second, using the state’s already-established “beneficial use” categories, a numeric TMDL is calculated for each waterbody; finally, a portion of the load is allocated to each discharger.

The fundamental problem of TMDLs, especially in waters polluted with nonpoint sources, is that they must be translated into specific numeric discharge limitations for each source of pollution (Houck, 1999). Because nonpoint source pollution (NPS), such as agricultural runoff, is inherently diffuse, the task of monitoring dispersed and dynamic discharges and connecting them back to their sources to identify what operation is polluting and to what extent is both expensive and complicated. However, efforts by the EPA are underway to make water quality modeling, specifically targeted at regulators implementing TMDLs and water quality standards, more easily accessible and affordable (EPA, 2015).

Similar to the Clean Water Act, California’s Porter-Cologne Act gives broad authority to nine Regional Water Quality Control Boards (“Regional Boards”) to

regulate water quality at a sub-state, localized scale. Regional Boards are responsible for water quality protection, permitting, inspection, and enforcement actions (Water Code §13225(a)). Any discharger that could affect water quality must obtain a permit to pollute (“Waste Discharge Requirement,” which is similar to a NPDES permit). The Regional Board issues permits on the condition that beneficial uses are protected and water quality objectives will be met. The Regional Boards also have the right to waive Waste Discharge Requirements (WDRs) for individuals or groups, including agriculture, if it is in the public interest (Water Code §13269). For agricultural discharges, Regional Boards have historically granted waivers rather than force growers to comply with WDRs. In October of 1999, with water quality high on the political agenda, Senate Bill 390 (S.B. 390) was passed, mandating that Regional Boards attach *conditions* to waivers and review them every five years (called “Conditional Waivers of Waste Discharge Requirements” or “Conditional Waivers”). All waivers need to include monitoring requirements for discharges that pose a risk to water quality. Such monitoring requirements must be adequate to verify the effectiveness of the Waiver’s conditions (Monterey Coastkeeper, et al. v. SWRCB, 2015). In effect, the Conditional Waivers function similarly to Waste Discharge Requirements: the discharger needs to meet conditions specified in the Waiver/Permit.

Each Regional Board has taken a different approach to controlling runoff from agricultural lands within their jurisdiction (Newman, 2012), but almost all have issued Conditional Waivers. In 2004, the Central Coast Region (Region 3) was the

first to adopt a Conditional Agricultural Waiver (“Ag Waiver”). The conditions attached to the 2004 Waiver required growers to enroll in the Agricultural Waiver program, complete 15 hours of water quality education, prepare a farm plan, implement water quality improvement practices, and complete individual or cooperative water quality monitoring. The 2004 Agricultural Waiver expired in July 2009, but the Order was extended five times from 2009 until 2012.

After nearly three years of continued negotiation, on March 15, 2012 the Central Coast Regional Board adopted a new Conditional Agricultural Waiver, Order No. R3-2012-0011. The updated 2012 Ag Waiver places farms in one of three tiers, based on their risk to water quality (Tier 1 being the lowest risk and Tier 3 the highest). Bigger and more polluting farms are held to tougher standards. For most of the Tier 1 and 2 farms, the 2012 requirements are similar to those in the 2004 Waiver: water quality education, water quality management plans, implementation of management practices, and either cooperative or independent surface receiving water monitoring and reporting. For Tier 3 farms (or a subset of Tier 3 Farms) and a subset of Tier 2 farms, additional conditions are added, including submitting an annual compliance form, conducting individual discharge monitoring and reporting, and implementing vegetative buffers. Soon after the 2012 adoption, the State Board received petitions from five parties, representing both the agricultural community and environmental organizations, requesting a “stay” (deferral) on specific provisions of the new waiver. The agricultural community argued that the Ag Waiver was too harsh, and environmentalists contended it did not go far enough (CCRWQCB, 2012).

The State Board asked the Central Coast Regional Board to review and estimate the costs of the provisions of concern and further explain the environmental and public benefits that the updated Waiver would accrue from compliance (SWRCB, 2013). The State Board rewrote sections of the Agricultural Waiver, and released a final version in September 2013.

Unsatisfied with the State Board's revisions, a coalition of environmental groups, together with an elderly woman who could not drink water from her tap because it was contaminated with agricultural waste, filed a lawsuit in Sacramento's Superior Court challenging the 2012 Central Coast Agricultural Waiver and the changes made by the State Board. The coalition claimed the State Board changes "cripple the already weak order," and as it's currently written, the Ag Waiver is "so weak, it did not comply with state law" (Otter Project, 2015). In his ruling on August 11, 2015, Superior Court Judge Frawley agreed that the Central Coast's Conditional Agricultural Waiver was doing an inadequate job of protecting regional water quality and needed to develop more stringent conditions.

Research Justification

A more contextualized story of adopting the 2004 and 2012 Ag Waivers is laden with complex and contentious trade-offs, negotiations, lobbying efforts, alliance building, scientific findings, and difficult to foresee "focusing events" (see Kingdon, 1995). This study pays special attention to assessing the effectiveness of the monitoring program and significance of data collected under the Conditional Agricultural

Waiver. Monitoring data are arguably the most pressing concern for nonpoint source pollution control plans. This Central Coast case illustrates a common trend in nonpoint source (NPS) pollution control and what Sunstein (1990) would mark as “regulatory failure due to information limitation.” The current monitoring data on agricultural water discharges are inadequate to allocate TMDLs and therefore implement and enforce water quality standards. In the absence of sufficient data, the Ag Waiver regulatory program cannot comply with state and federal law, and water protections are further delayed (Wittemore and Ice, 2001). In an attempt to comply with water quality standards, the Central Coast Regional Board has endeavored to ratchet up monitoring efforts. For example, the updated 2012 Agricultural Waiver program modestly expanded the amount of information it requires of Tier 3 growers to include some individual monitoring. Unfortunately, many are skeptical that this more “robust” monitoring program will, in practice, amount to much more in terms of useful information than the previous (2004) monitoring program, especially given the small number of growers in Tier 3. This study fills a gap in research on where monitoring efforts have succeeded and failed in the Central Coast’s agricultural NPS pollution control policies and in reaching TMDL goals.

There is also a growing need to identify realistic tools for water quality agencies charged with the difficult task of regulating agricultural NPS pollution. While this study will tailor recommendations specifically to the Central Coast Region, other states and localities facing similar difficulties can utilize results from this research to better manage agricultural pollution with their jurisdiction.

Case Study Selection

The Central Coast Region

stretches 300 miles from San Mateo County in the north to Santa Barbara County in the south, and is composed of 17,000 miles of streams and rivers and 4,000 square miles of groundwater basins. The 2010 Surface Water Ambient Monitoring program report found that the Central Coast

Figure 3-2. California's Central Coast Region



had the highest percentage of highly toxic waters in the state, of all sites samples, 22% were considered “highly toxic” (i.e., the mean for all samples from the site was more toxic than the high toxicity threshold) (Anderson et al., 2010). The topography is defined by several coastal mountain ranges including the Santa Lucia Range, closest to the coast, the Gabilan and Diablo ranges in the north, the Cholame Hills in the center and La Panza ranges in the south (DWR, 2009). Three major valleys are nestled among mountain ranges. They are, in order of size: the long Salinas Valley, stretching 120 miles from Moss Landing to Santa Margarita and two smaller valleys,

the Pajaro Valley in the north adjacent to the Salinas, and the Santa Maria Valley in the south.

The Central Coast Region covers approximately 435,000 acres of irrigated land (44.5% of statewide agricultural acreage) and approximately 3,000 agricultural operations. These operations produce a variety of specialty products such as lettuce, strawberries, raspberries, artichokes, asparagus, broccoli, carrots, cauliflower, celery, and herbs (EDD, 2012). While several microclimates exist, overall the region has a temperate, Mediterranean climate characterized by mild, wet winters, and warm, dry summers (DWR, 2009).

Methods

Both analyses will use a within-case method of “process tracing,” also called “historical analysis” or “detailed case studies” (King, Keohane, and Verba; 1994) to assess the factors that acted as drivers or limitations to developing the 2004 and 2012 Ag Waiver. Using in-depth qualitative methods and focusing on the single case of the Central Coast Region allows numerous variables and conditions to be explored to see which ones “activate” a particular outcome (George and Bennett, 2005). The goal of this process is to tease out which causal factors—be they part of the policy process or mechanisms embedded in the policy tool itself—contributed to the development of the 2004 and 2012 Agricultural Waiver. This strategy utilizes variation in the dependent and independent variables, an approach that has been successfully employed in social science research (George and Bennett, 2005).

Though a general causal hypothesis can be made that certain independent variables (factors within the policy and implementation process, such as budgetary and staff constraints) have a causal effect on policy-making, process tracing allows the researcher to narrow down the list of potential influential causes as well as uncover independent variables that otherwise would have been left out (George and Bennett, 2005). Process tracing can also identify whether or not these influential variables have a positive or negative effect on the policy outcome. Such a research design is an iterative, cyclical process—a broad hypothesis can be refined as more data are gathered. King, Keohane, and Verba (1994) explain that this type of “exploratory investigation”—selecting on the basis of variance in dependent and independent variables—generates a more precise hypothesis than that which can be made at the beginning.

Process tracing requires an in-depth understanding of causal mechanisms in the policymaking process in each case, relying on data from newspapers and magazine articles, websites, meeting minutes, policy documents, government reports, public comments, monitoring and enforcement data, and other archival documents. Key informants for this part of the current research include Regional Water Board staff, university extension specialists, agricultural organizations, growers, water quality agencies, and stakeholders involved in water quality efforts. Interviews were conducted in a semi-structured manner and key informants were identified using “snowball” sampling—starting with a few identified stakeholders who then share names of additional significant individuals to interview. In this study, data from

interviews are used to help contextualize events, perspectives, language or definitions and reaffirm information identified during the document analysis.

Policy Analysis Part 1: Forces Driving and Impeding Policy

A staff member at the Regional Board described why agricultural water pollution became a priority in the region: “what is different about the Central Coast Region [compared to other Regions], is that there is a *real* problem with drinking water here. It was the choice of a few people acknowledging that ‘this is a problem’ and it was time to move forward with more enforcements” (Interview with Regional Board staffer, October 3, 2012). At the same time, political alliances were being forged between unlikely interests groups (*e.g.*, the Farm Bureau and environmentalists) and water quality was becoming a statewide concern. According to a UC Extension advisor, during the first 2004 Ag Waiver process, participation and cooperation amongst the agricultural community helped move the regulatory process along:

Recognizing the problem was not going to fade, the Farm Bureau decided to jump on [the water quality issue] when it first started. The [Farm] Bureau became instrumental in calming [the growers] down. They decided to be pro-active and work with others to convince the farming community that [water quality control measures] were worth investing in. (Interview with UC Extension agent, February 4, 2013).

With the escalating momentum and the further impetus from S.B. 390, the 2004 Agricultural Waiver was passed by the Regional Board, marking a small but critical

step forward in regional agricultural water quality protections. The conditions attached to the 2004 Waiver (described above) were palatable to growers yet significant enough to initiate a regulatory program, with the underlying assumption that future Ag Waivers would gradually increase requirements if water quality did not improve.

Just as water quality was rising on the agenda, circumstances changed and priorities shifted. In September 2006, two years after passing the first Agricultural Waiver, an *E. coli* outbreak traced to the Salinas Valley killed three people and sickened more than 200 (Stuart et al., 2006). Due to public concern, large supermarket chains including Safeway and Costco Wholesale Corporation, demanded that growers have more stringent food safety requirements (Stuart et al., 2006). The *E. coli* sources of highest concern were from animals passing through crop fields. Subsequently, food safety auditors began requiring a “scorched-earth” policy including minimizing any vegetative habitat around farms that could attract wildlife. One farmer stated that the “Western Growers Association said they wouldn’t buy anything from farms with vegetative buffer strips.” Because maintaining vegetation on a field’s edge protects water quality from discharging into nearby waterbodies, calling for its removal could threaten efforts to address water pollution on the Central Coast (Stuart et al., 2006). The *E. coli* “focusing event” (see Kingdon, 2003) forced the Regional Board to rethink this key provision (vegetative buffer strips), which was already under discussion in drafts of the updated Agricultural Waiver. Mandating vegetative buffer strips for all farms would, quite literally, compete with food safety

requirements, which require farms to clear vegetation. The contradictory food safety requirement (remove vegetative buffers) versus water quality requirement (install vegetative buffers) left growers confused about which policies to follow. A representative from the Farm Bureau voiced frustration on behalf of the agricultural community, “ever since *E. coli* there has been a series of complex overlay of regulations” (Interview with Farm Bureau representative, February, 2013). Two additional issues related to buffer implementation concerned growers: the cost and the science driving the policy. Growers worried about the price not only of installing, irrigating and maintaining the new vegetation around their farms, but also the lost revenue from taking cropland out of production and replacing it with vegetation.

Moreover, some agricultural stakeholders contended that the science driving this mandate was inadequate. The improved water quality from vegetative buffers, including pollutant, nutrient and sediment retention, infiltration, sediment deposition, and absorption are well documented in the literature (see Arora et al., 2010; Mayer et al., 2007; Balestrini 2011). However, regional agronomic research demonstrating the effectiveness of vegetative buffers is limited to only a few studies, and their results are mixed, especially in regards to the most effective width-size and vegetation (Los Huertos, 1999; Rein, 1999). Buffer width became a cornerstone of debate since the jury was still out on exactly how wide a buffer should be to improve water quality. The results of a meta-analysis of over 80 scientific articles on vegetated buffers and sediment trapping efficacy concluded that while wider buffers provide a longer “residence” time for runoff water and thus, are more effective in reducing sediment,

sediment trapping efficacy does not improve significantly when buffer width was increased beyond 10 meters (Liu et al., 2007). In other words, beyond 10 meters, the law of diminishing returns takes effect. The analysis by Liu and colleagues also concludes that buffer width alone only explains about one-third of retention effectiveness, and other factors, such as soil, slope and vegetation play an equally important role. Because of these competing interests, the vegetative buffer requirement was substantially weakened throughout the Agricultural Waiver deliberation process. The 2010 Draft Waiver proposed that *all* farms should be required to implement a 50-100-foot buffer; by November of that year the mandate was reduced to only Tier 3 farms and the buffer width was reduced to 30 feet, and by the final 2012 Waiver the buffer requirement was left largely to the discretion of the agricultural operator, stating that either a buffer or a proposed alternative must be implemented to protect adjacent polluted waterbodies.

With the *E. coli* event still fresh on the public's minds, water quality temporarily faded from the regulatory spotlight. But not for long: the 2004 Ag Waiver was due to expire in July 2009, forcing the Regional Board staff to launch a new stakeholder process for the updated Ag Waiver. Unfortunately, the proposed public input process was deemed "not transparent or open to the public" by a California Farm Bureau representative, and did not keep pace with the 2009 deadline. The Waiver was extended for another year. In addition to the pending deadline, mounting scientific evidence of water pollution sources and mobilization of several interest groups pushed agricultural water pollution back on the agenda. Water quality data

collected over the preceding five years from the 2004 Ag Waiver Cooperative Monitoring Program clearly showed discharges from agricultural lands were a cause of pesticide toxicity as well as a contributing source of nitrate and sediment impairments in the region (CCRWQCB, 2012). Due to growing concerns about one contaminant in particular, nitrate, a 2008 Senate Bill (S.B. X2-1) was passed, requiring the State Water Resource Control Board to prepare a report addressing nitrate groundwater contamination. The Center for Watershed Sciences at the University of California, Davis conducted the report, and one of the watersheds they chose to study (because of known nitrate-contamination) was in the Central Coast region. Additionally, the 2010 State Water Resource Control Board Report found that the Central Coast Region had the highest percentage of toxic water sites statewide. Furthermore, several scientific reports found that pesticide use in the Central Coast was contributing to water column and sediment toxicity (Anderson et al., 2003), as well as cause human health problems, such as developmental delays in infants and children (Perera et al., 2006).

The Regional Board staff had the scientific evidence and momentum it needed to develop an ambitious 2010 Draft Waiver. Among the many sweeping reforms, the 2010 Draft Waiver required all dischargers to conduct individual surface water discharge monitoring, required Farm Plans to be accompanied by monitoring and site evaluation results, prohibited the use of excess fertilizer, required a comprehensive list of pesticides to be regulated, and required all farms to implement vegetative buffers. Members of the agricultural community voiced their concerns with the Draft

in Regional Water Board meetings, through comment letters, on the web, and in newspapers. In a December 2009 meeting, several agricultural representatives reiterated their frustrations about the public input process, their worries regarding the mounting costs, and their opinions that the existing 2004 Ag Waiver was working well and did not need to be amended. Environmentalists, on the other hand, believed the proposed Order should be adopted without further delay. At a standstill, the Board re-issued the existing Conditional Waiver four more times: November 2010, March 2011, July 2011, and August 2011.

Environmental groups, with agendas ranging from environmental justice to marine ecosystem protections to urban stormwater programs, were highly disappointed that the 2010 Draft Waiver was not adopted. The environmental community was strongly represented by the Santa Barbara Channelkeeper, The Otter Project, and Monterey Bay Keeper, providing extensive comments at Regional Board meetings up until the adoption of the 2012 Agricultural Order.

In 2012, published results from the State commissioned nitrate contamination study, although controversial among the agricultural community, found that cropland was the primary source (96%) of human-generated nitrate contamination in the Tulare Lake Basin and the Salinas Valley (located in the Central Coast), and that 254,000 people in the area are at risk for nitrate contamination in their drinking water. Because nitrate-contaminated drinking water is a well-known human health effects, including “blue baby syndrome” (Knobeloch et al., 2000), the results of this study

became a rallying-cry for the Department of Health to encourage a more stringent Agricultural Waiver.

The California Department of Health shed light on nitrate groundwater contamination, echoing concerns reported from the UC Davis report. The United Farm Workers and a coalition of groups rallied behind environmental justice concerns, representing the voice of people most affected by nitrate contaminated drinking water. At a Central Coast Board meeting in February of 2012, Marcela Morales of the Central Coast Alliance United for a Sustainable Economy explained that contaminated water is disproportionately impacting low-income populations and people of color. She strongly urged the Board to take action and not delay the updated Waiver, claiming that communities affected by drinking water contamination are in urgent need of basic protection to ensure clean drinking water.

Another impetus arose from water quality regulators in urban areas. Municipalities, facing ever-stringent regulations, began to question the fairness of waiving the agricultural water quality requirements (Meurer, 2011). City managers voiced their concern about pollutants from agricultural areas being deposited into receiving waterbodies within city boundaries, which cities are required to clean up through stormwater National Pollutant Discharge Elimination System (NPDES) permits. As the City Manager of Monterey, for example, suggested that agricultural industries and municipalities should be held to the same standard (Meurer, 2011).

On the other side, Farm Bureaus, individual growers and the Growers and Shippers Association represented the agricultural interests. California's \$43.5 billion

agriculture industry comprised of 81,500 farms spread over 25.4 million acres is one of the largest and most influential interest groups in the state (USDA, 2011).

Historically, the California Farm Bureau has had success at regional and national lobbying efforts. Between the two Agricultural Waivers (2004 and 2012), there were grumblings within the agricultural community that the Regional Board was not involving the growers in the deliberation process as much as during the 2004 Ag Waiver negotiations. As one farm stakeholder explained, growers felt they were not involved when figuring out solutions to water quality improvements, rather “[the Regional Board] set the rules without much input and expected growers to comply.” As a lettuce grower in the Salinas Valley stated, “the Regional Board didn’t take into account stakeholder opinion...The elephant in the room...[was] that there was no collaboration between the grower community and the regional water board staff... Discussions about the [Agricultural Waiver] and how to implement it should have been happening during the past four years, but it did not” (as cited in Campbell, 2012).

Several board meetings leading up to the March vote were packed with testimonies from agricultural interests assembling to delay the vote and water quality interest groups, encouraging the Board to pass a more stringent updated Agricultural Waiver. Steve Shimek (2012b), spearheading the environmental interests, described the dualistic nature of the unfolding politics: “on one side are community activists seeking tougher pollution limits and public access to water quality data. On the other side are too many farmers trying to avoid cleaning up the waste from their

operations.” At the March 15, 2012 Board meeting, the three-year long debate culminated in the passage of an updated Agricultural Waiver.

But the process was not over. As mentioned earlier, five groups requested a deferral on several provisions of the 2012 Ag Waiver. In September of 2013 the State Board adopted the existing Ag Waiver, which made some modifications to the 2012 version passed by the Regional Board. A few months later, environmentalists filed a lawsuit in Sacramento Superior Court challenging the modified 2012 Ag Waiver as being too weak. The modified waiver and lawsuit will be discussed in more detail in the next section.

Overall, the policy process leading up to the 2012 Ag Waiver was fraught with tension between a variety of stakeholders, including agriculture, cities, environmentalists, scientists and environmental justice groups. Consequently, the Waiver that ultimately passed was more robust than its 2004 predecessor, but weaker than ambitious draft orders that came to the fore during negotiations (*e.g.*, 2010). The next part of this chapter will analyze the effectiveness of the resultant provisions embedded in both Ag Waivers.

Policy Analysis Part 2: Policy Outcomes

Public policy literature presents several means to assess the efficacy of a policy. The criteria chosen for policy analysis is important, as it could influence the direction of the policy as well as future budget allocations. Cass Sunstein (1990), former Administrator of White House Office of Information and Regulatory Affairs for the

Obama administration, asserts that determining the success or failure of a regulation depends on its goals and scope. Dowd and his colleagues (2008) echo this claim in their paper on agricultural nonpoint source pollution policy in the Central Coast, stressing that the success of the Agricultural Waiver largely depends on the evaluative criteria used. Six parameters were carefully selected to measure the effectiveness of the 2004 and 2012 Ag Waivers: 1) complying with mandates set in the Agricultural Waiver, 2) evaluating quantifiable water quality improvements, 3) evaluating the requirements themselves, 4) assessing the significance of monitoring data, 5) comparing costs to growers vs. broader societal and environmental benefits, and 6) evaluating the equity of compliance across growers, including the distributive consequences.

Embedded evaluative criteria in the Agricultural Waiver

A logical place to begin evaluating the success of the 2004 and 2012 Agricultural Waiver is by measuring the degree to which growers met the compliance requirements. Based on the high level of enrollment in the 2004 Agricultural Waiver (1,800 operations, who manage 93% of the total regional acreage) the 2004 Waiver has been labeled a success by simple participation among growers. The number that completed The 2012 Ag Order boasts roughly the same enrollment numbers: 1,796 operations managing 94% of farm acreage in the region.

Evaluating compliance based on specific 2012 requirements, however, is more variable. As Table 3-1 indicates, there is a high compliance rate for simply enrolling

in the program, but slightly less so in regards to more complex requirements. For example, close to a quarter of all farms have not reported groundwater monitoring at the individual level for both domestic drinking water and agricultural wells. On the other hand, every farm (100% compliance rate) that is required to report total nitrogen applied to their farm has done so.

Table 3-1. Ag Waiver Requirements - Summary of Program Compliance (2014)

Tier			Requirement	Level	Required to Comply	Failed to Comply	In compliance (%)	Non-compliance (%)
1	2	3						
✓	✓	✓	Enroll – File eNOI	Farm Acres	435,000	25,540	94%	6%
✓	✓	✓	Develop/Update Farm Plan	Operation	1,796	288	84%	16%
✓	✓	✓	Install Backflow Prevention Device	Farm	3,093	104	97%	3%
✓	✓	✓	Update electronic eNOI	Farm	4,322	933	77%	23%
✓	✓	✓	Surface receiving water monitoring (cooperative)	Operation	1,775	147	92%	8%
✓	✓	✓	Surface receiving water monitoring (individual)	Operation	21	0	0%	100%
✓	✓	✓	Groundwater monitoring (cooperative)	Farm	1,861	<i>Pending</i>		
✓	✓	✓	Groundwater monitoring (individual)	Drinking	876	225	74%	26%
	✓	✓	Submit Annual Compliance Form	Agriculture	1,657	410	75%	25%
	✓	✓	Calculate risk of nitrate loading to groundwater	Farm	2,168	245	89%	11%
	✓	✓	Record and report total nitrogen applied	Farm	2,168	245	89%	11%
	✓	✓	Report individual discharge monitoring	Farm	467	0	100%	0%
	✓	✓		Farm	14	0	100%	0%

Source: Central Coast Regional Water Quality Control Board, 2015

Water quality improvements

Despite high compliance rates, the Ag Waiver has resulted in uncertain water quality gains. A number of water quality monitoring programs can be used to determine whether regional waterbodies are getting cleaner or more degraded since the implementation of the Ag Waivers. This assessment summarizes a subset of relevant water quality databases, reports, and scientific studies (see Table 3-2).

Table 3-2. Water Quality Data Sources

Agency	Program
Preservation Inc.	Cooperative Monitoring Program (CMP)
Surface Water Ambient Monitoring Program (Regional Boards)	Central Coast Ambient Monitoring Program (CCAMP)
Coastal Watershed Council	Snapshot Day/ First Flush
U.S. EPA	CWA 303(d) List of Impaired Waterbodies
U.S. EPA	Rivers and National Streams Assessments
Peer-reviewed scientific studies	Granite Canyon Lab (See work by Anderson, B.S., Hunt, B.M., and Phillips, P.A.)

The Clean Water Act Section 303(d) list¹ of Impaired Waterbodies for the Central Coast Region can be an indication, albeit a limited one, of how water quality has changed over time. Two relevant listing cycles, 2006 and 2010, indicate a dramatic increase in the number of polluted waterways in the Central Coast. Over these four years, Regional Board staff added 515 listings of impaired waterbodies,

¹ The “303(d) list” is short for the list of impaired and threatened waters that the Clean Water Act requires all states to submit for EPA approval every two years. The states identify all water where required pollution controls are not sufficient to attain water quality standards.

totaling 707 in the 2010 listing cycle (CCRWQCB, 2009). Agriculture is a source of impairment in the majority of these listed waterbodies. While these numbers are striking, trends using these data should be made with caution for at least two reasons:

- 1) the number of waterbodies assessed for the 303(d) list varies from year-to-year and
- 2) there may be a latency period between when a waterbody was surveyed and when it is listed.

The most commonly cited monitoring databases used to assess water quality in the region (CCAMP and CMP) also indicate degrading water quality. Reports from these two agencies suggest that many of the same waterbodies, especially in the two areas responsible for most water pollution, are more polluted than they were a decade ago (CCRWQCB, 2011). While some waters have improved—47 waterbodies were de-listed as impaired in 2010—the vast majority have not. The lower Salinas watershed and the lower Santa Maria area are responsible for most of the region's polluted waters; these areas are also the leading agricultural producers in the Central Coast (CCRWQCB, 2011).

The 303(d) list, CMP, CCAMP, CWC, and scientific studies from the UC Davis Marine Pollution Studies Laboratory at Granite Canyon, identify a number of water quality concerns, in particular, dissolved oxygen, elevated pH, elevated nitrate and ammonia, water and sediment toxicity, and habitat disturbances. Monitoring patterns show that these pollution parameters are variable throughout the region, and that particular watersheds are hotspots for certain pollutants. When listed together, these parameters are responsible for impairments to the beneficial uses of drinking

water, recreation, aquatic life, and agricultural uses. Of these concerns, nitrate contamination is the most serious and widespread problem in the region.

Regional water quality reflects a larger state and national trend of degrading and variable water conditions. California Water Boards' Annual Performance Report (2010-2011) found half of all surveyed streams in the state to be degraded or very degraded, as measured by the health of aquatic organism communities that live in the state's streams. The bioassessment studies show a clear relationship between increased water pollution and increased agricultural and urban land use (Worcester 2011).

Nationwide, agricultural nonpoint pollution is the chief impediment to achieving national water quality objectives (EPA, 2010). The EPA lists the chief components of these nonpoint source agricultural pollutants as nitrogen and phosphorus from fertilizers, pesticides, animal sources, soil erosion, and salts from irrigated fields. The National Rivers and Streams Assessment, conducted by the U.S. EPA in 2004 and again in 2008/9, uses separate monitoring data from the 303(d) listings. Over the course of five years, between 2004 and 2009, the Assessment found seven percent fewer stream miles were in good biological condition. Similar to the Central Coast, throughout the U.S. changes to water quality in streams were variable over time and space. Overall, the report found that U.S. streams and rivers are "under significant stress and more than half exhibit poor biological condition" (EPA, 2009).

Despite the diverse datasets, frequency and consistency of monitoring data are still not sufficient to verify the effectiveness (measured by improved water quality) of

the Agricultural Waiver (Monterey Coastkeeper, et al. v. SWRCB, 2015; Worcester, 2011). The following two sections will assess the value of the Ag Waivers requirements, particularly the monitoring provisions.

A Closer look at the Ag Waiver Requirements

A closer look at the requirements themselves highlights why compliance may not lead to improved water quality. The Agricultural Waiver, in theory, uses an approach that gradually increases compliance requirements, called an “iterative approach,” meaning dischargers implement increasingly improved management practices until the region has achieved clean water. This approach recognizes that progress towards achieving water standards can take time. Logically, the 2012 Waiver should be significantly more rigorous than its predecessor. While Tier 3 farms might have more stringent requirements, a handful of significant provisions for Tier 1 and 2, which make up 99% of all growers, have been so watered-down and in some cases eliminated that the 2012 Ag Waiver has been regarded as “only marginally stronger than the 2004 Ag Waiver” (Monterey Coastkeeper, et al. v. SWRCB, 2015).

Several examples illustrate this point. First, in its modifications to the 2012 Agricultural Waiver, the State Board eliminated the only enforceable provision that would control nitrogen pollution—the nitrogen balance ratio target². Instead, growers

² Agricultural nitrogen balance ratios can indicate which farms are at risk to nitrogen pollution. The ratio tracks the amount of nitrogen input to and output from the farm, and calculates the potential surplus of nitrogen on the farm. This surplus nitrogen (the amount not used by crops) can runoff or leach into nearby waterways, causing polluted. The aim is to achieve a one-to-one input-to-output ratio.

now only need to report the total N applied. Even with the 100% compliance rate of this mandate, the total N reporting provides substantially less information about which farms have nitrogen surpluses and might be contributing to pollution. Second, and arguably most importantly, the Ag Waiver does not have any quantifiable mechanisms to determine if management practices implemented by Tier 1 and 2 farms reduce pollution (Monterey Coastkeeper, et al. v. SWRCB, 2015). Third, choosing which management practices to implement is largely up to the discretion of agricultural operators. The Ag Waiver does not define what management practices should be implemented or verify if those practices are actually improving water (Monterey Coastkeeper, et al. v. SWRCB, 2015). Though management practices are a means to reduce pollution discharges and achieve water quality, the California's Nonpoint Source Policy establishes that "management practices may not be substituted for actual compliance with water quality standards" (SWRCB, 2004).

One new requirement that can aid the Regional Board in *estimating* improved water quality is the mandate to report all water quality management practices and outcomes. The online form requires growers to check all nutrient, irrigation, pesticide and sediment management practices that are being implemented and the number of acres on which the practices are applied. While this new tool will provide baseline data for the Regional Board to better understand how growers say they are managing their land and crops, there are no means to verify if those management practices are effective. Growers have the opportunity to report if they have seen a positive outcome from their implemented management practices, yet outcomes are measured

by the grower's perception of change rather than a numeric or quantifiable water quality data. For example, in the 2014 annual compliance form, the most commonly used method to confirm sediment reduction was by walking the perimeter of the property to verify erosion controls were in place and that sediment did not leave the ranch/farm during irrigation events and/or storm events; the least commonly used method to confirm sediment reduction was to measure turbidity in stormwater runoff.

Monitoring, will the data be meaningful?

The Agricultural Waiver has significant monitoring limitations. In the 2012 Ag Waiver, the Regional Board acknowledged that a critical limitation of the 2004 Ag Waiver was “the lack of discharge monitoring and reporting... and the lack of public transparency regarding on-farm discharges” (CCRWQCB, 2012). The 2015 Superior Court Judge ruling reiterated this point: “The 2004 Waiver has not been successful because it lacks adequate standards and feedback mechanisms to assess the effectiveness of implemented management practices in reducing pollution and preventing further degradation of water quality.” Despite adding a handful of modest monitoring requirements to contend with these limitations, the updated 2012 Ag Waiver suffers from the same shortcomings as its predecessor.

The biggest deficiency in the monitoring program is that data collected are neither comprehensive enough to verify the effectiveness of the management practices nor to identify individual operations that cause impairments (Monterey Coastkeeper, et al. v. SWRCB, 2015). This issue points to the most controversial Ag

Waiver topic: public disclosure and transparency of information. The most effective means of identifying a polluter is to conduct individual discharge monitoring at the edge of a discharger's field where pollutants enter the water. Because of its controversial nature, and the difficulty to collect data from thousands of individual farms, the 2012 Ag Waiver compromised by mandating that only the highest risk polluters—Tier 3 farms—need to report individual surface discharge monitoring. The biggest fear among growers is that of being identified as a point source polluter, and subsequently regulated under WDRs or NPDES permits, rather than a Waiver. As one Regional Board staff member put it, growers “don’t want to deal with a government agency managing their land and water, and they don’t want to be called part of the problem.” With individual discharge monitoring requirements as the driving force, growers did anything they could to get out of Tier 3. Farm operations split their ranches into sub-parcels, stopped using certain pesticides, or stopped farming altogether. To depict the drastic exodus out of Tier 3, in 2010, over 10% of farms were categorized in Tier 3, yet as of September 2015, only 1% of all farms in the Region are regulated under that Tier. As a result of the shift to lower tiers, monitoring and regulatory provisions, and the overall Ag Waiver itself, have been severely hindered, since most growers are not held to sufficiently strict mandates. A goal of requiring individual surface water monitoring of Tier 3 farms was to evaluate effects of waste discharge on water quality and beneficial uses; it remains to be seen whether data from such a small subset of growers will adequately achieve this objective.

In contrast, the 99% of other growers (Tier 1 and 2) must report surface receiving water monitoring, either cooperatively or individually. Surface receiving monitoring is conducted on the main stem of a river, rather than near a grower's fields. For growers, this is a much more attractive scenario: data are reported as an aggregate and pollutants detected from surface receiving water data can rarely be traced back to its source. Additionally, the cost is generally less than the fees associated with the individual surface water discharge Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP).

Monitoring challenges are exacerbated by the diffuse nature of nonpoint source pollution. Because agricultural runoff does not enter a stream at a well-defined point, and often occurs episodically (Andreen, 2004), continuous or targeted monitoring (i.e., set on a monthly or seasonal basis) are needed to evaluate the rapidly changing and dynamic local environmental conditions. Growers and the cooperative monitoring program are not required to collect data at the same time or even during the same rain event, making it difficult to compare results and establish trends. A nonprofit, the Coastal Watershed Council (CWC), has attempted to address this problem by testing several water parameters in watersheds throughout the region during the first rain event, or "First Flush", in their annual Snapshot Day. By collecting water quality data during the first rainfall, the CWC attempts to capture the most concentrated pollutants washing off the landscape in significant levels at the same time from year to year. The CWC's Snapshot Day found nutrients and turbidity from agriculture and urban areas to be a major source of regional water

contamination. However, the CWC program is volunteer-based and has a limited capacity to carry out high quality comprehensive monitoring.

Costs vs. Benefits

A related complaint by growers is that they will be substantially harmed by the cost of compliance. A 2012 *Ag Alert* article reported that the regulatory requirements in the 2012 Order amounted to more than \$230 million in lost revenue and an estimated 2,500 to 3,300 in lost agricultural jobs (Campbell, 2012). The Growers-Shippers Association of Central California added that the adopted regulations are “over-board and intrusive on grower operations” (as cited in Campbell, 2012). Some growers claim that the compliance costs are unwarranted because farm management practices similar to the ones being mandated are already in effect. A representative from the Santa Cruz Farm Bureau voiced the agricultural community’s frustrations, “in general, there has been a lot of concern about the regulations being applied. In particular, the Regional Board did not take into consideration what was already being done on the farm. [The Agricultural Waiver] adds a financial and time burden on growers.”

Several growers and agricultural organizations, including seven county Farm Bureaus, put into writing the perceived economic burden in their appeal to the 2012 Ag Order. In their request, agricultural petitioners claimed the cost of compliance would amount to 1.3-2.5%, 0.13-0.3%, and 0.8-1.5 % of gross crop revenues per acre for leaf lettuce, strawberry, and head lettuce, respectively. Some asserted that the

methods employed in the agricultural group's cost analysis were "not credible" and the numbers were "inflated," and "self-serving" (Shimek, 2012b). In its argument against the agricultural industry's estimated compliance costs, the Regional Board claimed that because the potential costs vary widely from farm to farm it is impossible to estimate the range over all farms. Another example of cost discrepancies was in the estimated monitoring expenditures for the two pesticides regulated in the Ag Waiver, diazinon and chlorpyrifos: the Regional Board estimated the total cost to monitor these two pesticides would be \$250 per farm, whereas the agricultural petitioners estimated \$7,000 to \$11,000 per farm.

It is nearly impossible to put a dollar value on the public health and ecological benefits gained from the two Agricultural Waivers, but it is worth mentioning some potential benefits from the Ag Waiver. In their rebuttal to the request for a "stay," the Regional Board listed several environmental benefits that would result from the 2012 Agricultural Waiver including improved drinking water, overall public health, decreased pollutant loadings in surface and groundwater, reduced threat to sensitive aquatic habitats, and more stabilization of stream banks in riparian areas. Whether these improved societal and environmental conditions outweigh the estimated 0.8-2.5% of gross crop revenues it would cost to comply will largely depend on who is asked.

Equity of Compliance and Distributional Consequences

Issues of equity are at the heart of public policy controversies (Stone, 2002), and can be used to measure policy effectiveness two ways: *fairness* (even distribution of benefits) or *redistribution* (channels costs disproportionately to those that lack them or channels costs to the biggest hazards) (Salamon, 2002). A related distributive conflict concerns communities disproportionately affected by a given policy. Factors that may play a role in measuring equity through the lens of environmental justice include (1) the level of participation among stakeholders and/or (2) distributive outcomes of pollution (OTA, 1995). These types of concerns harken back to the founder of policy studies, Harold Lasswell (1936), who encouraged policy scholars to ask: “Who benefits? Who gets what, when, and how?” Answers to such questions attempt to uncover the inevitable unequal allocation of resources that result the dynamic relationship of power and bargaining inherent in the making of any set of rules and regulations (Mahoney and Thelen, 2010).

In the case of the Central Coast Ag Waiver, three main distributional consequences of compliance have been highlighted as unfair. The first two are contestations among growers themselves. First, Tier 3 growers contend that the three-tiered system is imbalanced because it distributes a substantially higher burden on a small number of farms. This assertion represents a classic policy paradox: “equal treatment may require unequal treatment; and the same distribution may be seen as equal or unequal, depending on one’s point of view” (Stone, 2002). From the Regional Board’s perspective, requiring more stringent and costly compliance standards for higher-risk farms is more fair than holding all regulated entities to the

same standards. “If they are rational,” argues Sunstein (1990), “agencies will bring enforcement actions against the most dangerous violator.”

Another group of growers feel the Agricultural Waiver is unfair for a different set of reasons. This agricultural group asserts that while they are attempting to comply with the Waiver’s provision (i.e., enrolling in the waiver, implementing BMPs, paying an agency to monitor), other growers are able to get away with non-compliance due to a lack of enforcement. A farm advisor told a story of a San Benito County farmer that was “jumping through all the hoops to comply with the Agriculture waiver regulations saying, ‘I’m paying to have my tailwaters and wells tested, but how can I compete in the marketplace if my neighbor’s polluted tailwaters come through my farm and is not doing anything to comply? I cannot ask the market to give me a higher price for my crop to help offset the expenses.’” This statement speaks directly to the uneven impacts resulting from insufficient enforcement as well as the tough political economic conditions under which farmers are operating in the region.

The 2012 Ag Waiver attempts to address different aspects of fairness in its regulatory requirements. First, the Regional Board and staff acknowledged that each farm is unique and requirements should not be one-size-fits-all (see Transcript of Proceedings, 2011), which is why it devised a three-tiered system that intentionally split farms by size and risk to water quality. The Regional Board received several comment letters from smaller farms, perhaps like the one in the San Benito case, who were concerned about requirements being overly burdensome due to their size.

Because of these concerns and because smaller farms may (but not definitely) pose a smaller risk to water quality, they have been placed in Tier 1 with the least costly and onerous requirements. There was also some dialogue of creating an even lesser tier with no requirements for those farms that have very minimal discharges to act as an incentive to curtail pollution. However, a “Tier 0” would be the equivalent of stopping pollution altogether, and in such a case a farm would not have to apply for a permit at all. For Tier 2 and 3 farms, the option of transferring to a lower Tier does exist, however.

Additionally, governmental and third party agencies have established programs to provide technical and financial assistance to help growers achieve compliance mandates. For example, Section 319 of the U.S. Clean Water Act provides territories and tribes with grants for nonpoint source pollution. In 2012, these grants provided \$164.5 million for pollution abatement projects throughout the country (EPA, 2012). Another department, The U.S. Department of Agriculture Natural Resource Conservation Services (USDA-NRCS), works closely with landowners and growers to provide cost-share, technical assistance, and economic incentives to implement BMPs for water quality improvement. The USDA’s Conservation Reserve Enhancement Programs and the NRCS’s Environmental Quality Incentives Program (EQIP) offer free consultation and financial services to growers who implement best management practices (BMPs) for water quality protection. Nongovernmental agencies, such as the Community Alliance for Family Farmers (CAFF), offer similar assistance to growers, particularly those in need of

help financing and installing native vegetative buffer strips, which in the early phases of Ag Waiver negotiations was presented as a particularly challenging hurdle for Tier 3 farms. Consulting groups that aid in the implementation of BMPs in California include the University of California Cooperative Extension, academic and research institutions, and growers' consortia.

The concept of fairness and equity in regulations and monitoring also exist between different groups of stakeholders. In his opening remarks at a pivotal regional board meeting concerning the 2011 draft order (March 17, 2011), Assistant Executive Director to the Regional Board, Michael Thomas, aptly addressed this concept of fairness:

[Fairness] depends on who you are. If you're a farmer struggling to make a living today in this environment of increasing regulations from multiple agencies like ours, or if you are a fisherman...who's fishing in Oso Flaco Lake, that lake is now posted because of contamination in fish tissue due to pesticides, or if you're a person who's relying on groundwater as a drinking water source, and that water is contaminated, [that] picture can look very different.

In his testimony, Mr. Thomas also added that different sectors might perceive an unequal fairness in how much they are being regulated. Urban stormwater is regulated heavily because of its high threat to water quality, yet timber and agriculture are regulated the least, despite agriculture being the primary source of water contamination in the region. Municipalities in the area, such as the City of

Monterey (Meurer, 2011), agree that the urban sector incurs a higher degree of regulation and costs of compliance than do its agricultural counterpart.

Conclusion and Policy Recommendations

As runoff from crop fields continues to pollute waters throughout the Central Coast, policymakers are increasingly forced to tackle the monumental task of how to best regulate agricultural discharges. Several complicated factors either drive or constrain improved water quality management and pollution control. In California's Central Coast, conditions that have weakened agricultural water pollution policies in the region include budgetary and staff constraints, the 2006 *E. coli* breakout, and the powerful agricultural lobby. On the other side, environmentalists, environmental justice groups, health organizations, scientific studies, S.B. 390, and the 2015 California Superior Court ruling have pushed the Regional Board to develop more comprehensive water quality protections.

The 2004 and 2012 Central Coast Agricultural Waiver made incremental pollution protections. Both Waivers represent a significant step forward in the way society thinks about and growers manage discharges from agriculture. As one farm advisor explained, "the Agricultural Waiver was a success because it is a move in the right direction. Everyone in the research and extension community is trying to better understand nutrient management, which is a good thing... And it will inevitably impact growers' approach to [fertilizer] inputs in the future, including cover cropping and nutrient management plans." Though best management practices may be better

understood as a result of the Ag Waiver, water quality has still not improved as a result.

A top priority of the Regional Board should be to develop strategies for increasing adoption of effective management practices and evaluating their success through numeric water quality monitoring. No panacea exists to magically improve water quality in a short timeframe, except for barring agricultural operations altogether, which is politically, culturally and economically unfeasible. Rather, the Regional Board must use a diversified toolset, one that includes the implementation of science-driven best management practices to control pollution at its source.

A number of policy tools have successfully regulated pollutant inputs, such as the Dirty Input Limit (see Driesen and Sinden, 2009) and the Netherland's Nitrate Tax (see Mayzelle and Harter, 2011). The Dirty Input Limits (DIL) approach departs from conventional environmental regulation since its focus is on inputs, or sources of pollutants. Traditionally, environmental regulation focuses on outputs, using control mechanisms (*e.g.*, taxes, tradable permits, effluent limits) to abate pollution at the end-of-the-pipe. Most of the provisions in the Agricultural Waiver are cases in point—by monitoring ground and surface water and mandating certain BMPs in an attempt to control fertilizer runoff *after* they have been applied (*i.e.*, buffer zones), the Agricultural Waiver's regulatory tools focus on output, rather than input limits. The provision that most resembled DIL approach was the nitrate balance ratio, but as mentioned previously, the State Board eliminated this mandate in its modifications to the 2012 Agricultural Waiver. In addition to nitrate balance ratios, which targets

farmers use of fertilizers, the DIL approach also targets sources of contaminants further upstream. For example, manufacturers of pollutants such as fertilizers or pesticides might be required to cap their production, creating a ripple effect through the whole production stream. In theory, this type of tool could be highly effective in reducing the amount of fertilizers produced, sold, bought, applied and discharged into waterbodies. As suggested by Driesen and Sinden (2009), this approach is useful beyond the tool choice in that it provokes a new way of thinking about environmental regulation.

This approach has been successfully implemented in the Netherlands as a nitrate tax, directly targeting inputs. In an attempt to decrease fertilizer use, the Netherlands' federal government implemented a hefty penalty (seven times the cost of fertilizer at the time) on excess input of nitrogen (Harter et al., 2012). The policy proved to be remarkably effective in achieving its intended objective—one monitoring study showed that nitrogen surpluses in agricultural areas fell substantially as a result of its implementation (as cited in Harter et al., 2012). In this case, the federal government had broad authority to impose a highly coercive tool. Coercive tools are likely to be more effective, and yield redistributive results (Salamon, 2002); however, they are also the least politically feasible and popular because costs fall most heavily on regulated entities.

Given the severity of the water pollution problem on the one hand, and the tumultuous socio and political economic conditions under which regional water quality policies are made on the other, the Central Coast Regional Board has no easy

task. The Regional Board and its staff should be lauded for its efforts, but with water quality deteriorating it is clear that the current provisions do not go far enough. The three-tiered system was, in theory, a step towards more equity and fairness, increasing regulatory mandates for the most serious polluters. But the ease with which farmers have escaped Tier 3—the Tier with the most valuable individual monitoring data—begs the question of whether the tiered structured was effective. Compliance requirements include reporting implemented water quality best management practices, however this system amounts to little more than a mere checklist. When agricultural operators themselves, not third parties or Regional Board staff, are the ones verifying the implementation and effectiveness of best management practices, it is difficult to discern the actual outcomes of on-farm implementation techniques. A more comprehensive monitoring and reporting program is needed to not only verify the effectiveness of implemented management practices but also to use as a baseline for calculating pollution loads and meet TMDLs and water quality standards. The Regional Board might look to California Department of Pesticide Regulation’s successful data collection system to use as a model. Finally, it is in the Regional Board’s interest to continue to foster participation and cooperation with the regulated industry, since growers are ultimately the ones implementing on-farm water quality protections.

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Chapter 4. Agricultural water quality management:

Survey of agricultural operators in California's Central Coast

Summary

The focus of this chapter is on the change in growers' opinions related to the highly charged policy debate on water quality issues in California's Central Coast over the past decade. Previous research has shown that collaborative relationships between agricultural stakeholders can have an important influence on environmental decision-making. This study paid special attention to growers' trust and communication with other agricultural groups and water quality regulatory agencies, specifically the Regional Board. Two rounds of the same survey on agricultural water quality were sent to growers between the implementation of the two Conditional Agricultural Waivers. In 2006, the survey was sent to 1,994 growers with a 33% response rate (N=454). In 2015, the same survey was sent to 1,089 growers with a 20% response rate (N=230). Results corroborate with prior research—growers' trust in the majority of regional agricultural groups was closely correlated with communication. However, trust in the Regional Board did not correspond to the relatively high contact frequency with the regulatory agency, most likely due to a divergence of interests and institutional distance. This study also confirms anecdotes of declining trust between farmers and the Regional Board over the course of the two Ag Waivers. While further research is needed on this topic, research findings suggest that the Regional

Board's less collaborative approach during negotiations for the second waiver greatly strained relationships with growers.

Introduction

Water quality in agricultural areas is contingent on growers' land use decision-making and farming practices. Best management practices (BMPs) that might be adopted to protect water quality on farms include vegetative buffer strips, retention ponds, and nutrient and irrigation use efficiency. The choice to incorporate these BMPs into agricultural systems can be influenced by government policies as well as individual motivations and attitudes (Ryan et al., 2003). The agricultural industry, arguably more than other industries, faces myriad external pressures with regard to on-farm decision-making (Willock et al., 1999). Farms are increasingly forced to survive on slim profit margins, compete with highly mechanized systems, cheap labor and inexpensive agricultural products from overseas. Growers must weigh these economic factors against other demands, like those from regulators to implement water quality protection measures.

Growers' behavioral decisions to alter farming practices in favor of the environment have been widely researched (Beedell and Rehman, 2000; Prokopy et al., 2008; Knowler and Bradshaw, 2006). Prior studies in the field of agricultural economics have developed models to predict farmer decision-making, many of which are based on the assumption that farmers will maximize profits over other objectives (Willock et al., 1999). Work from behavioral economists, political scientists, social

psychologists and other social scientists have complemented this “profitability” literature, softening the assumption of self-interest by demonstrating how cultural and psychological concerns can also heavily motivate farmers’ decisions to change their behavior (Chouniard et al., 2008; Mzoughi, 2011, Leach and Sabatier, 2005). Dozens of in-site case studies, as well as several meta-analyses synthesizing these works (see Prokopy et al., 2008; Knowler and Bradshaw, 2006) cite a wide range of environmentally related decision-making factors influencing farmers’ choice to adopt or not adopt best management practices, including: a motivation to show others their environmental commitment (Mzoughi, 2011), an intrinsic desire to protect the environment (Greiner and Gregg, 2011), farmers’ strong attachment to the land (Ryan et al., 2003), and good stewardship (Brodt et al., 2004; Ryan et al., 2003).

Of particular interest to this research is a growing body of work in the fields of political science and environmental policy that demonstrates how trust between stakeholders, including regulators and regulated groups, can impact farmers’ decision making, as well as how those views can change over time. Trust has been reported as a pivotal factor in solving natural resource conflicts, especially common resources (Ostrom and Walker, 2003; Ostrom, 1999; Cox et al., 2009; Rudeen, 2012). Given its weight in environmental policy processes, researchers have endeavored to uncover ways in which trusting relationships are cultivated as well as how they degrade. Leach and Sabatier (2005) describe two theories of how trust can develop in political arenas. The institutional rational choice model assumes that perceptions of trust are largely based on the information, or lack thereof, about the subject or group in

question, whereas the Advocacy Coalition Framework (ACF) believes trust is embedded in a hierarchical belief system of primary core values and more malleable secondary policy positions. According to ACF, similar core values between two stakeholders allow those individuals to filter information in a similar way, drawing parallel conclusions and fostering trust, but when preexisting beliefs do not align, diverging interpretations of evidence can often lead to distrust (e.g., Rudeen, 2012).

Communication can also influence trust. According to Leach and Sabatier (2005), “The strength of each interpersonal relationship ought to increase with the frequency of contact and with the cumulative number of interactions over time.” Research also shows that it is not only the contact frequency, but also the type of contact that matters. For example, the history of interactions (Lubell, 2007) and of agreements or disagreements (Leach and Sabatier, 2005) can inform one’s trust. In-person or long distance communication also plays a role. Ostrom and her colleagues (1994) found that face-to-face communication is a promising means of fostering trust. Relatedly, others have found that a lack of face-to-face contact could be an influential factor. For example, institutional distance, which might entail physical distance between growers and regulatory agencies, could hinder trust building (Lubell, 2007). While institutional distance tends to be greater at the federal and state level, where decisions are centralized, the phenomenon can also be true at the regional level. Finally, Lubell and Fulton (2008) show that the power of communication on trust depends on the actors involved. In their study, the authors cite a strong relationship between contact frequency and trust between growers and other their agricultural

networks, and that these positive relationships can spill over into influencing other factors, such as group participation, BMP adoption and policy satisfaction. However, contact frequency between growers and a different network—regulatory agencies—was not correlated with trust or other variables.

Yet another influential and popular mechanism to garner trust and collaboration is through stakeholder partnerships, especially within the field of land use and water quality policymaking (Leach and Sabatier, 2005). In their study on agricultural watershed management in the Central Valley, Lubell and Fulton (2007) show how stakeholder networks are a necessary component in collaborative policy, where trust is often an explicit goal. These networks can have an important influence on policy implementation through spreading information to others in their network, fostering social capital and enabling social change. Of course, the presence of stakeholder networks does not automatically pave the way for a harmonious process in which all actors and third-party organizations are in agreement and trust one another (Stone, 2002), but, as Lubell and Fulton (2007) demonstrate, these networks can help encourage cooperation. The added benefits of these networks are especially important as the U.S. undergoes a major shift towards a new type of governance (Salamon, 2002). This new governance paradigm, called “networked governance” necessitates a different set of skills and alliances, which can bring together an array of third parties (Salamon, 2002). Networked governance and its call for outreach and dialog does not automatically equate to absolute behavioral change overnight. Kingdon (1995) describes the alliance building process as a long period of “softening

up” followed by tough political bargaining. The rich and complex relationships between regulators, regulated groups and other stakeholders is a decisive element woven into the policy process as well as on-farm decision-making.

The factors described above can all play a role in effecting policy processes and outcomes. Press’ (2002) policy capacity model in his *Saving Open Spaces* book provides a particularly useful framework for integrating a comprehensive range of variables into an explanation of environmental protection measures. Press’ model is based on the assumption that communities possess different environmental solving abilities, which are influenced by three basic components: internal constraints and resources, a community’s civic resources and external constraints and resources. This study pays close attention to the second component, civic resources and what Press refers to as “civic environmentalism,” including but not limited to a community’s attitudes, expectations, norms, face-to-face relationships, information resources and social and political trust/distrust. The chapter specifically seeks to understand how such variables affect environmental decision-making.

This study on farmers’ water quality (WQ) management decisions, opinions and relationships in California’s Central Coast region is particularly well situated to contributing valuable insights to these bodies of work. WQ regulation in California’s Central Coast is laden with contentious issues of trust, collaboration and stakeholder involvement (as discussed in Chapter 3), and is characteristic of the “networked governance” paradigm. A variety of third-party organizations in the Central Coast have arisen to assist the Regional Board in controlling water pollution and to help

farmers comply with the conditions in the Agricultural Waiver. Consequently, these organizations have become deeply embedded in the regional governance and agricultural support networks. For example, Central Coast Water Quality Preservation, Inc. (or Preservation, Inc.) manages the cooperative monitoring program (CMP)³ on behalf of growers in the Central Coast Agricultural Waiver; the California Department of Pesticide Regulation delivers statewide pesticide regulatory programs, and County Agricultural Commissioners offices regulate pesticide use on a local level, among other duties; local Farm Bureaus collaborate with other agricultural organizations to advocate and provide services for local farmers; and the University of California Extension and Resource Conservation Districts have established programs that provide technical and financial assistance to help growers integrate best management practices into farming systems.

Each agency has a different relationship with regional farmers colored by historical interactions and distinct institutional goals. This context offers the ideal opportunity to compare and contrast farmers' perceptions of trust, information value and communication with this diverse range of actors as well as how farmers' views of these actors have changed over time and in response to two different agricultural WQ regulations.

Anecdotal evidence suggests that issues of trust and communication are especially germane in the Central Coast region since regulatory relationships appear to be at a critical juncture. Local farming organizations have expressly voiced

³ Under the Agricultural Waiver, growers in the Central Coast have the option of conducting individual monitoring or opting into the Cooperative Monitoring Program (CMP)

concerns over decreased collaboration between regulators and growers over the past decade. Eight years ago, in discussions leading up to the 2004 Agricultural Waiver, agricultural interests recognized that the problem of water quality was not going to fade, motivating the Farm Bureau, a trusted agricultural organization, to become part of the conversations and solutions (Farm advisor, Personal Communication, February 2013). The political context at the time—mounting cases of polluted drinking water, the passage of Senate Bill 390, which reasserted pressure on Regional Boards to take more responsibility for comprehensive water control, and overall public frustration with polluted waterways (see Chapter 3)—set the stage for a unique regulatory process in which agricultural interests sought to support water regulations and become more involved (Kranz, 2004). As one U.C. Extension agent described, The Farm Bureau “became instrumental in calming [the growers] down, deciding to be proactive, and work with others to convince the farming community that [water quality control measures] were worth investing in.” In 2004, The Farm Bureau reiterated these collaborative sentiments, stating that although “the Central Coast [Agricultural Waiver] program [was]n’t perfect,” the Central Coast Regional Water Quality Control Board had taken a “constructive approach” (Kranz, 2004). Eight years later, the extent of perceived collaboration among agricultural stakeholders in the regulatory process leading up to the 2012 Agricultural Waiver dramatically shifted. Instead of the Farm Bureau lauding the regulatory process as “constructive,” in 2012 the same organization called the process “flawed” and lacking in collaboration and participation from all stakeholders (Campbell, 2012).

Although the Farm Bureau's perspective may shed light on an important trend occurring in the Central Coast regulatory process, no research has yet examined growers' opinions on trust, WQ issues and the regulatory process over time and the resultant policy implications. This research is the first to ground-truth changes in opinions and relationship patterns from hundreds of individual growers over a nine-year period.

Methods

This study utilizes data from two sets of public opinion surveys. The first round of surveys was conducted in 2006 by researchers at UC Davis and UC Cooperative Extension two years after the first Conditional Agricultural Waiver was adopted. This mail survey was delivered to 1,994 growers in the Santa Barbara and Southern San Luis Obispo counties of California's Central Coast Region. The grower's list was assembled from UC Cooperative Extension educational classes. A total of 454 surveys were received. Of these respondents, 34% report farming in Santa Barbara (SB) County, 54% in San Luis Obispo (SLO), and 7.7% in both counties. This first round of surveys employed Dillman's (2000) "total design" method, which includes an introduction letter followed by two waves of survey packages and reminder postcards.

The second round of surveys was sent out two years after the Ag Waiver was updated and implemented.⁴ To make accurate comparisons, the 2015 follow-up survey used the same survey techniques and prompts, with a few additional questions relevant to the updated 2012 Conditional Agricultural Waiver. Because the original 2006 list of growers was not publically available, the follow-up survey was sent to a list of all growers enrolled in the 2012 Agricultural Waiver program, which is publically available through the Central Coast Regional Water Quality Control Board. The follow-up survey was conducted through an email survey portal since on-line formats have become a common means of communication with growers. After the growers' contact lists were cleaned (i.e., duplicate emails, erroneous emails, and growers no longer farming removed), the survey was delivered to a total of 1,089 enrolled growers throughout the Central Coast Region. A total of 230 surveys were received. Similar methods were used to the first survey, an introduction letter was sent out with the survey followed by two waves of survey reminders.

Four categories of issues covered in the survey—(1) implementation of WQ management practices, (2) opinions on WQ issues, (3) opinions on WQ practices, and (4) opinions on trust, communication and information value of different WQ agencies and stakeholders—the study used both qualitative and quantitative methods. The analysis of survey results focused on changes in opinions and practices between 2006 and 2015. Qualitative methodologies included the two surveys and document

⁴ The updated Ag Waiver was passed in 2012, but because of a “deferral” or “stay” the Ag Waiver was not put into effect until 2013. However, the updated Ag Waiver is still commonly referred to as the “2012 Ag Waiver.”

analysis. Quantitative data analysis involved descriptive statistics, t-tests and Pearson's R tests.

A simple paired t-test was used to examine the differences in attitudes between 2006 and 2015 survey responses. Results from the t-test and associated t score were used to determine whether responses from the two different surveys were significantly different from each other, which can shed light on the impact of the 2012 Ag Waiver and as well as other factors that may have changed over time, such as water scarcity issues. The null hypothesis is that attitudes were the same in 2006 as they were in 2015. The level of significance was selected at $\alpha=0.05$, or a 95% confidence interval. The independent variable is time, and the dependent variable is water quality practices and growers' opinions. T-tests could be employed on questions where the dependent variable is measured at the continuous level (0-10) and the independent variable consists of two related groups. While the subjects in the survey were not exactly the same, for example the 2006 survey only surveyed agricultural operators in the SLO and SB counties, and the 2015 survey interviewed agricultural operators enrolled in the Ag Waiver throughout the entire Central Coast; all survey respondents are growers in the Region under the same regulatory system, the Conditional Agricultural Waiver.

Finally, in hypothesizing a close relationship between trust in a water quality agency and the information value received from that particular agency, Pearson's correlation tests were employed to test how similar these relationships really were. The Pearson's correlation coefficient, r , can range from -1 to +1, the stronger

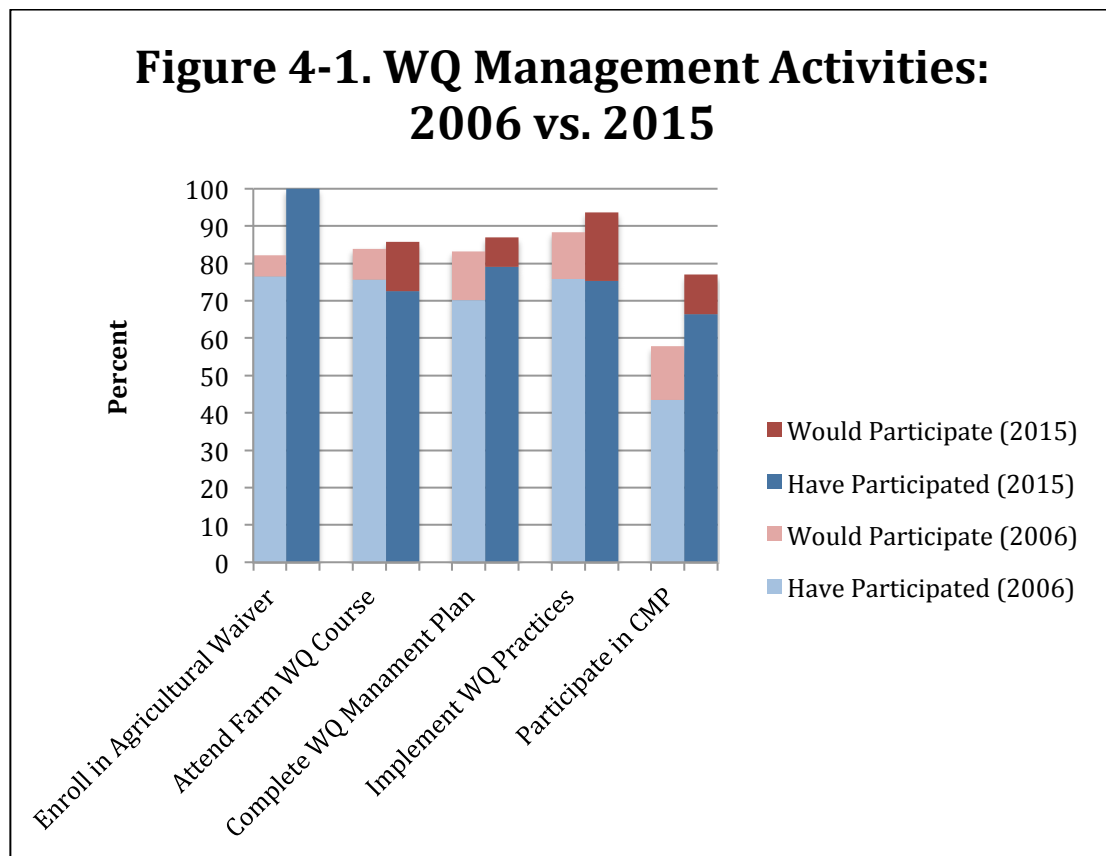
relationship between the two variables—trust and information value—the closer the value to -1 or +1.

Results and Discussion

Several results can be drawn from comparisons between the two surveys over time, as well as with simple statistical tests. Results are reported and discussed by survey category.

The first set of questions in the survey asked growers what types of water quality management practices have they implemented on their farms (see Figure 4-1). Growers scored very high on self-reporting the WQ management strategies they have already adopted or would be interested in adopting (Figure 4-1). One interesting result was the significant (as tested by a two-tailed t-test = 0.004, assuming $\alpha < 0.05$) increase in growers' participation in Preservation, Inc.'s CMP. Although both the 2004 and 2012 Agricultural Waivers allowed growers to participate in the CMP, a much larger percentage of growers decided to opt into the program in the later Waiver. A few factors could explain this result. First, not all farmers were enrolled in the Agricultural Waiver in the first (2004) survey (column 1, Figure 4-1), and consequently did not need to enroll in a monitoring program. Second, with increasing mandates, the recognition and attractiveness of CMP has increased over time; farmers have become more familiar with the benefits associated with CMP, such as cost-sharing and collective reporting to the Regional Board.

**Figure 4-1. WQ Management Activities:
2006 vs. 2015**

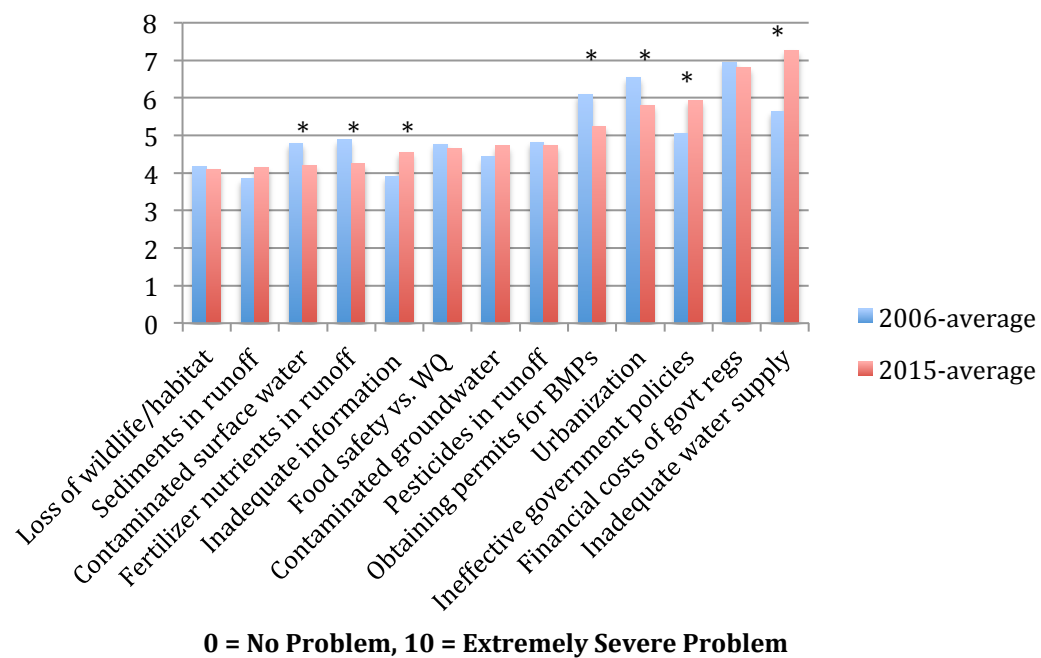


A second series of questions asked survey participants to share their opinions of WQ issues (Figure 4-2). Five WQ issues placed an average score of 5 or less, meaning growers thought these issues ranked closer to “*no problem at all*” than “*a very extreme problem*”, these included: pollution from pesticides, groundwater, fertilizers, surface water, and sediments. Of these, surface water pollution and fertilizer pollution significantly dropped in importance over the nine-year time period. Interestingly, despite perceiving these five WQ problems to be less severe than other problems, academics, scientists and regulators often cite these issues as the most problematic sources of WQ contamination (Anderson, 2010; Harter et al., 2012;

CCRWQCB, 2011; Anderson et al., 2003). For example, in review of scientific data, Regional Board staff “found that many of the same areas that showed serious contamination from agricultural pollutants five years ago are still seriously contaminated” and that “staff does not believe there is improvement in nitrate concentrations in areas that are most heavily impacted” (CCRWQCB, 2010). Additionally, between 2006 and 2010, the EPA reported a 170% increase in toxicity in rivers, streams and lakes in California (EPA, 2010). More specifically, scientific studies published during this time period showed increasing evidence of ambient toxicity in the Central Coast region due to organophosphate pesticides (Hunt et al., 1999; Anderson et al., 2006; Anderson et al., 2011)

While growers did not perceive what regulators and scientists have identified as the most serious regional water quality problems, they instead identified issues more directly impacting their farm viability and management practices as bigger threats. In the midst of a historic four-year drought, water scarcity unsurprisingly took top concern in the 2015 survey, up from the fourth concern in 2006. Another three of the top five issues worrying farmers were related to the regulatory process, rather than actual pollutants themselves. These included the financial costs of regulations, ineffective government policies, and obtaining permits. The significant increase of one policy concern in particular, “ineffective government regulations,” was expected in light of the Farm Bureau’s account of amplified frustration with the regulatory process over the same time period.

**Figure 4-2. Opinions on WQ Issues:
2006 vs. 2015**



The third set of questions asked growers their opinions on water quality management practices (Figure 4-3). These questions aimed to assess the motivations and cultural values in WQ decision-making. Of all the issues, over 75% of respondents from both surveys agreed with the following statements:

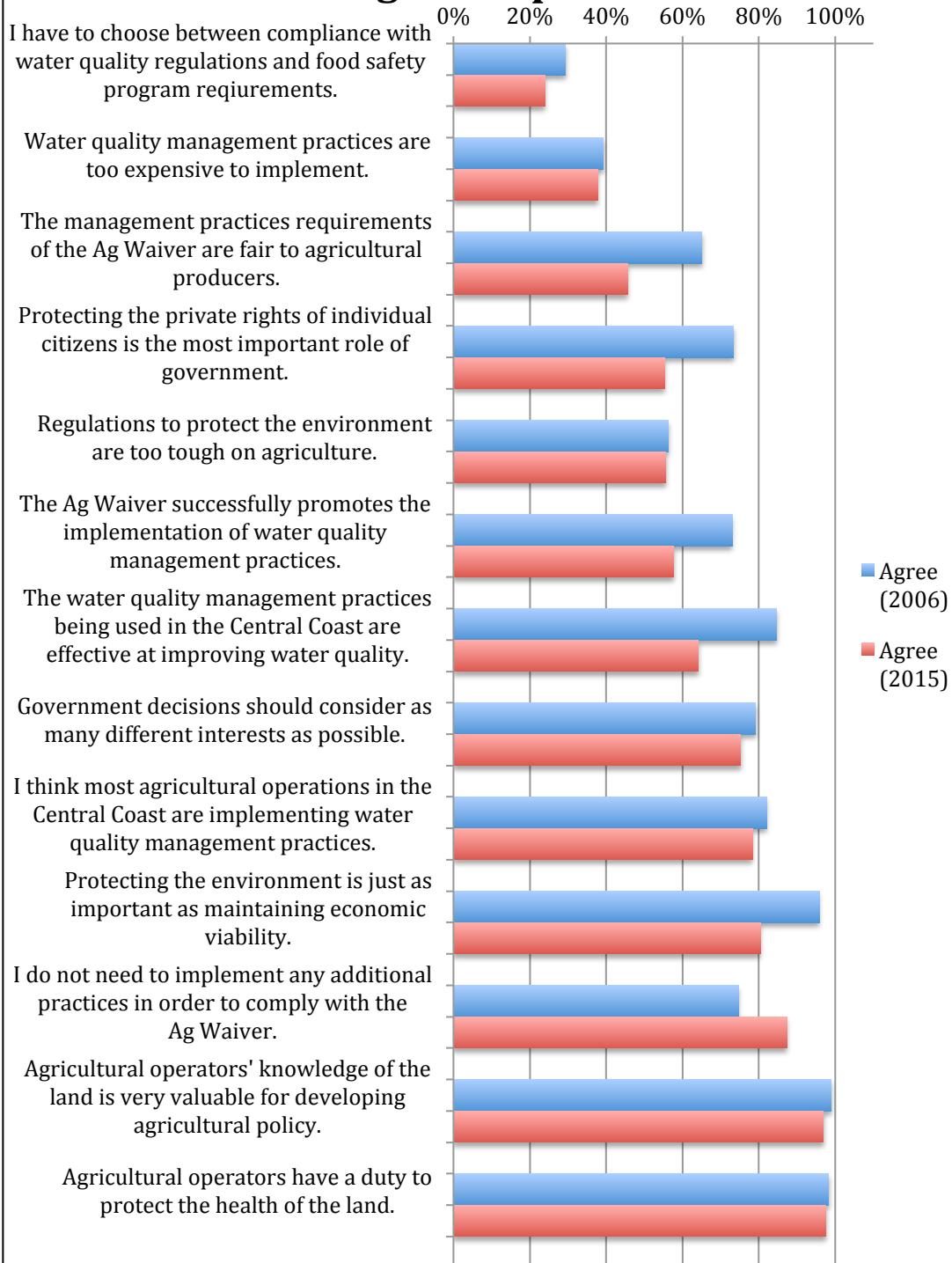
- Farmers have a duty to protect the land
- Farmers knowledge is important for policymaking
- I am complying with WQ regulations
- Protecting the environment is as important as economic viability
- Farmers are implementing WQ practices

- Government decisions should consider as many different interests as possible

These results indicate that farmers generally believe they are protecting water quality, have a duty to do so and that environmental goals are just as important as profitability. These results corroborate with previous studies demonstrating that ecological and moral concerns matter in farmer decision-making, and that motivations are not exclusively profit-driven (Chouinard et al., 2008; Mzoughi, 2011). The later statement seems intuitive—growers would hope policymakers would include a diverse range of perspectives into their decisions, especially in light of growers’ sentiments on a lack of stakeholder participation during the updated waiver.

Interestingly, one issue that more farmers agreed with in 2006, yet more respondents disagreed with in 2015 was that “management practice requirements of the Agricultural Waiver are fair to growers.” As described in Chapter 3, fairness was a hotly contested issue in the 2012 Agricultural Waiver negotiation process, spanning a number of equity issues from the types of BMPs required to the cost and unequal burdens of tiered mandates. This finding is another testament to farmers’ increasing frustration with the Ag Waiver process and mandates, as alluded to by the Farm Bureau.

Figure 4-3. Opinions on WQ management practices



The final series of questions in the survey asked growers about their trust and communication with other groups and water quality agencies as well as the value of information they received from those organizations (Figure 4-4). In both years, environmental groups were the least trusted and had the least contact frequency, whereas other farmers were the most communicated with but not necessarily the most trusted.

Survey data show a very close relationship between information value from and trust in an organization. Results from a Pearson's correlation test between information value and trust found a strong positive relationship between the two variables, the coefficients (r score) were close to a perfect positive relationship ($r=1$), only varying between 0.80 and 0.99. While data from this survey is not sufficient to test a causal relationship, for example, if the quality of information from a given agency influenced feelings of trust, however, these results do substantiate the institutional rational choice model's belief that there is indeed a strong relationship between information and trust (Leach and Sabatier, 2005)

There also appeared to be a close positive relationship between the amount of communication, trust and information value associated with a given organization (Figure 4-4). These results support the body of literature on the connection between trust and contact frequency. Interestingly, results show a few exceptions to this trend, just as they did in Lubell and Fulton's (2008) study. Growers reported a dip in trust despite more communication in relationships with a few different organizations, all of which had regulatory roles, including the Regional Board and Preservation, Inc., and

to a lesser extent, the County Agricultural Commissioners office. These cases could be examples of the “institutional distance” phenomenon (Lubell, 2007), whereby regulators might have a higher frequency of contact with growers, but a physical distance prevents face-to-face communication and/or centralized decisionmaking making the institutional distance greater. Another possible explanation for the dip in trust despite more communication could be due to different values and interests between growers and regulatory agencies, as described by the Advocacy Coalition Framework (Leach and Sabatier, 2005). The biggest dip in trust despite higher communication was with the Regional Board, the most significant water quality regulatory agency in the Region. Lubell (2007) explains this phenomenon:

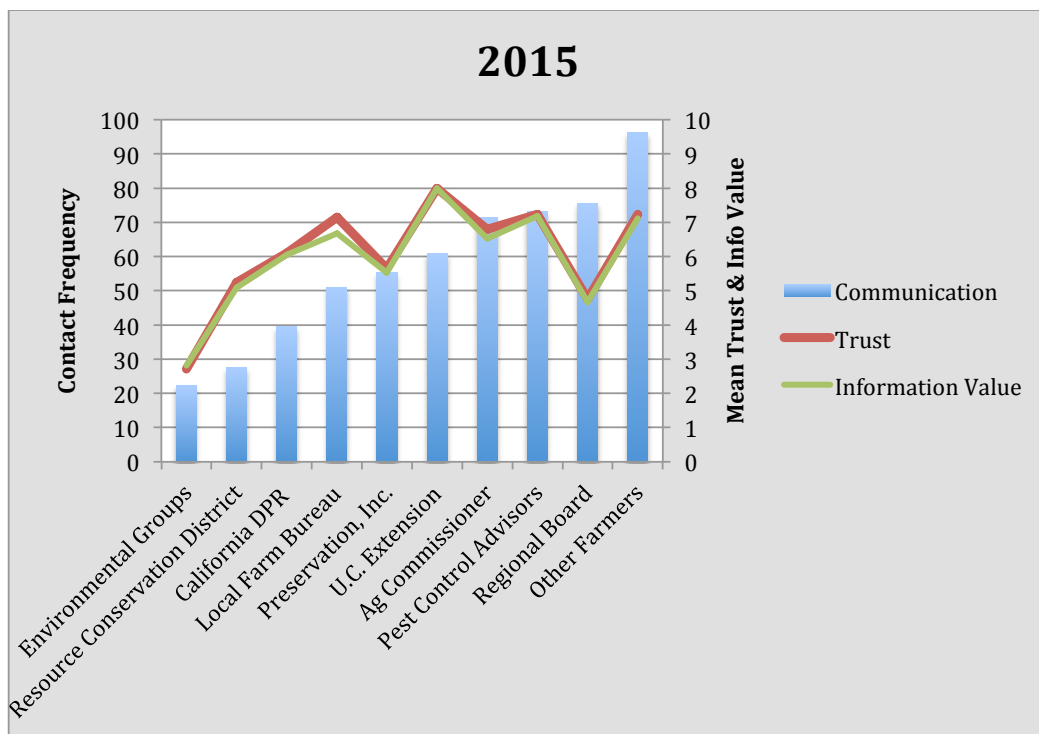
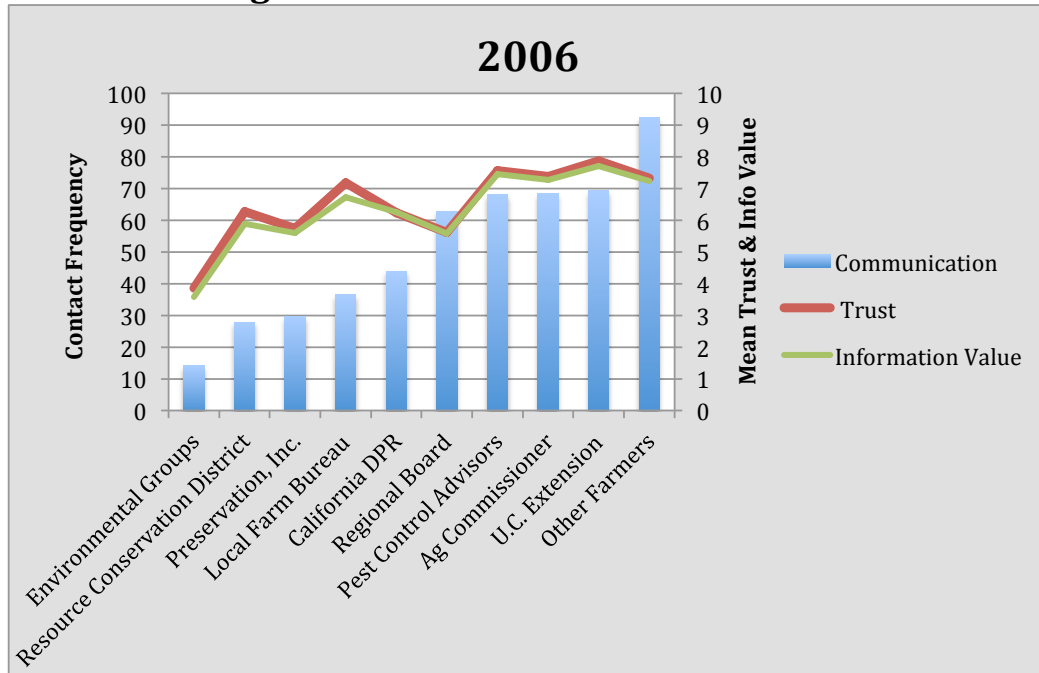
“Farmers tend to categorize policy organizations according to their perceived policy interests: regulatory agencies are viewed as serving environmentalists, while local agricultural agencies and private agricultural organizations are seen as serving the farmer. Thus, farmers view regulatory agencies as less trustworthy and local agricultural agencies as more trustworthy.”

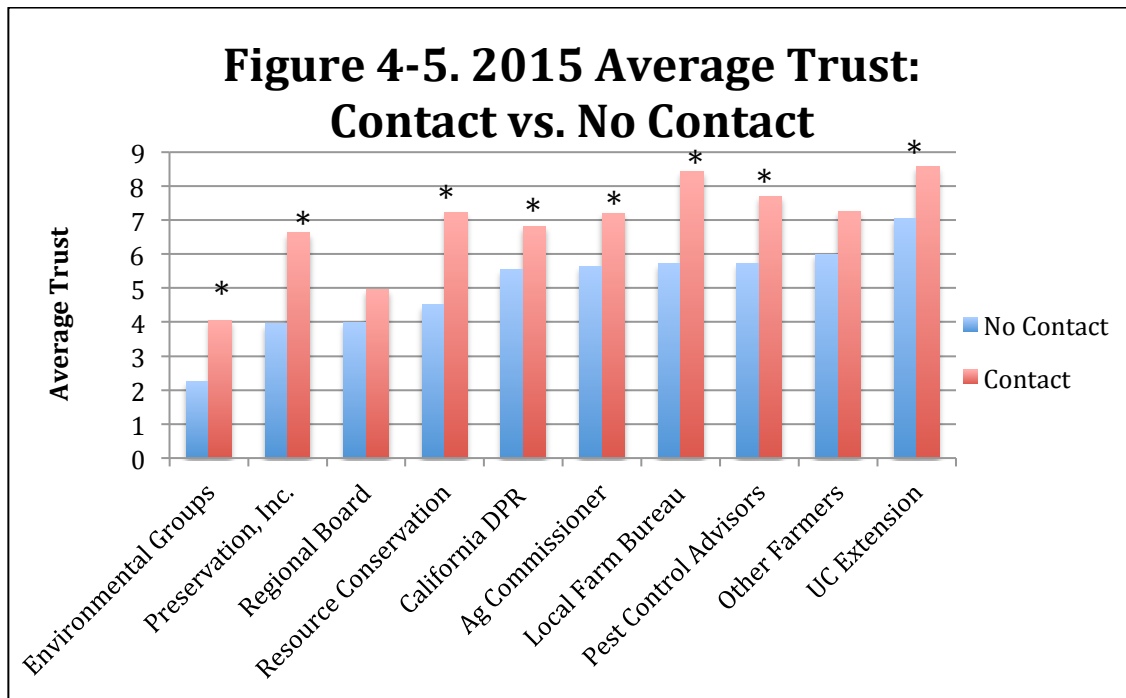
These different interests could also help explain the low scores on trust for the other group that might be perceived as having very different view and interests than growers—environmental groups, which scored 3.6 out of 10 in 2006, and 2.8 in 2015.

Despite these exceptions, a more in depth look at the association between trust and communication confirms a strong relationship between the two variables for most non-regulatory agencies. The 2015 survey results show that there was a significant improvement in the amount of trust when a grower had contact with an organization

compared to when it did not have any contact with that group (Figure 4-5). The only two exceptions to this trend were farmers' relationships to the Regional Board and farmers' relationships to other farmers. In both cases, trust did not significantly improve with contact, perhaps suggesting that the complex historical relationships with these two polarizing groups—the group regulating farms (the Regional Board) and the group most aligned with your values (other farmers)—overshadows factors such as contact frequency when measuring trust.

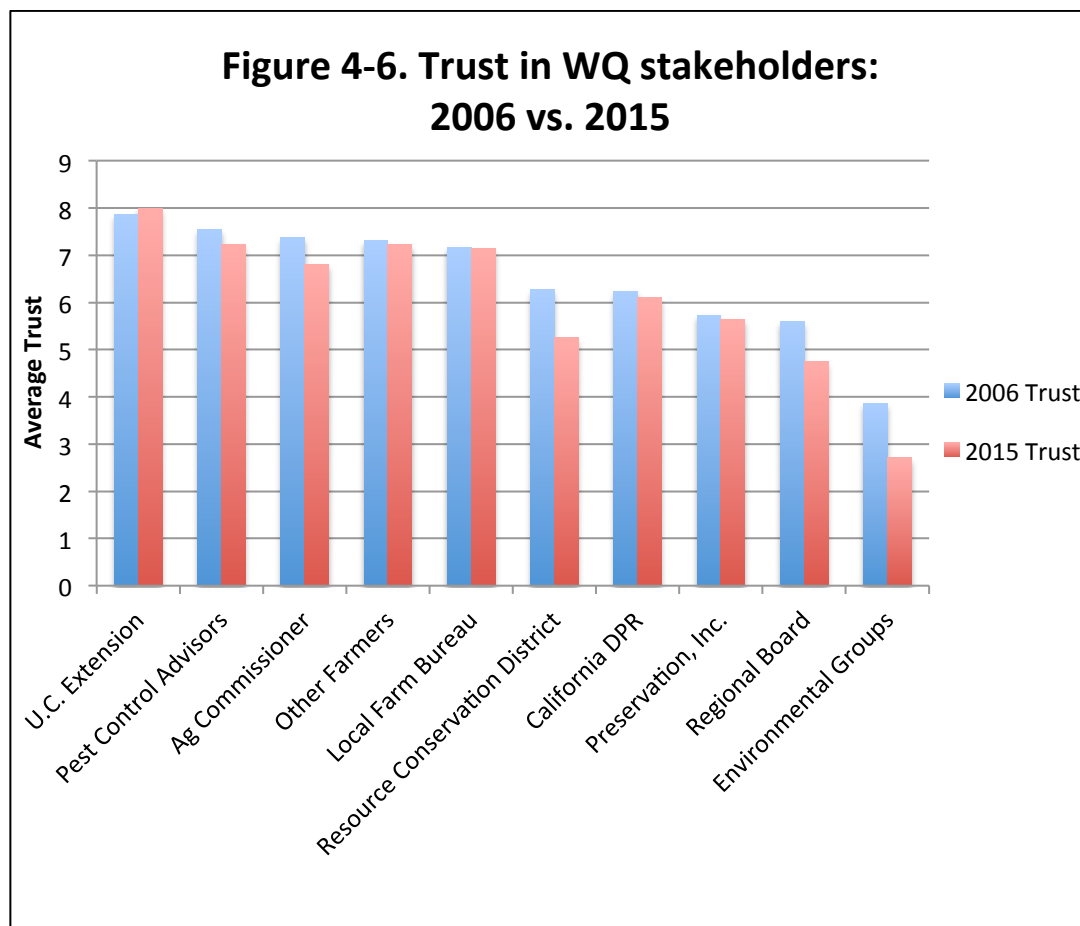
Figure 4-4. Communication & Trust





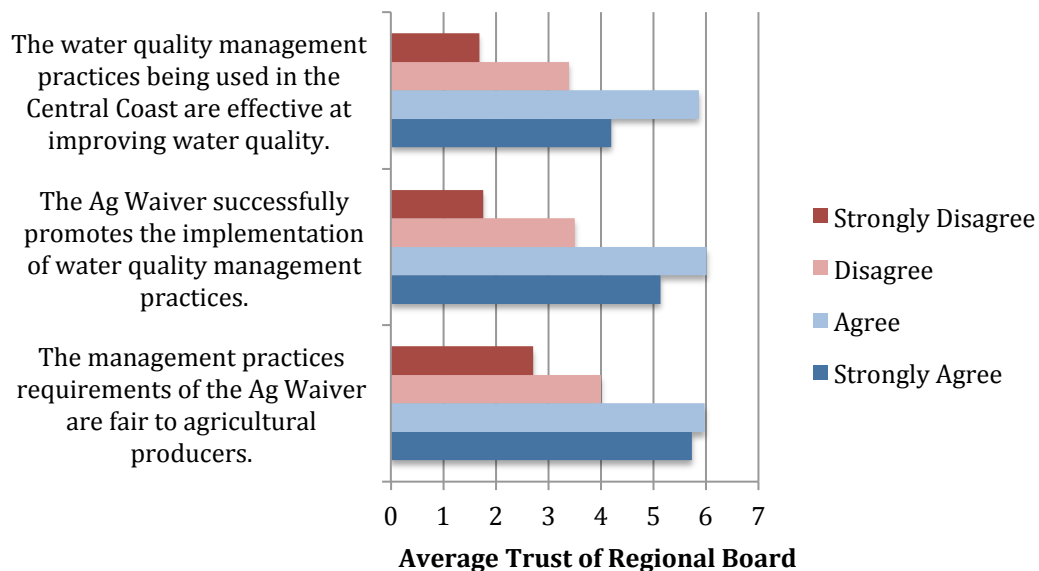
To test the Farm Bureau’s observation of trust decreasing between the two Agricultural Waivers, mean trust in an agency were compared side by side for the two surveyed years and significance was tested in a two-tailed t-test (Figure 4-6). Results show that trust in the Regional Board decreased significantly (t score = 0.002) between 2006 and 2015. Yet despite the significant decline, the mean trust scores for the Regional Board were relatively close between the two surveys (average of 5.6 in 2006 and 4.75 in 2015). Another group that experienced a significant decrease in trust over this time period was environmental groups (t score = 0.0002). While the information from the survey is not comprehensive enough to verify a causal relationship between decreased trust and the two Ag Waivers, the significant decrease in trust over time does give credence to the Farm Bureau’s concern about growers’

declining relationship with the primary regulatory agency, the Regional Board. Interestingly, one group that might have been expected to gain trust from growers between the two surveys, but did not, was Preservation, Inc. Created in 2004, Preservation, Inc. was still little known during the first survey, but by the second survey, the agency was providing valuable services to the vast majority of growers. One possible explanation for the unchanging trust in the primary monitoring agency despite more communication was that their core values differed substantially, heavily swaying growers' perception of the agency.



Finally, a subset of responses from the third set of questions, opinions on water quality management practices, and a subset of responses related to trust from the fourth set of questions, were assessed for correlation, with a particular attention to trust in the Regional Board. Findings suggest that trust in the Regional Board is associated with growers' opinions on water quality management practices (Figure 4-7). Trust in the Regional Board was greater among growers who agreed or strongly agreed (blue) with statements related to the fairness, effectiveness and success of water management practices mandated in the Ag Waiver. Trust in the Regional Board was lower (red) among growers who disagreed with these statements. These last set of findings are intuitive, given previous research on trust being a function of aligning core beliefs between two groups. As Lubell (2007) states "People will trust actors who they believe have very similar beliefs and interests to their own, and their trust will decline as the difference in policy-core beliefs increases." Growers trusted the Regional Board more when they agreed or strongly agreed with the Regional Board's decisions and opinions on water quality practices, and growers trust in the Regional Board declined when they disagreed or strongly disagreed with the BMP provisions implemented in the Ag Waiver. Interestingly, there is a stronger correlation between those growers that "agreed" with statements than those growers that "strongly agreed," perhaps indicating a threshold or a range at which growers trust is correlated with beliefs.

Figure 4-7. Trust in the Regional Board & Opinions on WQ Management Practices: 2015



Conclusions and Policy Implications

Previous research shows that repeated, face-to-face communication is a promising tool to bolster trust between water quality agencies and growers, as well as to alter attitudes relating to water quality management practices. Prior studies also demonstrate that other factors, such as historical relationships, core values, and institutional distance can act as equally strong forces in influencing trust, undermining the significance and value of communication between policy stakeholders (Lubell, 2007; Ostrom, 1994; Leach and Sabatier, 2005). Results from this study corroborate with this literature. Growers' trust in the majority of regional agricultural and water quality groups were closely correlated with the amount of

communication as well as the value of information they received from that group. However, growers' trust in a few agencies, all with regulatory arms, did not correlate with contact frequency or information value. This was true in 2006, but much more so in 2015, and this was particularly true of growers' trust in the primary regulatory agency, the Regional Board. These findings suggest that growers' frequency of contact with the Regional Board, which increased between 2006 and 2015, did not relate to trust in the regulatory agency, which decreased between 2006 and 2015. These results do not suggest, however, that communication with regulatory agencies altogether does not matter. Rather, communication could play an important role in trust-building relationships, as suggested by the literature, but more research is needed into the types of communication utilized by the Regional Board, how communication has changed over time and how it might influence relationships with the regulated group. Preliminary research from a document review, discussed below, demonstrates that communication patterns are becoming more institutionally distant (e.g., more centralized, less face-to-face) and deserves more research attention.

While contact frequency with the Regional Board was not correlated to trust, opinions of water quality practices were. As the last set of findings illustrate, in 2015 there was a positive relationship between growers' trust in the Regional Board and their opinions on water quality management decisions. These results cannot confirm causation—that trust leads to a convergence of beliefs, or a convergence of beliefs leads to trust; however, prior studies suggest the latter. To build trust when two rival political actors do not hold the same views is not a simple task, especially because core

beliefs can be culturally embedded or shaped by historical events. However, building trust between adversaries is not impossible and should begin by achieving agreement on, at very least, empirical issues with sound evidence. Leach and Sabatier (2005) offer a few ways to undertake this process: (1) a “professional forum” exposing scientific evidence from competing coalitions mediated by a neutral facilitator (p. 464), (2) starting negotiations with a period of “joint fact finding” and consensus-building on the basic dimensions of the various problems (p. 499), and/or (3) pursue empathy-building exercises such as field trips (p. 499).

Another aim of this study was to examine anecdotes from the Farm Bureau regarding declining trust and collaboration between farmers and the Regional Board over the course of the two Ag Waivers. While encouraging accounts of a working, collaborative relationship between growers and the Regional Board during the first Agricultural Waiver are difficult to substantiate from the survey responses, results from this longitudinal study as well as further evidence from agriculture testimonies do confirm that what rapport remained after 2004 was markedly soured during the next round of negotiations. There was a significant drop in trust between the two Agricultural Waivers, and growers reported to be more frustrated by the policy process during the second Ag Waiver—the majority agreeing that regulations were “unfair” and “too tough” despite their perceived efforts in adopting water quality management practices and their desire to be involved in the policy process. These results are somewhat contrary to literature that assumes “trust ought to be correlated with the length, depth, and recency of past collaboration” (Leach and Sabatier, 2005);

since only eight years prior to the follow-up study, farmers and the Regional Board joined efforts to pen the first ever regulatory program for agricultural water quality in the Central Coast. Why did trust degrade over this time period? And what lessons might be learned for future Agricultural Waiver negotiations?

One somewhat fatalistic explanation for the waning relationship between farmers and the Regional Board is that the decline was inevitable. Comfortable with the 2004 provisions that they had collaboratively designed, growers were frustrated by the idea of increasing mandates. Unavoidably, the 2004 Ag Waiver was going to be made tougher—scientists, the State, and the public demanded that the Regional Board act on the growing evidence that water quality was not improving. This first explanation has dismal implications for future Ag Waivers since it assumes that little could have been done to save a relationship that was fleeting and inevitably going to decline.

A second, more plausible theory is that the approach the Regional Board staff took during the drafting of the second Ag Waiver, beyond simply increasing mandates, tainted relations. The first Agricultural Waiver took a softer, collaborative and educational approach, slowly easing the agricultural industry into water quality regulations. Whereas negotiations for the second Agricultural Waiver came out of the gates strong, proposing a very tough 2010 Draft Order that took a more centralized approach, categorizing farms into set tiers with coupled mandates, bringing individual monitoring into the fold for the first time and required certain blanket provisions for all farms. Several agricultural interests claimed the new regulatory program was “the

most rigorous in the state” (Transcript of Proceedings, 2011). Although the new waiver was significantly watered down by the time it passed in 2012 and was ratified by the State Board in 2013, the policy process leading up to the 2010 proposal greatly strained rapport, opening a rift between growers and the Regional Board that would be difficult to restore during that round of negotiations.

Growers’ reactions to the updated waiver, especially the 2010 Draft Order, were diverse and abundant. Interestingly, many farmers and agricultural stakeholders highlighted their disappointment in how the negotiations were handled above all else, emphasizing the process itself more than individual mandates. A letter from the Santa Barbara Farm Bureau lamented the new approach, stating that its members supported the 2004 Ag Waiver because it “focused on collaboration” and was “based on a good faith effort from both the agricultural community as well as [the Regional] Board,” however, they were “extremely disappointed” by the stakeholder participation process for the updated waiver, calling it a “failed” attempt due to staff members’ “reluctance to collaborate”. Another stakeholder organization, the Salinas River Channel Coalition (SRCC), shared similar sentiments: “The SRCC have been involved for many years with water quality solutions in the Central Coast. The first Ag Waiver process was about improvement of water quality, but this current process has become nothing more than regulation to develop fines and fees.” The SRCC also added that the new Regional Board staff did not show they wanted to understand the agricultural industry, nor did they have “a desire to continue the proactive cooperation and educational approach which was used to develop the last Agricultural

Waiver”. A statement from the Central Coast Wine Growers Association (CCWGA) echoed these remarks, stating:

“The CCWGA was a leading force and a catalyst in the development and implementation of the original discharge waiver. The association took that role because of the value that was seen in an effort that encouraged growers to look at their whole farming system and modify practices as they made sense, to improve water quality...The proposed waiver is nothing more than a set of rules that pits growers against regulators.”

Yet another statement that more pointedly aimed at issues of declining trust and collaboration between growers and the Regional Board came from the Santa Barbara County Flower and Nursery Growers Association:

“It appears that [Regional Board] staff is proposing to squander the spirit of cooperation that has been so assiduously developed over the years, and to destroy the degree of trust between the private and public sector that has been diligently promoted over these same years. This arrogant, and heavy-handed, jack-boot approach will utterly destroy any hope of cooperation or trust from the private sector.”

Despite the Regional Board’s startlingly different approach taken during the second Ag Waiver, Sacramento County Superior Judge Timothy Frawley recently (2015) ruled that the updated 2012 Ag Waiver does little more than the 2004 Ag Waiver in improving water quality, and needs to be greatly strengthened to meet its goals (as discussed in Chapter 3). If the Regional Board did not improve water

quality through its new structure and mandates, and if it soured relationships with growers along the way, were these “heavy-handed” efforts all for naught? Could the Regional Board have generated a more collaborative negotiation process while improving upon the prior waiver? Or did the Regional Board’s tough plan backlash into a weakened waiver that did little of what it set out to achieve?

Discussions related to these questions are beyond the scope of this chapter, however, what is clear is the Regional Board must move forward. In response to Frawley’s ruling and a looming expiration date on the 2012 Agricultural Waiver, the Regional Board is preparing to update the Agricultural Waiver yet again. Results from this research confirm that trust and collaboration from agricultural interests does matter and is associated with growers’ opinions on water quality management practices and the regulatory process in general. Consequently, the Regional Board should invest time and effort into rebuilding these important relationships as they proceed. Additionally, results from this research suggest that rather than focus on contact frequency with growers as a means to build trust, the Regional Board might reconsider the ways in which it communicates with growers, as well as possibly restructuring future negotiations to enhance consensus-building and address the difference in opinions and beliefs between growers and regulators from the outset.

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Chapter 5. Unintended consequences of pesticide regulation:

A case study on diazinon and chlorpyrifos control

Summary

Chlorpyrifos and diazinon, both organophosphate pesticides, are the most common sources of water column toxicity in California's Central Coast. These pesticides are almost exclusively used for agricultural pest control, and have been targeted in the most recent regional agricultural water quality mandate: the 2012 Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands. This water quality policy is the primary regulatory mechanism to achieve the Clean Water Act's 303(d) requirements for water toxicity impairments in the region. Using mixed quantitative, qualitative and spatial analyses, this study provides a valuable means of examining the provisions focused on diazinon and chlorpyrifos in the region. Results indicate that the 2012 Agricultural Waiver was successful in dramatically curtailing the use of two pesticides known to cause harm in local waterways, however, the resultant behavioral choice outcomes also have a mixed bag of environmental, regulatory and societal implications. This chapter discusses those implications as well as what lessons can be learned to address the upcoming classes of pesticides—pyrethroids and neonicotinoids.

Introduction

While the Clean Water Act (CWA) has achieved significant results in water quality standards, and the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) endeavors to prevent chemicals from causing unreasonable harm to the environment and human health, pesticides continue to contaminate America's waters. In California's Central Coast, two pesticides in particular have been identified as the primary sources of water column toxicity and targeted for regulation. Because agricultural operations in the Central Coast have historically relied on diazinon and chlorpyrifos for use on several crops, the region has been a testing ground for important research on the effects of these two organophosphate (OP) pesticides. Impacts of chlorpyrifos and diazinon on regional ambient and sediment toxicity are well-documented in the literature (Smalling et al., 2013; Hunt et al., 2003; Hunt et al., 2006; Hunt et al., 2008; Hunt et al., 1999; Anderson et al., 2003; Anderson et al., 2006a; Anderson et al., 2006b; Anderson et al., 2011; Phillips et al., 2004; Phillips et al., 2006; Phillips et al., 2012; Holmes et al., 2008). However, less researched have been the policy implications of their use and discharge into waterbodies.

This chapter fills several critical gaps. Identifying challenges and successes of applied pesticide control policy offers valuable information and recommendations to water quality regulatory agencies charged with controlling agricultural pollution in the region and beyond. Several studies have reviewed policy tools aimed at agricultural nonpoint source pollution (Shortle et al., 2012; Horan and Shortle, 2001; Weinberg and Claassen, 2006), including a comprehensive policy analysis specific to California's Central Coast region (Dowd et al., 2008), yet even the authors of that

study cite a dearth of case studies of implemented policy approaches. This case study analyzes several specific pesticide-related provisions of the 2012 Agricultural Waiver. Of particular interest is why and how two pesticides—chlorpyrifos and diazinon—rose to the top of the policy agenda during the recent regulatory process over a long list of other chemicals used in the region, and what intended and unintended consequences have resulted from this regulatory spotlighting.

This study utilizes a blend of historical and social scientific methods to comprehensively evaluate rich datasets relevant to issues of agricultural pesticide use, pollution, chemical switching and environmental governance. Integrating information from policy documents, meeting minutes, interviews, survey responses, water quality data, monitoring and enforcement data, organic crop production data, and Pesticide Use Records from County Agricultural Commissioner offices and the California Department of Pesticide Regulation, this chapter advances the conversations on pesticide and water quality policy at the regional level and offers insights into larger systemic issues of regulatory spotlighting a limited number of pesticides.

Background

Chlorpyrifos and Diazinon Use and Associated Risks

Chlorpyrifos and diazinon are both broad-spectrum organophosphate (OP) insecticides used throughout the U.S. and California for the control of invertebrate pests (Zhang et al., 2012). Historically, both were widely applied for home pest control. But in 2000, due to mounting evidence of human health risks, the U.S. EPA

eliminated virtually all indoor and outdoor residential uses for both chemicals (EPA, 2004). Consequently, the overall use of diazinon and chlorpyrifos in California urban areas has dramatically declined (Phillips et al., 2012; Spurlock & Lee, 2008), and both pesticides are now used almost exclusively for agricultural pest control.

In the Central Coast region, chlorpyrifos is primarily used on broccoli and cauliflower to control

Table 5-1. Crops with the highest chlorpyrifos and diazinon application in the Central Coast	
Pesticide	Crop
Chlorpyrifos	Broccoli, cauliflower, wine grapes
Diazinon	Head lettuce, leaf lettuce, spinach

soil maggots and on wine grapes to target vine mealybug and ants. From 2006 to 2010, the Salinas Valley, Imperial Valley, Santa Maria Valley and Pajaro Valley regions used only 10% of statewide chlorpyrifos, but they had the highest frequencies of chlorpyrifos detections and exceedances (Zhang et al., 2012). All of these regions except the Imperial Valley are located within the

Central Coast.

Diazinon is predominantly applied to head lettuce, leaf lettuce

Table 5-2. Properties influencing the potential for chlorpyrifos and diazinon to move in runoff			
Pesticide	solubility (mg/L)	K _{oc}	Aquatic toxicity
Chlorpyrifos	1.18	9930	Extremely high
Diazinon	60	1,520	Very high

Source: Long et al., 2005

and spinach to kill a variety of insect pests, including green peach aphid (*Myzus persicae*), potato aphid (*Macrosiphum euphorbiae*), pea leafminer (*Liriomyza huidrobrensis*) seed corn maggot (*Delia platura*), springtails and cutworms (IPM Centers, 2001). In 2001, diazinon was one of the only registered options for these

pests (IPM Centers, 2001). Diazinon use in the Salinas Valley, “the salad bowl of the world,” nearly tripled from 1997 to 2004 (CCRWQCB, 2011), before it began its steady decline.

Seasonal use of chlorpyrifos and diazinon fluctuates with the cropping cycles (CCRWQCB, 2011). Because two or three vegetable crops per growing season are common in the region for brassicas and leafy greens, chlorpyrifos and diazinon use often peaks several times a year.

Between 2011 and 2014, over 20 waterbodies in the Central Coast Region were listed as impaired for chlorpyrifos and/or diazinon and/or unknown toxicity. These water bodies included the Lower Salinas River Watershed (listed in 2011) and several more in the Pajaro River Watershed (listed in 2013) and Santa Maria River Watershed (listed in 2014).

While the use and target species vary between chlorpyrifos and diazinon, the mechanisms of toxicity and associated risks of organophosphates are similar. Several studies suggest that even low-level contact with these neurotoxicants can have serious health implications. The EPA determined that the amount of chlorpyrifos and diazinon that can be consumed in drinking water at which no adverse health impacts would occur for adults is 0.02 mg/L and 0.0006 mg/L and respectively. Exposure has been associated with neurobehavioral deficiencies, including attention deficit and hyperactivity disorder in children (Bouchard et al., 2010). A study conducted in the Salinas Valley of Latina mothers and newborns found that exposure to the pesticides in utero can cause serious health effects to babies, whom are less able to detoxify

organophosphates (Furlong et al., 2006). Another recent study links exposure of organophosphates to lung damage in children (Raanan et al., 2015).

Despite the long list of serious human and environmental health implications posed by diazinon and chlorpyrifos, one advantage of using these pesticides over others is their relatively shorter half-lives. The half-life of chlorpyrifos and diazinon in the water column ranges from 30-138 days depending on field conditions (CCRWQCB, 2011).

Regulatory Background

Chlorpyrifos and diazinon's impacts on agricultural workers, children, water quality, fish and other wildlife species have put both in the national, state and regional regulatory spotlight. Since 2000, several regulatory actions have restricted the use of these chemicals, or threatened to do so.

National and State Regulations

In the U.S., a number of major federal and state laws govern pesticides. The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) was passed in 1947 with the original goal of protecting consumers from ineffective products. Through a series of amendments, the Act's function has evolved to include protecting human health and the environment from unreasonable adverse effects of pesticides. One such amendment that fundamentally changed EPA's regulation of pesticides towards a health-based focus was the 1996 Food Quality Protection Act (FQPA). The FQPA

was the first to mandate the evaluation of a pesticide's sensitivity to children, infants and fetuses as well as the aggregate risk of multiple exposures (e.g., food, water, residential) (Colborn and Short, 1999). Since its passage, the EPA has taken action under the FQPA targeting chlorpyrifos and diazinon for review due to their potential risk to children. Between 2000-2004, the Agency reviewed the two pesticides through a comprehensive Interim Registration Eligibility Decision (IRED) and Registration Eligibility Decision (RED). During the review, an agreement was made with the technical registrants of chlorpyrifos (MANA) and diazinon (Dow Agrosciences) to terminate the registration and begin a phase out for nearly all residential uses of both chemicals. As an extra measure to mitigate health risks, the EPA also required that all use of chlorpyrifos products be discontinued on tomatoes, and restricted its use on apples, citrus and tree nuts. The diazinon RED required more extensive mitigation measures for diazinon use on agricultural crops, including canceling or restricting agricultural uses for more than 20 crops, eliminating all aerial application except for lettuce crops, and limited overall use of the chemical. The agreement also began the process of developing special dormant spray label restrictions for diazinon and chlorpyrifos products. By 2006, product labels were amended to include restricted use during the rainy season, increasing buffer zones, prohibiting certain applications, requiring recommendations from pest control advisors and mandating certain best management practices. In 2012, after initiating a new registration review of chlorpyrifos, the EPA expanded the size of required buffers around sensitive sites, like schools.

Chlorpyrifos and diazinon are also regulated under several sections of the 1972 U.S. Clean Water Act (CWA). Water monitoring data collected during the IRED review process highlighted areas where more regulation was needed and where efforts to curb water pollution were already underway. Based on the detection of diazinon and chlorpyrifos in effluent from publically owned treatment facilities, National Pollution Discharge Elimination System (NDPES) permits were amended to include more monitoring and in many cases effluent restrictions. Many states had already begun listing water bodies impaired by chlorpyrifos and diazinon, and begun the process of setting Total Maximum Daily Loads (TMDL) for these waters. In California's Central Coast, over 20 water bodies have been listed as impaired by chlorpyrifos and/or diazinon: the Pajaro River, Pajaro River Estuary, Llagas Creek, Santa Maria Watershed, Lower Salinas River, Arroyo Paredon, Moss Landing Harbor, Old Salinas River, Tembladero Slough, Blanco Drain, Salinas Reclamation Canal, Espinosa Lake, Chualar Creek, Quail Creek, Espinosa Slough, Alisal Slough, Natividad Creek, San Lorenzo River, Zayante Creek, Arana Gulch, Branciforte Creek, and San Antonio Creek. Additionally, the review process brought attention to several cases of toxic amounts of diazinon and chlorpyrifos in drinking water, forcing regulators to take action under the CWA and Safe Water Drinking Act.

The two pesticides have also been identified as impacting several endangered species: California's red-legged frog, Pacific salmon and steelhead species, the Delta smelt and tidewater goby. Under the Endangered Species Act, the EPA has assessed the risks of the chemicals on each of these species and mandated specific practices for

their protection. Mandates have included designating critical habitats, vegetative buffers, no spray zones, wind speed restrictions and fish mortality incident reporting requirements.

In addition to federal laws, states may also have their own pesticide and water quality regulation programs. For example, in California, the 1969 Porter-Cologne Act gave all nine Regional Water Quality Control Boards (Regional Boards) broad authority to grant waste discharge requirements for all dischargers in their jurisdiction, as well as the authority to waive those requirements. However, in 1999, with evidence of increased water pollution, the state repealed the Regional Board's authority to issue waivers, requiring them to, at the very least, attach conditions to waivers and to review these conditions every five years (S.B. 390). To comply, each Regional Board has issued individual "Conditional Waivers of Waste Discharge Requirements" (or Conditional Waivers). In some cases, like in California's Central Coast, a Conditional Waiver can act as the primary means for achieving TMDL requirements, raising important policy implications since Waivers have not historically allocated numeric loads to dischargers.

California is the only state in the country where a permit and license are needed to apply pesticides. County Agricultural Commissioner offices collect the licensing information and pesticide use records and report these data to the state regulatory agency, the California Department of Pesticide Regulation (CDPR). In addition to collecting information, the CDPR, as authorized by the California's Food and Agricultural Code, has the power to reduce pesticide use. In 2015, the CDPR

exercised that authority, restricting agricultural uses of chlorpyrifos by requiring applicators to obtain an additional permit from their County Agricultural Commissioner's office.

Yet another means of restricting pesticides is through litigation. For example, in 2015, in response to a lawsuit filed by Earthjustice on behalf of Pesticide Action Network (PAN) and the Natural Resource Defense Council (NRDC), the 9th Circuit Court of Appeals ordered the U.S. EPA to file status reports on chlorpyrifos.

Regional Regulations: The Central Coast Agricultural Waiver

As discussed in previous chapters, two Conditional Agricultural Waivers have been adopted in the Central Coast Region—one in 2004 and an updated version eight years later, on March 15, 2012. In addition to controlling farm discharges from entering waterbodies, one of the major goals of the Agricultural Waiver is to collect monitoring data. Water quality data are not only used to assess the state of the regions' waters, but also to assess and select appropriate BMPs, help characterize agricultural pollution problems, and identify pollution hotspots. In the 2012 Ag Waiver, BMP and monitoring requirements vary by tier (see Chapter 2). A farm is placed in one of three tiers based on its risk to water quality: tier 1 being the lowest risk and tier 3 being the highest.

Just as monitoring requirements vary, so too does the usefulness of the data collected. The variance in monitoring information value depends on four factors: (1) where, (2) when, and (3) what parameters are collected, as well as (4) what test

organisms are used to assess water and sediment toxicity. There are also noteworthy differences in the usefulness of data depending on whether data is collected from surface water or groundwater. While this chapter largely focuses on surface water, the challenges of groundwater monitoring and assessment will also be addressed. The **location** of the monitoring station is an important element in identifying what farm is polluting and to what extent. For example, upstream edge-of-field monitoring on a tributary offers more precise and detailed data on the pollutants discharging from surrounding farm(s); whereas data from a monitoring station located downstream along the main stem of a river are a composite of all upstream sources, making the task of teasing out probable nonpoint sources of pollution near-impossible. The **timing** of data collection is also important because water quality can change during and after storm or irrigation events, or during or after fertilizer or pesticide applications, increasing pollutant concentrations. If monitoring data were taken before applying a pesticide, for example, that information might not accurately portray the pollutants present in the waterways for the next several months. The issue of timing is even more problematic when testing groundwater; research has shown that it can often take decades for leached pollutants, particularly, nitrates, to show up in groundwater (Wang et al., 2013). Thirdly, **the parameters** limit the extent of knowledge about the health of a given waterway. For example, collecting basic parameters, such as dissolved oxygen, turbidity, temperature, nutrients, metals, and pH, provides a good baseline by which to assess water health, but other important parameters, such as the amount of a specific prevalent pesticide in the water column,

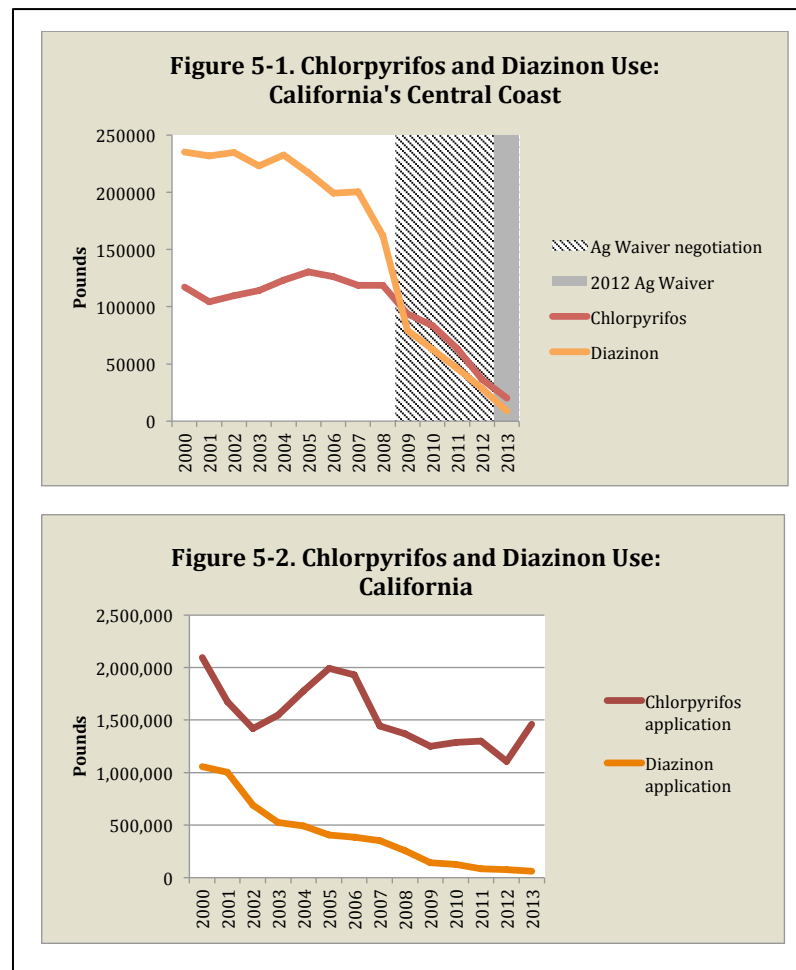
might be overlooked, and could be the key to more accurate problem identification. Finally, certain **test organisms** are more appropriate for certain pollutants. For example, *Ceriodaphnia dubia* (a common water flea) is an appropriate test organism for testing water toxicity, while *Hyalella azteca* (an amphipod) is more suited for assessing sediment toxicity. These two are commonly used in regulatory monitoring programs, however, other new classes of pesticides in the offing will require new test organisms, ones that are not part of the current cadre of test organisms used for regulatory monitoring in the Central Coast region and California in general. For example, a more suitable test organism to use for burgeoning classes of pesticides, such as neonicotinoids, but one that was not incorporated into monitoring programs until 2015, is *Chironomous dilutus* (a midge, or “non-biting” fly) (SWAMP, 2016).

Tier 1 and 2 water quality monitoring is conducted in the main stem of a tributary and reported as an aggregate twice a year. The usefulness of these data pales in comparison with that of individual discharge data taken at the edge-of-field from tier 3 farms. One of the biggest concerns among growers during the drafting and implementation of the 2012 Ag Waiver was public disclosure. Farmers soon to be classified in tier 3 were concerned about reporting individual discharge water quality data due to matters of privacy and value of information, but also due to fear of being regulated as point source dischargers. Three factors that weigh heavily on tier criteria are a farm’s size, risk to nitrate pollution, and risk to water column toxicity. Mounting scientific evidence of nitrate groundwater contamination as well as pressure from environmentalists and environmental justice groups elevated the nitrate issue to the

top of the agenda during the 2012 Ag Waiver negotiation process. Additionally, a series of several scientific studies from the Granite Canyon Laboratory (Hunt et al., 2003; Hunt et al., 2006; Hunt et al., 2008; Hunt et al., 1999; Anderson et al., 2003; Anderson et al., 2006a; Anderson et al., 2006b; Anderson et al., 2011; Phillips et al., 2004; Phillips et al., 2006; Phillips et al., 2012) pointed to two particular types of organophosphate pesticides—diazinon and chlorpyrifos—as the culprits of water toxicity in the region. While pesticides did not receive specific attention in the first (2004) Agricultural Waiver, these two pesticides found their place at the top of the agenda during the 2012 regulatory process over a long list of other potentially harmful pesticides used in the region.

Drivers of Pesticide Decline

Agricultural use of chlorpyrifos and diazinon has decreased dramatically in California's Central Coast region over the past decade (Figure 5-1). The regional decrease of diazinon application reflects a larger statewide trend (Figure 5-2). However, while chlorpyrifos use in the region has plummeted, statewide use has stayed relatively consistent over the past decade, with minor fluctuations. What causal factors drove the regional chlorpyrifos and diazinon decline, and how much of the decrease can be attributed to the 2012 Agricultural Waiver? What conditions made the chlorpyrifos decline possible in the Central Coast region, but not in other regions or California as a whole? What societal, environmental and regulatory implications have resulted from farmers' decisions to stop using both chemicals?



The following section explores these questions by assessing data collected from interviews, survey responses, a thorough review of policy related documents, water quality information, organic production data and pesticide use records in three different California regions. Survey responses were collected from a subset of questions in a 2015 study on growers' opinions of water quality management practices and policies in the Central Coast Region (see Chapter 4). The set of survey questions relevant to this study asked growers if and how their use of chlorpyrifos and diazinon had changed since the Agricultural Waiver was implemented. Sixty-five

growers responded to this optional part of the survey. Forty-seven of the 65 reported a change in chlorpyrifos and diazinon practices; their responses are reported below. Results from the survey and other data suggest that a grower's decision to apply the two pesticides or not depends on several factors, including specific regulatory requirements embedded in the 2012 Ag Waiver as well as regulations generally, concerns over workers safety, harm to the environment, the cost of pesticides and their application, the availability of alternatives to manage pests, as well as the extent of pest damage and the value of the crop; each of these will be discussed in more detail.

Regulatory Mandates: The 2012 Ag Waiver

A number of regulatory battles, discussed above, have played a major role in some growers' decision to cut back the use of diazinon and chlorpyrifos. In the Central Coast region, the 2012 Agricultural Waiver's tier 3 mandates weighed heavily on growers' decision to stop using the pesticides if they were using them previously. Of the 47 survey respondents that described a change in their pesticide use in the region, 15 (32%) responded that they had stopped using diazinon and/or chlorpyrifos because of increased regulations, and the majority of those respondents specifically emphasized tier 3 requirements as the motivation for their decision. The following quotes demonstrate these pointed remarks directed at the Ag Waiver's tier 3 mandates for their change in pesticide practices:

- *“Pain in the neck to move to a higher reporting level” – San Benito County farmer*
- *“Keeping our ranches out of Tier 3 status even though we don't drain to any watershed as [The Central Coast Regional Board] doesn't believe that's possible.” –farmer who previously used both chlorpyrifos and diazinon*
- *“Do not want to be classified in a risky tier and we have alternatives available” –Salinas farmer*

Dislike

Another motivation for the decline in diazinon and/or chlorpyrifos use was that growers simply did not like using the two pesticides knowing they caused harm to their workers and the environment. It appears that growers were aware of the growing scientific evidence documenting the impacts of chlorpyrifos and diazinon on the environment, ranging from water and air quality to small invertebrates to human health. Of the survey responses, 5 (10%) stated they stopped using the pesticides because of worker safety, while 10 (21%) cited environmental factors as their motivation. Selected quotes from survey responses are reported below.

Worker safety

- *“I do all the spraying. So the elimination of any ‘neuro-toxins’ is very important to me. I have had great results using*

pheromone lures to reduce the codling moth population. Using a non-selective pesticide makes no sense to me.” – Santa Clara County farmer

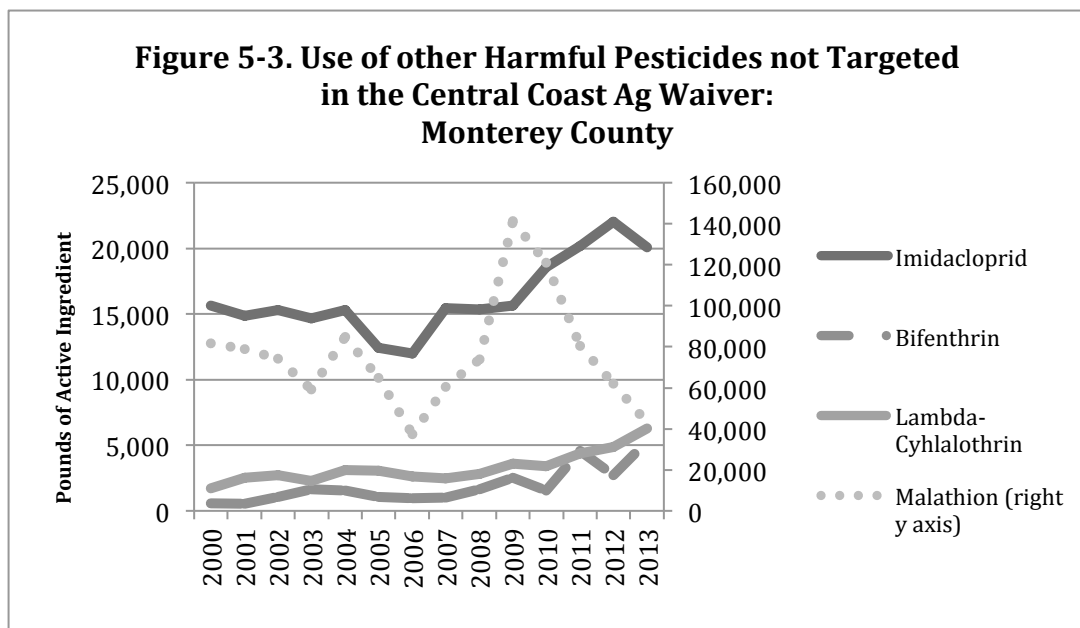
- *“We moved away from those chemistries more for worker safety than groundwater” – San Luis Obispo County farmer*
- *“Worker safety concerns with chlorpyrifos and label restrictions for diazinon use.”*

Environmental reasons

- *“Adverse environmental impacts” – San Luis Obispo County farmer*
- *“Harmful to predators” –Santa Cruz County farmer*
- *“Toxicity to environment” – San Luis Obispo County farmer*
- *“It’s been found in local streams, lets get rid of the [organophosphates] if they are hurting us.” –farmer who previously used chlorpyrifos*
- *“Concern for water quality” –Santa Clara County farmer*
- *“Stay away from groundwater contamination” –Santa Cruz County farmer*

Other pesticides in the spotlight, the possibility of pesticide switching

Several pesticides are popping up as the next big threat to water quality (Figure 5-3). Malathion is the third most commonly used OP insecticide next to diazinon and chlorpyrifos with similar chemical characteristics, yet interestingly, was not targeted in the 2012 Ag Waiver. Imidacloprid is in the neonicotinoid class, and studies have linked the pesticide to bee colony collapse disorder (EPA, 2016). And third, pyrethroid chemicals, such as bifenthrin and lambda-cyhalothrin, are being linked to sediment toxicity issues in the region. While less toxic than OP pesticides, neonicotinoids and pyrethroids (when bound to sediment particles) have longer half-lives.



As chlorpyrifos and diazinon have steadily decreased, many of these new pesticides, which are differently or equally as harmful as OPs, have increased. To address if growers have switched to other chemicals to replace diazinon and chlorpyrifos in the Central Coast region, growers' use of possible substitutes were

assessed. Two datasets were reviewed: the University of California Integrated Pest Management (UC IPM) reports, CDPR pesticide use data, as well as scientific literature.

In Monterey County (the highest broccoli producing county in the region), chlorpyrifos use on broccoli declined by 86% from 2000 to 2013, yet the total pesticide use on broccoli only declined by 47% over those years. Were growers substituting chlorpyrifos for another pesticide to control cabbage maggots? UC IPM reports show that one of the only viable alternatives for use on a commonly targeted pest (cabbage maggots) is diazinon. From pesticide use records, it is apparent that broccoli growers are not readily switching to diazinon, since it comes with the same baggage of regulatory and environmental problems as its counterpart. In response to the growing demand for an alternative pest management strategy to control cabbage maggot, a new study by Joseph and Zarate (2015) in the *Journal of Crop Protection* explored at least eleven other insecticides with similar or superior efficacy to chlorpyrifos on cabbage maggots; of these five of these are pyrethrins plus pyrethroids, and one is a neonicotinoid. To identify if growers were switching over to any of these five promising, but potentially environmentally-harmful, new pesticides, CDPR use data on broccoli was assessed for each chemical. Results from this analysis showed that while these alternative pesticide numbers are still relatively small, growers might be increasingly turning to them in the future, especially if cabbage maggot pest problems escalate and the value of broccoli continues to rise.

Diazinon's demise has been even starker in lettuce than chlorpyrifos on broccoli in the Central Coast, as well as in the two other regions assessed in this study (see below) and the state as a whole. From 2000 to 2013, diazinon use on lettuce in Monterey County dropped by 99% compared to a 26% drop in the total pesticide use on lettuce, with diazinon removed. However, data from UC IPM reports and CDPR pesticide use data, as well as scientific literature do not suggest a widespread switch to other pesticides, rather organic practices might be the larger force. Diazinon use on lettuce crop pests is more diversified, making any switch from diazinon to another chemical more dispersed. With broccoli, because chlorpyrifos use is limited to controlling cabbage maggots, a switch to another chemical (or not) was more easily identifiable. Diazinon use on lettuce, on the other hand, has historically been used to control at least six different pests (green peach aphid, beet armyworm, potato aphid, leafminers, lygus bug, various soil insects), each opening up a pandora's box of alternative chemicals. CDPR pesticide data on diazinon's use on Monterey County lettuce shows no dramatic chemical-for-chemical switch. For example, as diazinon dramatically falls, no single pesticide rises up to take its place. Because diazinon's use on lettuce was so varied, it is logical that several different chemicals might be used in its stead to fit one or more specific needs pest needs.

Although there does not appear to be overwhelming evidence of growers replacing either chlorpyrifos or diazinon with a specific pesticide in particular, survey responses suggest that some pesticide switching is occurring:

- *"Other pesticides usage."* – San Luis Obispo County farmer

- *“We used chlorpyrifos on apple moth ... Now we use Conserve and Entrepid.”* –Santa Cruz County farmer
- *“We were able to evaluate our programs: being a vegetable seed breeding R&D facility and make necessary changes to use other insecticides to cover the need.”* –San Benito County farmer

Organic/Less pesticide use

The lack of readily available pesticide alternatives for use on broccoli’s cabbage maggot, or the scarce use of them thus far, alludes to growers simply using fewer chemicals to grow broccoli, and perhaps switching to organic farming practices. The same appears to be true for lettuce growers, although the data are more limited.

The option of switching to organic production with higher profit margins and the consumer demand for less chemical use offer appealing motives for many growers to curtail their diazinon and chlorpyrifos use, in addition to other pesticides. The number of farms, value and acreage of organic production has blossomed over the past decade in the Central Coast. The top three agricultural producing counties in the region have steadily increased the amount of land in organic production every year. In San Luis Obispo County, the conversion to organic was even more staggering: In 2005, 4,493 acres were dedicated to organic production and by 2014 50,636 acres were grown organically—an eleven-fold increase. In Santa Cruz County, 2,700 acres were under organically production in 2005, and by 2014 4,058 acres were grown

organically. In Monterey County, the organic production nearly tripled, from 16,410 acres in 2005 to 46,570 acres in 2014.

More specifically, in Monterey County organic production of broccoli doubled over the past decade and a half: 1,430 acres of broccoli were grown organically in 2000, increasing to 2,862 acres in 2015 (Office of the Agricultural Commissioner of Monterey County, 2016). Organic's proportion of the total broccoli grown in Monterey County also grew: in 2000, organic production accounted for 2.3 % (61,500 acres), and by 2015, roughly 4.5% (63,561 acres⁵) of all broccoli production was devoted to organic. Although organic still does not account for a significant portion of total Monterey County broccoli production and cannot explain the chlorpyrifos decline alone, corroborated with growers' survey responses (reported below), it is safe to conclude that a transition to organic has played a role in the declining use of the two pesticides.

While long-term longitudinal data was not available for organic head and leaf lettuce production in Monterey County to assess whether or not organic production played a role in diazinon's decline, a related crop, spring mix, was available. From 2000 and 2015, the organic production of spring mix lettuce increased 153% in Monterey County. Short-term lettuce data in the County reflect this trend. Since the passage of the 2012 Ag Waiver (2013-2015), organic head lettuce production has increased 155%, from 112 acres to 174 acres, organic romaine lettuce has increased by roughly the same percentage, from 2,750 to 4,096 acres, yet organic leaf lettuce

⁵ Total broccoli data was based on 2014 acreage, the most recent data available.

production in the county has increased decreased slightly from 1,088 acres to 1,066 acres. An upward trend in organic production (by acreage) is also true for the two other crops in Monterey County for which there are longitudinal data—organic cauliflower has more than quadrupled, from 180 acres to 780 acres between 2000 and 2013, and organic strawberries production has grown exponentially, from 48 acres in 2000 to 2,082 acres in 2015.

Of the survey responses, transitioning to organic or using less or no pesticides at all was the second highest reported reason growers decided to stop using diazinon or chlorpyrifos, accounting for 26% of responses. The following survey responses are reflective of the appeal to switch to organic and/or less pesticide use:

- *“Transitioning to organic for personal reasons as well as protection for my kids (we live on our acreage).”*
- *“We have moved to organic practices and consequently do not use broad spectrum insecticides”*
- *“Our produce is sold directly to the public. Our use change has evolved over about a dozen years to satisfy customer requests for less pesticide use.”*
- *“Conversion to organic. Safer for my kids (live next to our orchard).”*
- *“We grow biologic we use other bugs to control the bad bugs if we use any chemicals they are some of the ones used in the organic growing.”*

- *“We have moved to organic practices in past 3 years.*

Consequently we do not use man made, chemically synthesized materials.”

Crop Loss

Despite the appeal of using fewer pesticides for human health, the environment and higher profit margins, a possible drawback associated with less pesticide use and/or organic production is increased pest damage resulting in crop loss. The amount of crop loss depends greatly on the pest pressure in a particular area and crop type and stage. Even within the same cropping system, pests can have varying levels of destruction. For example, cabbage maggots can cause yellowing, retarded growth or even plant death on brassicas (Joseph and Zarate, 2015), but in some propitious situations (e.g., an already-established crop), the same brassica plants could survive cabbage maggot infestations unimpeded (Natwick, 2009). The severity of pest damage can also differ within a particular region, as it does with cabbage maggot in the Salinas Valley (Joseph, 2014). For example, the acceptance of pest pressure on farms could also greatly vary. The two survey responses that referenced pest damage, both from San Luis Obispo County and both who previously used diazinon demonstrate the varying degrees of frustration growers have with accepting crop loss. One respondent who previously used diazinon to control beetle populations shared his sentiments of surrendering to the pests, *“We are accepting cucumber beetle damage on annual crops.”* The second survey response offered a more exasperated reaction to

increasing pest pressure, alluding to the fact that he wished there was alternative pesticide to use, “*There is no substitute. The ants are thriving.*” The two responses could be representative of varying degrees of pest pressure on two different targeted pests (beetles versus ants), different value systems, or different financial circumstances allowing one farm to accept pest pressure more readily than another.

Using fewer pesticides, however, does not automatically mean a farm will experience more pest damage and lower yields (Dimitri and Greene, 2000). For example, a study comparing organic and conventional apple production in the Central Coast showed not only increased profits from transitioning to organic production, but also increased yields (Swezey et al., 1994). Additionally, a recent study in *Nature* found that organic farming methods promote a stronger pest control among natural enemies as well as yield larger plants than management practices typical under conventional farming systems (Crowder et al., 2010).

Costs

The costs of chlorpyrifos and diazinon also could have played a small part in some farmers abandoning their use. Clearly, data on chlorpyrifos and diazinon pricing varies substantially based on the size and cropping system of the agricultural operation and the volume discounts that large farms might receive. UC Extension, however, has estimated operating costs in their detailed Cost and Return studies, including specific material and labor costs related to insecticide use for a variety of California crops. In 2009, Smith and his colleagues at UC Extension published a Cost

and Return study for leaf lettuce producers in the Central Coast region. This report estimated roughly 1 lb/acre of diazinon use on lettuce at a price of \$10.45/acre. Compared to the costs of other insecticides, such as Radiant SC (\$90/acre), or other herbicides, such as Kerb 50W (\$90/acre), diazinon was a minor cost, and only 4% of overall insecticide expenditures (\$236/acre total). Additional costs associated with diazinon include cultural costs (i.e., labor, material and rent costs). In the report, these costs were estimated as an aggregate totaling \$128/acre for several pest control agents, including diazinon. Weighing these costs against estimated net returns per acre is complicated by the range of farm productivity and prices received for lettuce; for example, net returns for a head lettuce farm producing 400 12-3 count cartons per acre at an average market price of \$11/acre was estimated around \$-2,407/acre, whereas a production of 1000 12-3 count cartons per acre at the same price was estimated to yield \$111/acre in net gains.

None of the recent Cost and Return studies on broccoli in the Central Coast include estimations on chlorpyrifos use in their calculations. However, a UCE study on a related crop, cauliflower, estimates about 7.00 lb/acre of chlorpyrifos is needed for root maggot control, the target pest for both cauliflower and broccoli. The cost of the chemical (Lorsban 14G) was valued at \$2.80/acre for a total of \$19.60/acre (Smith et al., 2001a). Compared to total operating costs for cauliflower (\$4,669/acre) and broccoli (\$4,257/acre), expenditures on chlorpyrifos for this specific pest were relatively small (Smith et al., 2001a; Smith et al., 2001b). As with lettuce, net returns on broccoli vary substantially by productivity and price. A farm producing 545

boxes/acre receiving an average price of \$6.80/box had an estimated net loss of \$569/acre whereas a farm producing 785 boxes/acre receiving the same price was also in the red with a net loss of \$112/acre.

These data suggest that cost was not a persuasive factor in growers' decision to cutback on chlorpyrifos and diazinon use. The lack of survey responses highlighting cost to be a major impetus in decision-making corroborate with these data; only one survey respondent cited the cost of diazinon and chlorpyrifos as playing a part in his decision-making to stop using them.

Crop type and pesticide dependency

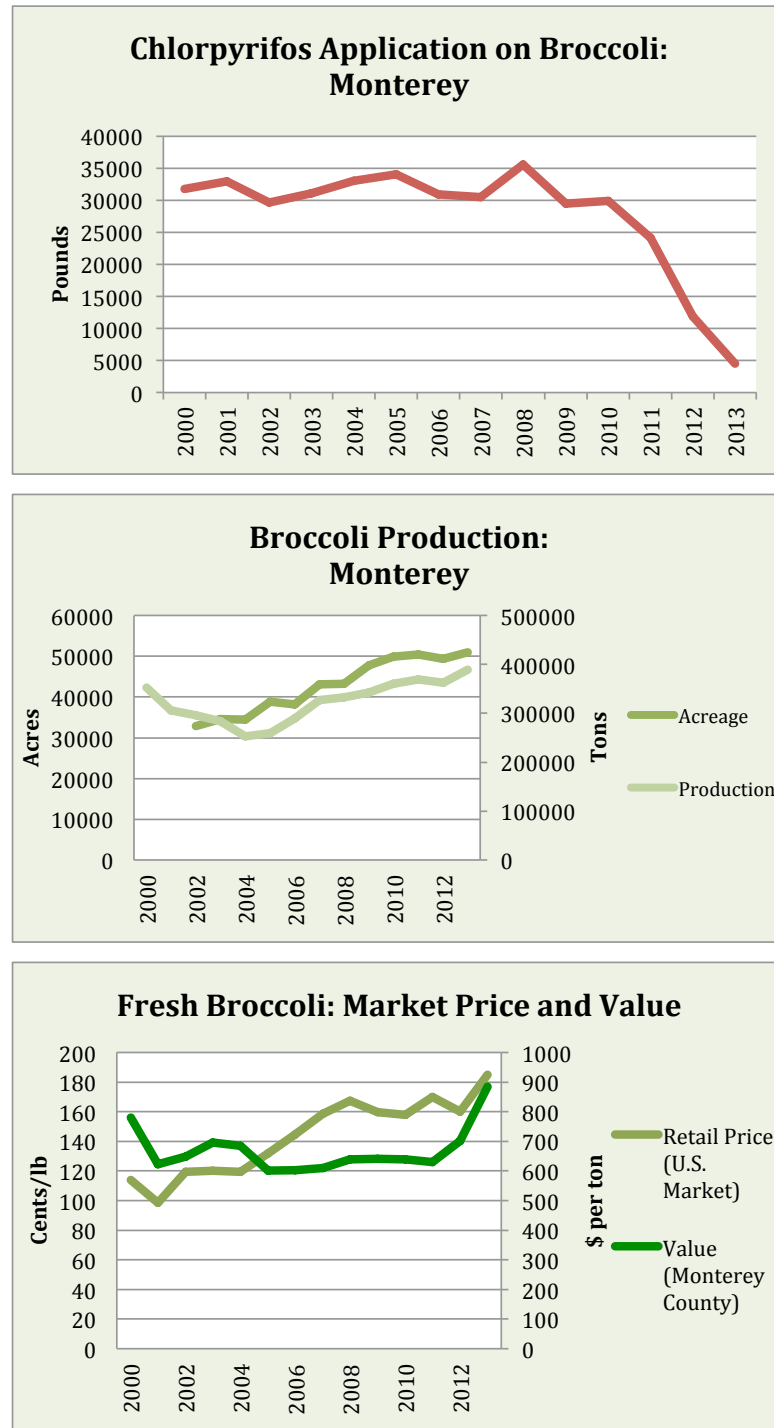
In the Central Coast region, broccoli has historically been one of the top three crops with the heaviest use of chlorpyrifos, and lettuce (head and leaf) is the chief crop with the highest diazinon use. The region's year-round mild climate offers the ideal growing conditions for these cool season crops; however, the cool, wet weather is also favorable to cabbage maggots (Natwick, 2009), the predominant target pest of chlorpyrifos on broccoli. Monterey is the leading broccoli-producing county in the state, with 40 percent of the acreage and production (Le Strange, 2010). The Salinas Valley, located in Monterey County is the "salad bowl of the world," producing 80% of the salad greens consumed in the U.S. A closer look at chlorpyrifos and diazinon application on broccoli and lettuce in Monterey compared to other regions and the state as a whole sheds light on why crop type may be a pivotal factor in allowing Central Coast growers to give up chlorpyrifos, while growers in other regions have

held on to it for survival, and why crop type did not have as powerful an effect on diazinon's demise.

Monterey County

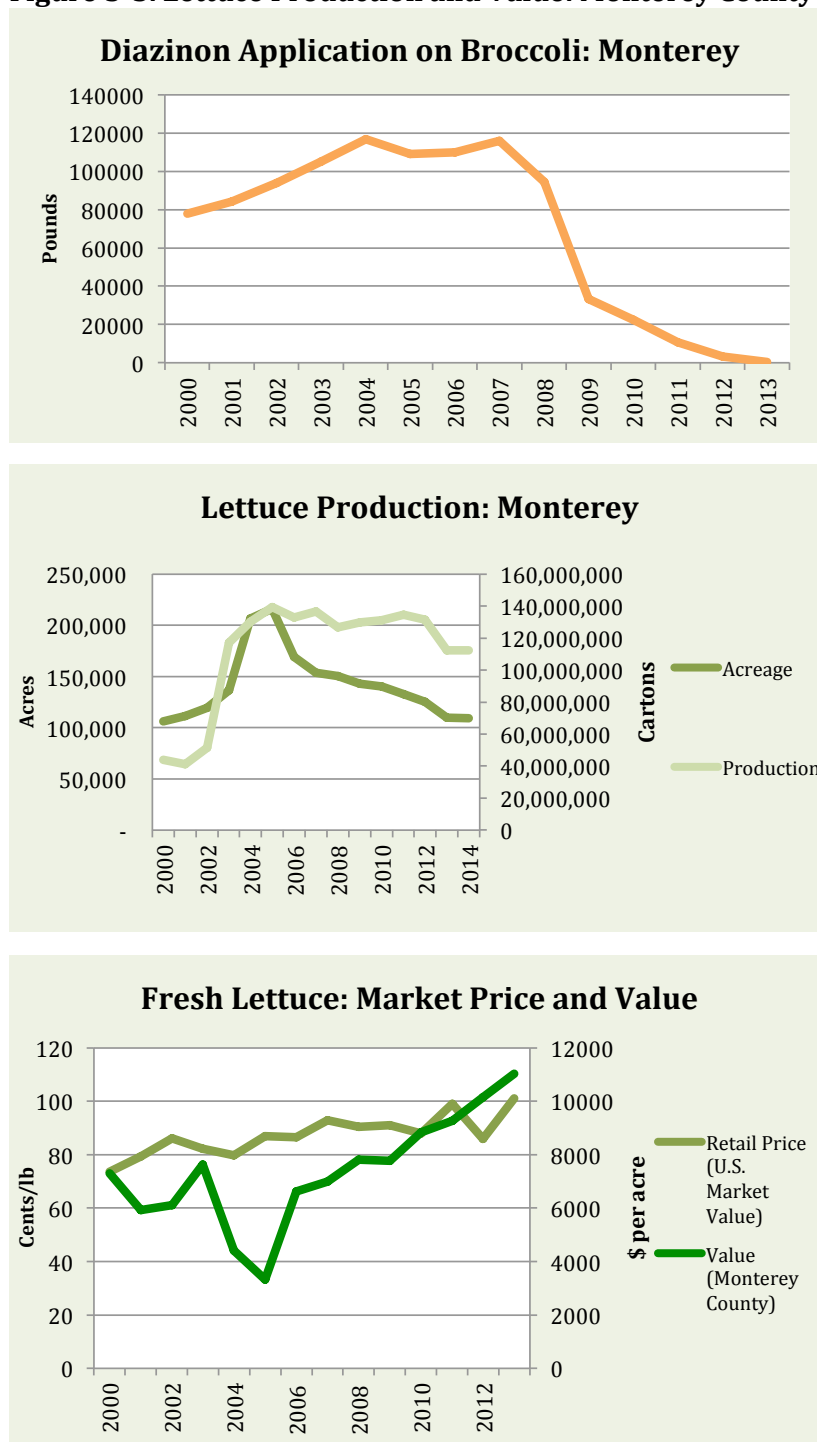
Chlorpyrifos has been one of a handful of insecticides that broccoli farmers rotate into their pest management plan to slow potential pest resistance (Takele, 2001). According to pest advisors and the UC ANR IPM program, growers tend to use chlorpyrifos on broccoli prophylactically, targeting cabbage maggots at the larval stage before the pest hatches and before it can cause damage to crops. Encouragingly, despite cutting back on chlorpyrifos, the Monterey County broccoli industry appears to be thriving. The number of acres in production and the total amount of broccoli produced continue to climb (Figure 5-4). At the same time, the market price for the crop is also on the rise, making the value per ton the highest it has been in recent years. In just over a decade, from 2000 to 2013, the value of Monterey County's broccoli crop rose from \$280.4 million to \$426.9 million (Monterey County Crop Reports, 2000 and 2014). These data suggest that regional broccoli growers on average are not only surviving, but thriving without the use of chlorpyrifos.

Figure 5-4. Broccoli Production and Value: Monterey County



Sources: CDPR Pesticide Use Records; Monterey County Crop Reports; USDA ERS Vegetables and Pulses Data.

Figure 5-5. Lettuce Production and Value: Monterey County



Sources: CDPR Pesticide Use Records; Monterey County Crop Reports; USDA ERS Vegetables and Pulses Data.

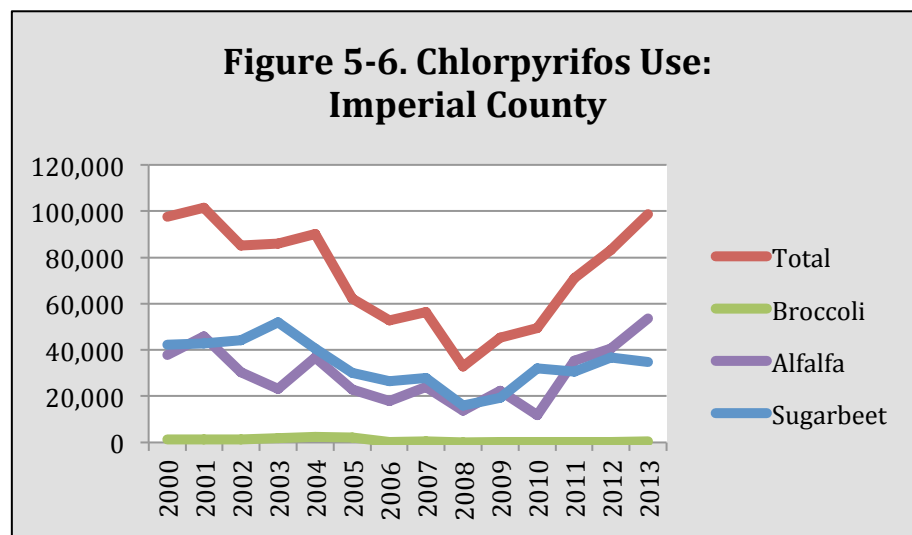
As with broccoli, Monterey is the leading producer of lettuce in the state with 57% of production. Monterey and the second-lettuce producing county in the state, the Imperial County, together account for 70% of all lettuce produced in California, or roughly half of all lettuce produced in the U.S. Unlike chlorpyrifos, diazinon is used on lettuce for a variety of insect controls; and for each pest, there are a handful of readily available chemical alternatives. Consequently, the world-renowned “salad bowl” was unscathed by diazinon cutbacks. Both the production in lettuce acreage and crop totals have steadily increased in Monterey County (although there has been a short-term decline in recent years) as well as the price/value of the crop (Figure 5-5). In 2014, the most recent data available, Monterey’s lettuce crops were the highest they had ever been, valued at \$1.2 billion.

Imperial County

Comparing these same data with the second highest broccoli and lettuce-producing county in the state, the Imperial County, demonstrates that the Central Coast’s unique cool season cropping systems may be at the core of why agricultural production can thrive without chlorpyrifos, while growers in other regions are not willing or able to give it up so readily. The Imperial Valley is located in southeastern Southern California in the Colorado River Basin Region. With high summer temperatures, the Valley is well known for its number one agronomic crop, alfalfa, grossing \$220 million in 2014. The region also has a reputation for its midwinter vegetable crops, including head lettuce, leaf lettuce, cauliflower, broccoli and cabbage. Alfalfa

growers in the Imperial Valley have become ever more reliant on chlorpyrifos due to the increased pest pressures from blue alfalfa aphids. Chlorpyrifos is preferred by alfalfa growers for the suppression of these aphids over alternative insecticides, and is a fundamental tool in most growers' IPM programs (CDPR, 2013). Consequently, the region has not experienced the same downward trend in chlorpyrifos use that Monterey and the Central Coast have. Though broccoli farmers in the Imperial County were able to curtail chlorpyrifos application, alfalfa farmers in the region use a much larger share of the chemical, trumping any decline benefited by chlorpyrifos cutbacks on broccoli (Figure 5-6).

Diazinon use in the Imperial Valley has declined on broccoli as well as on all crops.

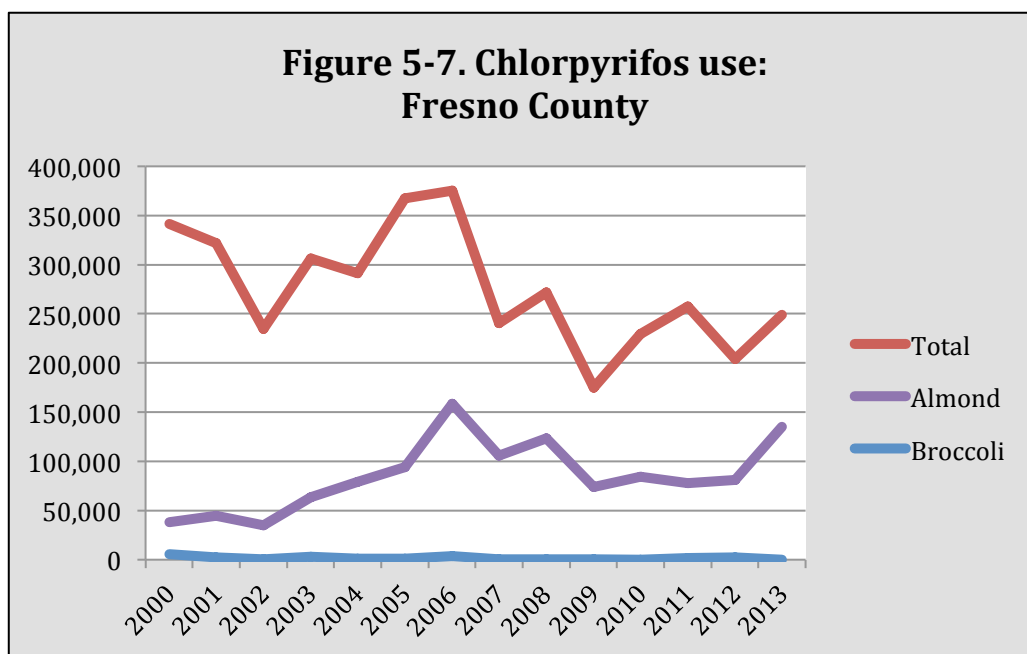


Fresno County

Fresno County, the third largest broccoli and lettuce-producing region in the state, has a parallel story to the Imperial County. Fresno County is located in the Central Valley

and is characterized by its hot mediterranean climate. Taking advantage of Fresno's ideal growing conditions as well as the lucrative almond market, farmers have been steadily converting land to almond production. In 2014, almonds were farmed on 170,711 acres up from 82,700 acres just a decade earlier. In 2013 and 2014 almonds grown in Fresno surpassed the billion dollar mark, outdoing grapes for the number crop value in the county. As of 2013, almonds had the highest economic value of any California nut crop and were the highest export value of any American specialty crop (CDPR, 2013). Vegetable production is also an important part of Fresno County agriculture. The county is the third largest producer of broccoli and lettuce in the state, and produces a variety of other vegetables including tomatoes, onions and melons.

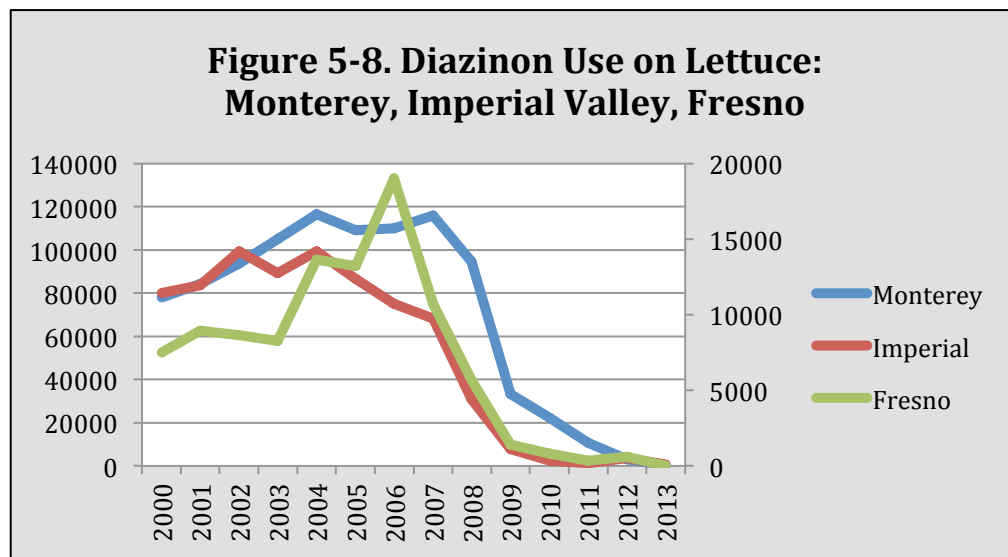
In 2013, chlorpyrifos had the greatest percentage increase in use among insecticides (by amount of active ingredient) and most of this increase was dedicated to almond production (CDPR, 2013). Almond growers became increasingly dependent on the chlorpyrifos due to budding populations of two crop pests: leafhoppers and navel orangeworms (CDPR, 2013). Chlorpyrifos use on broccoli, on the other hand, steadily decreased as it did in Monterey and the Imperial Valley, and was trumped by use on almonds and other crops (Figure 5-7).



Over the past decade, diazinon use in Fresno has declined overall as well as specifically on lettuce crops, mirroring Monterey, Imperial Valley and statewide trends.

Comparing chlorpyrifos use between Monterey County, the Imperial County and Fresno County underscores the importance of crop type and pest pressure on growers decision to apply the chemical or not. This comparison leads to several interesting policy questions: Would the Imperial Valley or Fresno County have stopped using chlorpyrifos on alfalfa or almonds if it were held to Central Coast Tier 3 requirements? Or would growers have complied with Tier 3 requirements to continue producing their most profitable crops? Or, lastly, would growers have given up the alfalfa and almonds altogether to escape individual monitoring mandates?

The widespread decline in chlorpyrifos use on broccoli in three different regions under three different regulatory programs gives considerable credence to other macro-conditions, besides the 2012 Ag Waiver, as causes for the pesticide's demise. However, before jumping to this conclusion, other factors, such as differing pest pressure, must be considered. It is likely that soil maggot pest pressure on broccoli is generally lower in the Imperial County and Fresno County, where summers are hot and dry, than in the cooler, moist Central Coast climate where the pest thrives. If the pest pressure was even moderately higher in the Central Coast than the other regions, yet Central Coast growers still decided to stop using chlorpyrifos on broccoli for maggot control, the 2012 Ag Waiver could have played a role in suppressing the chemical in the region.



In the case of diazinon, there was an even greater drop in use, not only in lettuce (Figure 5-8), but in all crops in all three counties. While the 2012 Ag Waiver could have acted as the final nail in diazinon's coffin, it seemed that diazinon's fate

was already determined, perhaps because partly due to the strict federal label restriction greatly limiting the use of the chemical on all crops except a few.

Water Quality Outcomes

Logically, less pesticide use should equate to less pesticide presence in waterways, and less harm to humans and other living organisms. Previous studies and technical reports cite a strong correlation between pesticide use and surface water detections (Zhang et al., 2012; Hunt et al., 2006). The CDPR databases also offer a valuable means of establishing a correlation between pesticide use and detection. In addition to their Pesticide Use Records, the CDPR hosts an extensive database of surface water quality data documenting the presence of pesticides in waters throughout the state. However, more limited are studies and information that take the next step in linking the application of pesticides in Central Coast waters to toxicity to living organisms. While there are a number of individual peer reviewed journal articles offering single case and often short term evidence of a relationship between pesticide use and toxicity; the CMP is one of the limited number of regional monitoring programs that provides consistent longitudinal data as a basis for understanding if and how regional water quality is fairing in response to declining chlorpyrifos and diazinon use, however even this dataset is relatively new and limited in geographic scope and the number of sampling sites.

Beginning in 2005, the CMP initiated this new database with the aim of examining the relationship between organophosphates, in particular, and toxicity to

aquatic invertebrates. The CMP collects water quality monitoring samples from over 20 sites and analyzes each for organophosphate compounds as well as tests samples for toxicity to invertebrates, fish and algae. Although these data are not part of specific Agricultural Waiver requirements, this additional toxicity project was conducted as a collaborative endeavor between CMP and the Regional Board (Schmidt, 2009). Since the beginning of the program, water quality samples have found diazinon and chlorpyrifos to be pervasive in the Central Coast, and frequently at concentrations of known toxicity to aquatic invertebrates (Schmidt, 2009). These results corroborate with individual scientific studies throughout the Central Coast conducted by the Granite Canyon Lab (see reference list for Anderson, Hunt, and Phillips) and researchers at the CDPR (see Zhang et al., 2012). More recent information from this database reveals toxicity to aquatic invertebrates as well as fish have largely improved through 2013, and possibly through 2014; however, toxicity to invertebrates in sediment has regressed over that time (Table 5-3). These data suggest that the decline in chlorpyrifos and diazinon use is likely contributing to a decline in toxicity to aquatic invertebrates, and that other pesticides, such as pyrethroids, which remain in high use and are less regulated, may be contributing to a growing sediment

Table 5- 3. Percent of Aquatic Toxicity Samples Showing Toxic Effects: 2014 vs. Initial years (2005-2009)

	<u>Fish</u>		<u>Invertebrates, Water</u>		<u>Invertebrates, Sediment</u>	
	2005-'09	2014	2005-'09	2014	2005-'09	2014
Survival	5%	2%	37%	26%	52%	74%
	<i>declining toxicity</i>		<i>declining toxicity</i>		<i>increasing toxicity</i>	

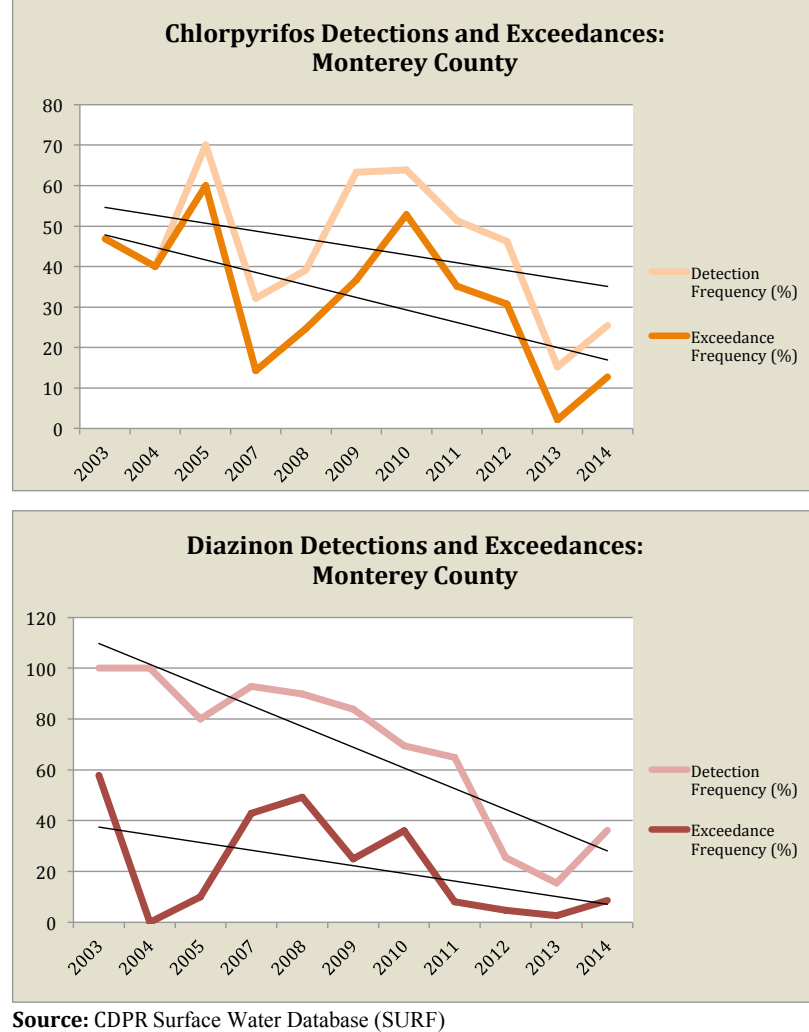
Source: adapted from CMP, 2015

toxicity problem.

Although the CDPR's dataset, Surface Water Database (SURF), is more limited than CMP's in the diversity of water quality information it reports, the SURF database is rich in quantity and geographic scope. The database contains over 554,000 chemical analysis records in 58 California counties from over 3,000 samples sites. SURF is categorized by county, rather than region, and reports the presence of pesticides in state waters from various studies conducted by federal, state and local agencies, private industry and environmental groups.

To assess relevant SURF data from Monterey County for use in this study, the database was queried by county (Monterey) and chemical (diazinon and chlorpyrifos). The query provided 459 data points/water samples from 2003 to 2014 for chlorpyrifos, and 465 data points over the same time period for diazinon. No data was available for 2006. The data were catalogued by number of samples and detection frequency. In addition, I calculated the exceedance frequency per chemical per year based on California Department of Fish and Wildlife's freshwater quality criteria for chlorpyrifos (0.025 µg/L) and diazinon (0.160 µg/L). Percent of detection frequency was calculated using the number of detections per total samples per year, and the percent of exceedance frequency was calculated using the number of exceedances per total samples in a given year. Results from these calculations suggest that diazinon and chlorpyrifos detections and exceedances are rapidly declining in the Monterey County (Figure 5-9), as expected from the decrease in their use in recent years.

Figure 5-9. Chlorpyrifos and Diazinon Presence: Monterey County



While there is strong evidence to suggest that diazinon and chlorpyrifos presence in Central Coast waterways are declining, it is too soon to judge if the water column toxicity problem has been solved. Several factors could explain why water toxicity could linger even after diazinon and chlorpyrifos were almost unilaterally abandoned. First, even if the majority of growers discontinue use of the two pesticides that most cause most water column toxicity, a few heavy polluters can continue to wreak havoc on waterways. Additionally, chlorpyrifos is bound partially

to sediment creating the possibility of re-mobilization in the stream system. If chlorpyrifos does remain in a stream, the pesticide could be detected at toxic levels for a period of time after it came off a farm. Thirdly, continued use of malathion, and to a lesser extent pyrethroids, could be contributing to water column toxicity. Malathion, a third organophosphate pesticide, has similar chemical properties to diazinon and chlorpyrifos and has been known to contribute to water column toxicity. And although the vast majority of pyrethroids tend to attach to sediment particles, some pyrethroids are water-soluble and could be a source of water toxicity.

Despite incomplete evidence, water column toxicity due to chlorpyrifos and diazinon has largely been written off as resolved. Due to budget and staff constraints, the great need to prioritize TMDLs has forced the Central Coast Regional Board to move onto the next pressing, and arguably more difficult pollution problem: sediment toxicity due to pyrethroids.

Discussion and Policy Implications

Calling out just two chemicals in the 2012 Central Coast Ag Waiver has resulted in a de facto ban. While the elimination of any very problematic chemicals can have desirable affects on human health, aquatic organisms and water quality, the resulting improvements can only be as good as the resulting behavioral consequences. When the 2012 Agricultural Waiver was implemented, Central Coast growers had a choice to respond to the policy decisions in several ways. While growers had the option of 1) carrying on with the use of chlorpyrifos and diazinon, as long as they complied with

increased policy mandates, almost all decided to instead halt their use of chlorpyrifos and diazinon by 2) putting up with more crop damage, 3) experimenting with other chemicals, or 4) switching to organic. Each of these actions carries a mixed bag of policy, environmental and societal implications.

The first option, complying with tier 3 policy mandates, would have substantially bolstered policy objectives relating to the Ag Waiver's monitoring program despite greatly hindering water quality objectives. A central goal of requiring individual surface water monitoring of tier 3 farms was to evaluate the effects of farm discharge on water quality and beneficial uses. Individual surface water monitoring on all tier 3 farms, or 10% of farms as estimated in 2010, would have contributed momentously to this goal. However, the benefits of less harmful pesticides in regional waterways far outweigh the added information that would have been gathered if growers had stayed in tier 3 and continued using diazinon and chlorpyrifos.

Instead, most decided to ditch chlorpyrifos and diazinon to escape individual monitoring requirements and/or protect the environment and workers. In omitting these chemicals several ensuing on-farm management decisions followed. Some growers decided to simply put up with more crop damage, which could be especially costly for a small farm with thin profit margins or if and when pests became unmanageable without alternative control measures. Though individual farms may have experienced a financial squeeze as a result of giving up the chemicals, economic data show that Central Coast lettuce and broccoli growers on average are thriving,

producing more crops at a higher crop value, despite abandoning use of both chemicals.

Switching to organic farming practices offers another possible option of increasing profits when abandoning pesticides. While fewer chemicals could yield positive environmental and human health results, the cost in both producing and purchasing more expensive organic crops could cause possible distributional effects. For example, entry into the organic industry might not be economically feasible for all farms. Farms with sales over \$5,000 must pay for organic certification in order to label their products as organic. While price premiums for their products could cover the initial entry cost, for some small businesses this added expense imposes too hefty an economic barrier to become organically certified (Klonsky and Greene, 2005). Another potential distributional effect is who is benefitting from organic production, both on the consumer and production end. Historically, organic products were more exclusively available in niche food and health stores, and often at a much higher premium; from 1990-1996, natural food stores sold two-thirds of all organic products in the U.S. (Dimitri and Greene, 2000). Consequently, wealthy, white, and more-educated consumers made up the majority of the organic consumer base. Encouragingly, in recent years the number and diversity of consumers of organic products is expanding (Dimitri and Oberholtzer, 2009), at least partially due to increased accessibility of organic products—as of 2000, more organic food was purchased in conventional supermarkets than in any other venue (Dimitri and Greene, 2000). On the production end, the switch to organic could have profound

implications for farmworkers; however, research is showing that organic systems might not change working conditions as much as society might expect. While clear benefits of working on an organic versus conventional farm may include less exposure to harmful pesticides, a clear health and lifestyle benefit, a recent California study shows that other socio-economic perks that are often expected of organic agriculture, such as higher wages and benefits trickling down from higher price premiums, multi-cropping farming systems, more likelihood of year-round employment and overall healthier working conditions, are more of the exception rather than the rule (Shreck et al., 2006).

Focusing regulation too narrowly on a small subset of pesticides could have encouraged a third, more damaging farm management response – switching to more harmful pesticides. In the case of California’s Central Coast, while it appears that there has not been an absolute transference from chlorpyrifos or diazinon to a single alternative pesticide, there is some evidence, albeit inconclusive and incomplete, that growers have switched to other, more harmful chemicals. Interestingly, the trend of chemical switching from organophosphates to pyrethroids, was identified several years prior to the Ag Waiver. In a 2008 Regional Board report on toxicity problems in the Central Coast, the Board staff found that “pyrethroids are a newer class of pesticides that are replacing diazinon and chlorpyrifos for both urban and agricultural uses.” Additionally, as Joseph and Zarate’s (2015) article points out, brassica growers in the region are on the hunt for new pesticides to control cabbage maggots since chlorpyrifos and diazinon are no longer viable options. Their research has found a

handful of pyrethroid pesticides and a neonicotinoid pesticide to be as effective or more effective than chlorpyrifos in maggot control; and many of these alternatives have a significantly longer half-life and different chemical properties than organophosphates.

Regulating a pesticides, or even nitrates with longer half-lives and/or ones that bind to sediment is further complicated by the time lag in water quality response. The same individual monitoring requirements would unlikely pinpoint a deleterious polluter until well after their lease is up or they have retired, leaving legacy harms that cannot be quickly undone and making it difficult for water quality regulators to address. Upcoming classes of pesticides targeted in the most recent Central Coast sediment toxicity TMDLs, pyrethroids, are especially prone to this issue. Because pyrethroids tightly bind to the soil, the most common transport mechanism off-farms and into nearby waterways is on suspended solids (Amweg et al., 2005). While pyrethroids have a short half-life in aqueous solutions, one California study found that bifenthrin, a pyrethroid commonly applied to strawberries in the Central Coast and one of the pesticides that showed to be highly effective in Joseph and Zarate's (2015) study on cabbage maggot control, has a half-life in soil solutions of 165 days (Lee et al., 2004). This means that the chemical will still likely be toxic coming off a field approximately a year later. By the time the chemical is detected in a waterway, the polluting strawberry grower might have moved, and the residual material coming off the farm would be the problem of the next grower. Under these circumstances, individual edge of field monitoring (as used for diazinon and chlorpyrifos), or even

individual groundwater monitoring (for nitrates), would not be as suitable a policy tool.

The success of the 2012 Agricultural Waiver in dramatically curtailing two pesticides known to cause harm in local waterways are laudable. Threatening to put growers in tier 3 was an effective tool in discouraging farmers from using chlorpyrifos and diazinon. However, the unique sets of circumstances paving the way for growers to readily discontinue their use of the two pesticides in the region should not be overlooked. Regardless of tier 3 mandates and the Agricultural Waiver, growers' opinions about both chemicals were lukewarm at best. As an increasing number of scientific studies published the negative impacts of both chemicals, there was a growing discomfort among growers in using pesticides that could likely cause harm to their workers and the environment. Additionally, in the case of chlorpyrifos use on broccoli, the overall effectiveness of the chemical on pest suppression and crop health was uncertain, even in the cooler maggot-friendly climate. Brassica growers use chlorpyrifos only prophylactically, or as a preventative measure, and as one study suggests, one or even two applications of the pesticide could have little to no effect on cabbage maggot infestations (Joseph, 2014).

Additionally, differences in the fate and transport of organophosphate pesticides lent themselves to the policy tools employed in the Ag Waiver. For example, the threat of individual monitoring requirements is greater for growers applying short half-life and water-soluble pesticides, like chlorpyrifos and diazinon, because they could be identified as a discharger in a short time frame through water

quality monitoring. This response would not be expected with nitrates or longer-lived, sediment-binding pesticides for several reasons. First, reducing the use of or finding a substitute for the valuable fertilizer would be difficult, if not impossible. Also, nitrates naturally occur in the environment, creating the added complexity of identifying which nitrates were naturally occurring and which originated from excess fertilizer application.

A much more difficult task lies ahead for Central Coast water quality regulatory agencies. Unable to re-use the policy tools that worked so effectively in 2012, the Regional Board is forced to creatively assemble a new set of regulatory instruments to address the next set of chemicals rising to the fore. Among the many aspects of programs and tools the Board will need to consider is which best management practices to mandate or encourage, since best management practices to mitigate off-farm movement substantially vary with the chemical, class of chemical, and crop targeted. The ability of Central Coast's agricultural industry to continue to thrive economically and produce food for much of the nation while not polluting waterways will depend upon a more comprehensive management approach that encourages best management practices and integrated pest management systems.

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