FROM CRISIS TO CONNECTIVITY

Renewed Thinking About Managing California's Water & Food Supply

Ag Innovations Network

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ABOUT CRWFS

The California Roundtable on Water and Food Supply (CRWFS) is a consensus-based forum to uncover obstacles, identify solutions, and take action to enhance water security for agriculture, the public, and the environment. Participants share a dedication to a healthy and balanced future for California, and each brings to the table deep experience on issues at the intersection of water supply and agriculture. The Roundtable membership represents a broad and balanced cross-section of stakeholders, including, but not limited to, representatives from agriculture, water supply management, government, fish and wildlife, natural resources, stewardship, environmental justice, rural economic development, and academia. Recognizing that polarized debates on water in California often end at an impasse, the Roundtable first came together in the summer of 2010 with the conviction that a creative and frank "off-the-record" dialogue could help draw out the wisdom and ideas needed to develop strong new pathways forward for water management in California. Roundtable members have found significant common ground even amid ongoing water debates.

Previous reports produced by CRWFS include *From Storage to Retention: Expanding California's Options for Meeting Its Water Needs* (2012) and *Agricultural Water Stewardship: Recommendations to Optimize Outcomes for Specialty Crop Growers and the Public in California* (2011).

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EXECUTIVE SUMMARY

Modern water management has largely focused on the near-term objectives of a particular user group, be it agriculture, urban, or environment. Over time, competing demands for our finite water resource has led to intractable water conflicts and a water infrastructure that is managed by a highly complex and fragmented network of local, state, and federal institutions. These institutional and water infrastructures abound with missing, broken, or dysfunctional connections between agricultural, urban, and environmental water users, creating negative impacts for all.

Addressing these challenges requires a new and strategic approach that is based in understanding the whole system. Fortunately, a shift toward a whole-systems approach is already developing within a number of disciplines that inform water resource management, food supply systems, and environmental stewardship. In this report, *From Crisis to Connectivity: Renewed Thinking about Managing California's Water and Food Supply*, the California Roundtable on Water and Food Supply (CRWFS) builds on this shift and identifies the concepts of connectivity and connected benefits:

Knaggs Ranch experimental agricultural floodplain habitat units. Photo courtesy of Jacob Katz.

- Connectivity defines the relationships that link the individual parts of a system to form a whole. It recognizes that the actions of one component within a system have an impact, both on the other components of that same system, and upon other, linked systems. The connectivity approach uses this understanding to better align the interactions between human systems (i.e., engineered resource systems, cultural norms, and institutions) and ecosystems (i.e., climatic, chemical and biological systems, and natural resources). This approach proposes that human systems are a central subsystem of the larger ecosystems, rather than systems that exist apart from and only linked to ecosystems. The goal of this alignment is to more effectively design for, and simultaneously achieve, benefits for agricultural and urban users, while ensuring environmental restoration, protection, and stewardship.
- The concept of connected benefits refers to achieving simultaneous benefits across all major water users. The idea of connected benefits builds on the positive historical trend from single to dual and multiple benefits that evolved as a way to respond to California's increasing water management challenges.

Based on our assessment of current needs and the patterns of disconnects, we have identified three initial high-priority areas in which we believe the connectivity approach can effect significant change in California's food and water systems. Each high-priority area has several principles to help guide assessment of water and food issues, as well as design and implementation of solutions.

Guiding Principles

CONNECTED THINKING

1. Understand natural systems: Integrated thinking and science-based solutions
2. Recognize that water, farmland, and habitat are finite resources that depend on each other
3. Emphasize connected-benefit projects
4. Recognize that food is water
5. Focus on long-term goals versus short-term fixes
6. Avoid unintended negative consequences of past and emerging approaches

INSTITUTIONAL LINKAGES

1. Move beyond institutional goals and entrenchment
2. Address conflicting policies and regulations
3. Manage political and economic drivers
4. Shift from 'one-size-fits-all' solutions to collaborative, regionally-appropriate, whole systems strategies
5. Assess and manage unintended consequences
6. Design and implement approaches to manage the transition from existing to new practices

PUBLIC AND STAKEHOLDER ENGAGEMENT

1. Participate versus consume
2. Public action from the ground up
3. Communicate with the public
4. Increase awareness and effectiveness of educational programs

Five cases have been selected to highlight water management projects that are already employing these principles. The cases are summarized in this report, and described more fully in the accompanying booklet, *Applying the Connectivity Approach: Water and Food Supply Projects in California that Connect, Link, and Engage*, which can be accessed at aginnovations.org/roundtables/crwfs/action/#Connectivity.

As more and more of us begin to apply the connectivity approach to the water challenges currently facing California we will develop longer-term and more systemic solutions to California's water quality and supply reliability issues.

METHODOLOGY

Since 2010, the California Roundtable on Water and Food Supply (CRWFS) has been cultivating a systemic approach to understanding and addressing the complex water and food supply issues in California. The results of this approach can be found in the three completed modules: ag water stewardship, water retention in the landscape, and improving connectivity in our water management approach.

Underlying this systemic approach, and central to the production of the reports from each module, is the social methodology that CRWFS uses to develop and support the capacity for renewed thinking and leadership among its members. Two critical elements of this methodology are bringing together diverse stakeholders and engaging them in respectful, trusting, and generative dialogue over time. This emphasis on strong relationships across different perspectives and over long time cycles enables a more thoughtful, holistic, and overarching perspective than any one stakeholder could achieve alone. It is within this type of atmosphere that a group of diverse stakeholders are best positioned to understand the needs of the whole system and to develop systemic recommendations, guiding principles, and strategic solutions that can address them. The social methodology used for CRWFS is, in fact, an approach for achieving connectivity. Members connect with one another, work together to identify an approach and guiding principles, and in this way generate the kind of connected thinking and connected-benefit solutions we advocate for in this report.

Rice from Knaggs Ranch. Photo courtesy of Jacob Katz.

Dialogic inquiry, which is an important component of the CRWFS methodology, is used to guide the discovery process to build shared understanding of a topic. A dialogic inquiry is guided by questions that evolve as insights become clear and the focus of a topic sharpens. This is accomplished by suspending judgment in the initial stages and seeking to understand underlying assumptions. Out of this practice mutual understanding and consensus often emerges. The dialogue on connectivity that ensued over the course of 2013 was guided by the following questions:

1. What are the missing, broken, or dysfunctional connections in our water and food supply system? Which are most serious? Are there patterns that cause those systemic failures, and what are they?
2. What reconnections or new connections would effect the most change at this time, and into the long-term future?
3. How do we best conceptualize a framework for connectivity that will help us think about and identify strategies and principles to build a more connected and resilient water and food supply system?
4. What are the guiding principles for building a more effectively connected water and food supply system, and what current projects may already demonstrate these guiding principles in action?

This report captures the critical insights that CRWFS members gained from these dialogues.

Birds in the Delta. Photo courtesy of Matt Grimm.

CONTENTS

CONNECTIVITY

A Systemic Approach

Water crises in California are not new. In recent times, however, record drought, groundwater contamination and overdraft, environmental degradation, aging infrastructure, a growing population, competing water needs, and climate change have further elevated the sense of urgency in addressing California's water quality and supply reliability. The complex and long-term nature of the challenges demands a new, strategic and unified approach, one based in an understanding of our whole system, including political, economic, cultural, practical, and environmental aspects. In this report, the California Roundtable on Water and Food Supply (CRWFS) presents such an approach, and invites you to apply the enclosed principles to the water management decisions we all make every day at various levels.

DISCONNECTIONS

California's water users are usually divided into agricultural, urban, and environmental sectors. Following the impact of mining associated with the California Gold Rush, the modern era of water management began in the mid-1800s and evolved independently in each sector. In most cases, management focused on the near-term objectives of a particular user group. Over time, competing demands for this finite resource led to intractable water conflicts and forged a culture of divisiveness that continues to challenge water management in California.

Agricultural Water Uses: In California agriculture, water is used primarily to grow and process food. Considering our state's diminishing supply of water, and the fact that California is a major producer of food for both domestic and international markets, we must nurture a more sustainable relationship between food and water.

Urban Water Uses: While some domestic water uses are obvious, such as showering, watering our lawns, and filling swimming pools, it's easy to lose sight of the water needed to produce the food we eat, the fibers we wear, the buildings we occupy, and the vehicles that transport us. The convenient, yet invisible, nature of our water infrastructure (both natural and engineered), contributes to a general lack of awareness of water use and sources, and prevents most people from becoming effective water stewards.

Environmental Water Uses: Water is indispensible to maintaining a healthy ecosystem and to restoring those ecosystems that have severely suffered from human manipulation and the decline of various wildlife populations. Just as the natural environment is dependent on water, our survival as humans is dependent on a wide range of essential resources and services supplied by our ecosystems. It is essential that we protect water availability for environmental uses.

Today, our water infrastructure is managed by a highly complex and fragmented network of local, state, and federal institutions. The ongoing goals of these institutions are to deliver water to a growing population of Californians (now at 38 million), to support a robust agricultural economy, and to restore and maintain our rich but fragile diversity of ecosystems.

Missing, broken, or dysfunctional connections between agricultural, urban, and environmental water users abound. Some are disruptions in the natural environment caused by human interventions in our natural system. Others prevent or discourage more holistic approaches to water management. Some examples of disconnects include:

» Over extraction of water at inappropriate times or locations, leading to negative social and ecological impacts
» Climate change impacts that alter the timing and availability of water resources

» Limited ability to move water around the state
» Separate management of surface water and groundwater
» Over allocation of existing water resources, resulting in conflict
» Planning processes that manage water uses separately from land uses
» Dispersed regulatory authority, such as single-species protections that do not consider the greater ecosystem or watershed

RECONNECTIONS

"The significant problems we have cannot be solved at the same level of thinking with which we created them." —ALBERT EINSTEIN

It is imperative at this point in time that we address the historic disconnections that permeate our water management system for all users. Fortunately, a systemic shift is already developing within a number of disciplines and approaches in water resource management, food supply systems, and environmental stewardship. In this report, CRWFS builds on this shift and identifies the concept of connectivity, or connected-benefit thinking, which is an evolution from existing multiple-benefit thinking. In addition, this report and its accompanying booklet, *Applying the Connectivity Approach: Water and Food Supply Projects in California that Connect, Link, and Engage*, highlight water management projects that are already employing these concepts.

Addressing the historical disconnections requires that we acknowledge the full extent of the challenges we face and ask ourselves tough questions. It demands that we identify and question deeply embedded ideas, mental models, and beliefs that have shaped our current thinking. It requires knowledgeable, open-minded, and committed leaders, representing all water users and regions, to participate in transparent and sustained dialogues and think together about the immense challenges California faces.

Whether we like to admit it or not, we are all connected to water in the most crucial ways possible — we need water to drink, to grow the food we eat, and to sustain and care for the environment. We all must take ownership of the strategies and solutions that stop us from being simply consumers of food and water, and help us become investors in the landscape in which we live. The connectivity approach provides such a strategy.
—THAD BETTNER, General Manager, Glenn-Colusa Irrigation District

In the pages that follow, we describe what we have discovered about improving connectivity through a dialogue process that took place over the course of nearly a year. This discovery process was significantly informed by the insights we gained from our two previous years of work on ag water stewardship[1] and retention of water in the landscape,[2] both of which were also based in systemic approaches. First, we define the term 'connectivity' and describe the 'connectivity approach' that we have identified. We offer a historical overview of water uses in California that highlights the evolution toward achieving connected benefits — a path that has already been pioneered by some in the water management world. We conclude with a set of principles that you can utilize to approach water management issues from a systemic perspective and develop solutions that achieve connected benefit outcomes.

THE CONNECTIVITY APPROACH

Connectivity defines the relationships that link the individual parts of a system to form a whole. It recognizes that the actions of one component within a system have an impact, both on the other components of that same system, and upon other, linked systems. For example, if groundwater extraction exceeds certain limits, the area potentially loses its recharge capacity, and in turn compromises the long term availability of water for the local agricultural community and the environment. These impacts, however large or small, may take time

to become apparent, hindering our awareness of the consequences, either intended or unintended.

Building on the systemic shift that is already underway, the connectivity approach will help to further align how human systems and ecosystems interact. We propose that human systems are a subsystem of the larger ecosystems, rather than systems that exist apart from and only linked to ecosystems (see sidebar, *Re-visioning Connectivity,* on page 4, for more detail). This alignment enables us to more effectively design for and simultaneously achieve benefits for agricultural and urban users, while ensuring environmental restoration, protection, and stewardship. We refer to these benefits as connected benefits (see *A Historical Perspective: From Separate to Connected Uses and Benefits* on page 5 for more detail on this development toward connected benefits).

We believe that the connectivity approach contributes to our collective capacity for more coherent and systemic thinking, which in turn generates more coherent and systemic results across all levels and scales of resource management in California.

If we do not see our connectivity, which is to see ourselves as a part of the big picture, we will continue to move in the same direction and continue to escalate our existing water conflicts.

—TOM ROGERS, Farmer, Dan & Tom Rogers Farm, Madera

A successful triple-bottom-line approach — supporting the needs and the opportunities for people, the planet, and prosperity — can only be achieved when we fully appreciate the complexity and connectivity of the entire system.

—GLENDA HUMISTON, California State Director, U.S. Department of Agriculture (USDA), Rural Development

Geese above cow pasture in the Yolo Bypass Wildlife Area. Photo courtesy of Dave Feliz, CA Department of Fish & Wildlife.

RE-VISIONING CONNECTIVITY

California's water and food supply systems are supported by two related and highly interdependent systems: ecosystems and human systems. Both of these systems are constantly evolving and interacting with one another. The following definitions highlight the characteristics of connectivity within each system. We propose that human systems are a central subsystem of the larger ecosystems, rather than systems that exist apart from and only linked to ecosystems.

Ecosystems

In broad terms, an ecosystem is best described as a lattice of physical, chemical, and biological connections. Interconnected natural resources flow between them. This lattice of connections and flows provides a framework for the structure and function of an ecosystem. Our ecosystems have been extensively altered by human systems. A more detailed look at the variety of connections and flows follows:

- **Physical connections:** climatic, geologic, geomorphic, hydrologic, etc.
- **Chemical connections:** salts, nutrient cycles, etc.
- **Biological and ecological connections:** species and the relationships between species, habitat, etc.
- **Interconnected natural resources:** air, water, soil, salts, nutrients, etc.

Human Systems

The human system is described as the lattice of physical, cultural, and institutional connections. Interconnected natural- and human-created resources flow between them. This lattice of connections and flows structures the way that human communities engage with each other, and how they relate to ecosystems. The system of connectivity between human systems and ecosystems is shaped by natural processes and systems and at times is disrupted by extreme or catastrophic natural events. A more detailed look at the variety of connections and flows of human systems follows:

- **Physical connections:** engineered systems such as water delivery systems, flood management systems, food cultivation systems, food delivery systems, transportation systems, etc.
- **Cultural and institutional connections:** governance/political systems, legal systems, educational systems, cultural/personal value systems, monetary systems, economic value systems, etc.
- **Interconnected resources:** money, information, knowledge, human communication, etc.

Common Perception of Connectivity

The common perception is that ecosystems and human systems are separate, with distinct features, operational dynamics, and processes that act upon each other. We believe that this perception has misled us to exploit and degrade the natural resources that are necessary for human survival, and limits us from seeing how interdependent the two systems really are.

Underlying this misperception is the fact that we have historically valued the resource needs of our human systems above the needs of ecosystems to maintain equilibrium and resilience over time. By functioning almost exclusively within the realm of our human systems, disconnected from the realm of ecosystems, we are forced to invest excessive amounts of time and resources in managing the limitations and breakdowns that result when our human systems collide with the powerful nature of ecosystems (e.g., climate change and land subsidence). The ongoing failure of human systems to align with ecosystems will continue to degrade both our human and natural resources, and potentially lead to catastrophic environmental, economic, and/or social consequences.

Common Perception of Connectivity

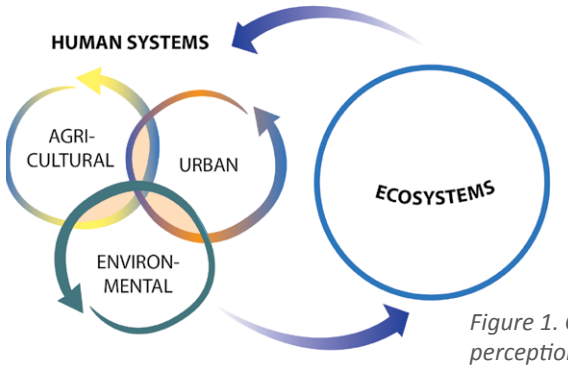

Figure 1. Common perception of connectivity

New Vision of Connectivity

When human systems are seen as a subset of ecosystems, forming one interrelated system, we reduce contradictions between the two systems and generate new opportunities. Though the systems will always act upon each other, their interconnectivity expands the range and potential of human systems, and allows significant reductions in the resources needed to manage the existing disconnects between our human systems and the ecosystems in which we live. We can avoid costs and achieve more sustainable outcomes by utilizing nature's services and synchronizing ourselves with natural systems.

New Vision of Connectivity

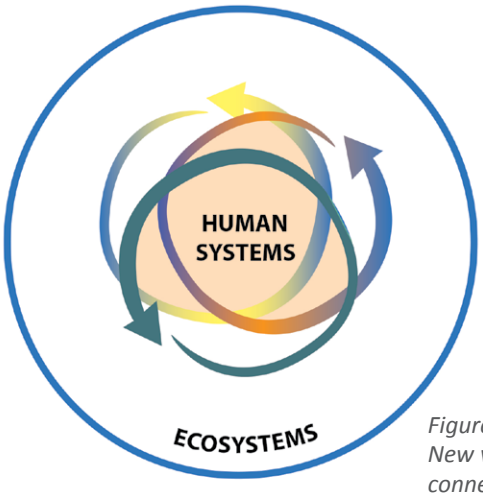

Figure 2. New vision of connectivity

HISTORICAL PERSPECTIVE

From Separate to Connected Uses and Benefits

A look at California's water history (as depicted in Figure 3) reveals the modern development of water use from mining and agriculture to rising urban demands to the acknowledgment that water is needed for the environment. This history also demonstrates a change in thinking about water projects over time, from single- to dual- to multiple-benefit solutions. The connectivity approach presented in the report builds on this trend. We propose a focus on 'connected' uses and benefits. This focus attempts to achieve multiple benefits for all three major uses of water simultaneously, rather then achieving multiple benefits for a given project within only one or two of the three major uses of water.

Mining Water Uses

The Gold Rush initiated the first significant manipulations of California's natural water system for human uses. The impact of mining on water lasted about 30 years, effectively ending in 1884 when a court ruled to end the practice of hydraulic mining.

Agricultural Water Uses

By the end of the Gold Rush, water demands for food production had already eclipsed the needs for mining and urban use, and soon thereafter, agriculture became the largest diverter of water in California. Appropriative water rights were transferred to agricultural water suppliers, termed 'irrigation districts,' under the Wright Act in 1887. The establishment of irrigation districts ushered in the era of engineered, single-purpose projects, primarily aimed at delivering water for irrigation. Twentieth century projects included water storage systems and power generation. As the state's water delivery system was developed, few anticipated the cumulative impacts the projects would have. But as the population swelled, and more water was demanded to quench California's agricultural and urban thirst, the environmental impacts of these activities and projects became harder to ignore.

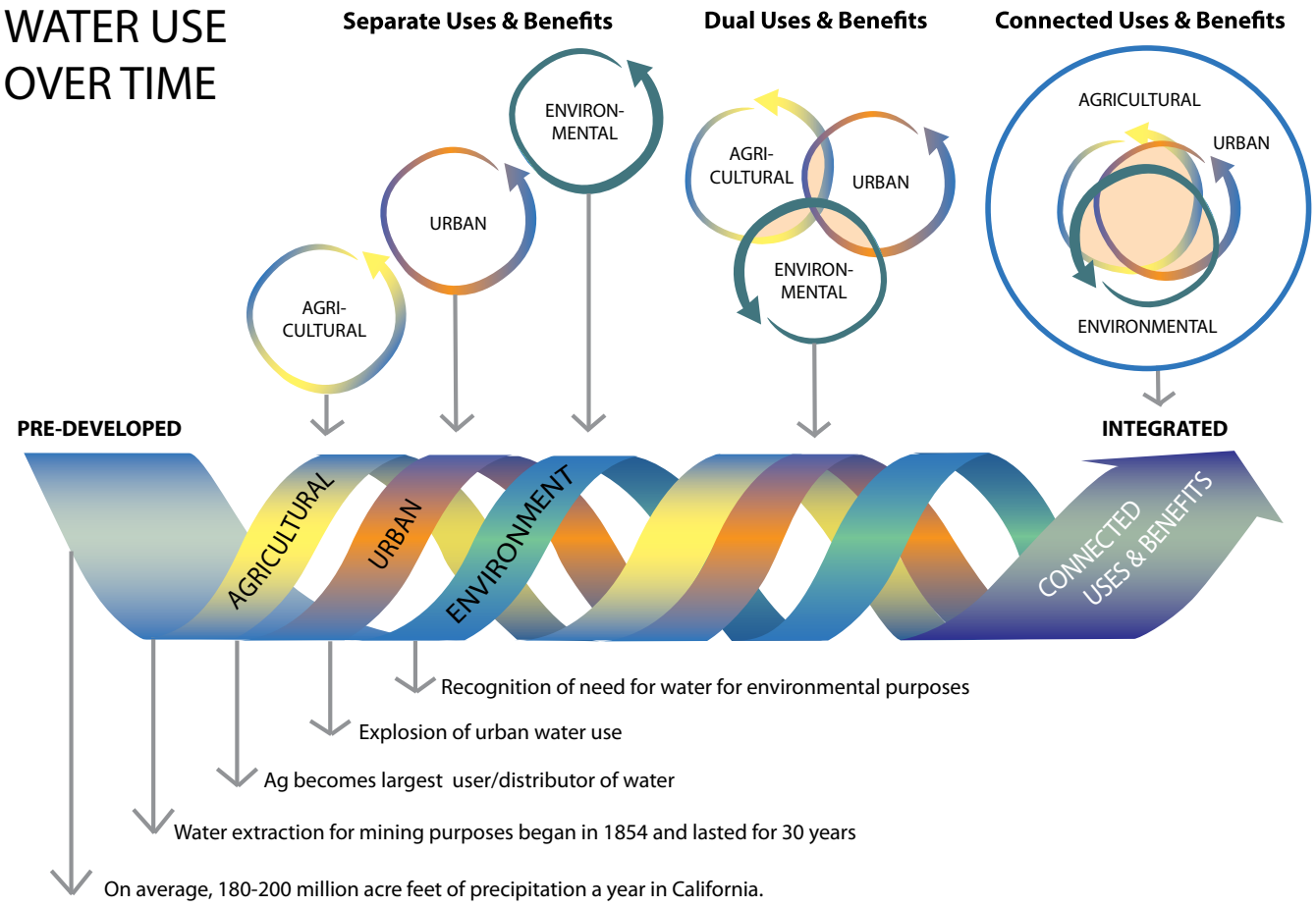

Figure 3. Water use over time

Urban Water Uses

Urban water uses include domestic, commercial, industrial, and institutional uses of water. The demand for water by California's urban population exploded during World War II and continued to grow over time. Existing single-purpose projects were augmented to meet the new demand.[3] Although the intent was primarily to deliver water for domestic use, projects began to mitigate for some environmental impacts.

Environment Water Uses

National parks were among the first natural resource protection efforts, even before the engineered water projects of the 20th century. Despite the environmental protection goals, large amounts of resource extraction occurred in national parks and forests, including logging, hunting, grazing, and mining. It was not until the 1960s that more comprehensive legal and regulatory remedies were enacted to address human impacts on the environment.[4] While environmental laws were successful in developing regulatory programs and controls to ameliorate the human impacts of single-purpose projects, they failed to consider whole ecosystems or watersheds in their evaluations and solutions to environmental problems.

CONNECTED USES & BENEFITS

In recent decades, water managers have begun to recognize the cumulative impacts of agricultural and urban water development, as well as the need to provide water for the environment. They have also discovered the importance of designing water projects to meet the needs of more than one user, or multiple-benefit projects. This thinking forms the basis for the connectivity approach, which emphasizes the relationships between human systems and ecosystems, and anticipates how those relationships interact and evolve over time. The goal of connected-benefit projects is to develop synergistic solutions across the whole range of needs – agricultural, urban, and environmental – within any given system or region. The approach advocates water management decisions that establish connections, such as those between urban and agricultural users and the remote headwater areas that supply them, or between urban consumers of agricultural products and the producers of those products. Activities that serve connected benefits and improve the system as a whole should be the focus of future public investment. The role of Integrated Regional Water Management (IRWM) plans and the groups that come together to prepare them collaboratively, is an excellent example of this shift in thinking that has led to projects which better balance human and ecosystem needs.

Resource managers and planners need to transition from the past model that placed value primarily on extracting natural resources like water, to a new model that values projects with connected benefits and sustainable outcomes. We need to innovate and integrate to build water and flood management systems that meet our needs – in harmony with the environment – to enable future generations to meet their needs.

—KAMYAR GUIVETCHI, Manager of Statewide Integrated Water Management, Department of Water Resources

Despite our historical misperceptions, agricultural, environmental, and urban water and resource needs are deeply connected. Reintegrating our institutions, infrastructure, and culture to leverage that connection may be the greatest opportunity of this time.

—DR. RENE HENERY, California Science Director, Trout Unlimited

CRWFS's previous report, *From Storage to Retention: Expanding California's Options for Meeting Its Water Needs*,[5] is an example of water management solutions that can be generated by applying the connectivity approach. In the case of retention, human systems and ecosystems are aligned by linking existing hydrologic networks (both human built and natural) to achieve a landscape with distributed storage that retains more water and facilitates more timely delivery to serve humans and the environment.

Juvenile Chinook salmon raised at Knaggs Ranch.
Photo courtesy of Jacob Katz.

CASE SUMMARY

Nigiri Project at Knaggs Ranch

The California Central Valley was once dominated by vast stretches of wetlands and floodplains, extending hundreds of thousands of acres across the valley floor. During most winters and springs, the valley's rivers overflowed their banks and spread out, forming a vast seasonal wetland mosaic — perhaps the most productive wetland-floodplain complex in North America, supporting a diverse and abundant spectrum of wildlife.

The once dynamic Central Valley landscape has been significantly altered over the last century, leaving a mosaic of leveed and diverted rivers, flood-bypass channels, and agricultural lands. This landscape continues to support hundreds of species of plants and animals, although at levels far below their historical abundance. Recovery of the Central Valley's seasonal wetland and floodplain habitats requires that we apply connected thinking to re-integrate habitat and species conservation, agriculture, and flood protection into a new vision of a connected-benefit working landscape. One project doing just this is the Nigiri Project.

Centered on the 1,700-acre Knaggs Ranch at the northern end of the Yolo Bypass, approximately 11 miles northwest of Sacramento, California, the Nigiri Project proposes to incrementally develop a flood-neutral management approach for agriculture, fish, and waterfowl over thousands of acres in the Yolo Bypass.[6] Innovative use of existing agricultural infrastructure allows for the seasonal creation of floodplain habitat for endangered native fishes and waterfowl during winter and spring each year on fields that remain in agricultural production in summer and fall.

Early results point to high growth rates for juvenile salmon, indicating that seasonal inundation of agricultural lands can provide excellent food-rich rearing habitat for Chinook salmon. Rice production at Knaggs Ranch has continued with little impact from the new management practices of extending the winter inundation period for waterfowl through the spring (~April 1) for salmon. While those involved continue to explore different approaches to increasing the relative benefits for fish and rice production, farmers have shown support for the project so far. The success of the Nigiri Project has already spawned similar pilot efforts on rice fields in the Sutter Bypass, and the potential for replicating the approach holds great promise for fish and farmers alike.

The full case assessment also includes the application of guiding principles to the Yolo Bypass Wildlife Area. The case can be accessed at aginnovations.org/roundtables/crwfs/action/#Connectivity.

Relevant Principles:

CONNECTED THINKING

- Understand natural systems: Integrated thinking and science-based solutions
- Recognize that water, farmland, and habitat are finite resources that depend on each other

IMPLEMENTING CONNECTIVITY

Guiding Principles

Based on our assessment of current needs and the patterns of disconnects, we have identified three initial high-priority areas in which we believe the connectivity approach can effect significant change in California's food and water systems:

- Connected thinking
- Institutional linkages
- Public and stakeholder engagement

For each of these high-priority areas we have developed several principles to help guide assessment of water and food issues, as well as design and implementation of solutions. Guiding principles are best employed by forming them into questions to be considered relative to your project. Guiding questions encourage an exploration of the issue from a strategic level, which helps reorient thinking and enables the discovery of innovative solutions.

CONNECTED THINKING

Connected thinking helps us bridge the silos of our thought patterns, and move from single-issue thinking to whole-systems thinking. By shifting our focus to analyze issues in the context of whole systems and their interconnectedness, we can design solutions that provide connected benefits and avoid unintended consequences. This requires that we increase our understanding of natural systems and the evolving interactions between our ecosystems and human systems over time. It also suggests that we emphasize the need for protection and restoration of our ecosystems in light of our growing human demand for resources.

FROM RESOURCE DEVELOPMENT TO WATERSHED MANAGEMENT

The way we are beginning to think about watershed management is an example of connected thinking.

In the nineteenth and twentieth centuries, water management was primarily dominated by an engineering-oriented, "water resources development" approach. In his 1985 book, *Rivers of Empire: Water, Aridity, and the Growth of the American West*, Donald Worster famously termed the resulting social and political framework 'hydraulic societies.' Hydraulic societies are built with the goal of controlling nature. And indeed, this engineering mind-set has continued into the present time.

Today, however, we also have an increasing involvement of other disciplines including geology and ecology, human geography and anthropology, as well as planning and a variety of other physical and social sciences that shape how we think about and manage our water resources. These disciplines approach water not only as a resource to be 'developed' or used, but also as a resource that is best thought about and managed as a connected system of natural and human functions and relations.

A watershed management perspective, for example, emphasizes the connectivity approach. While we typically tend to only focus on single sources of water, such as a creek or river, looking through the lens of the watershed allows us to see the myriad connections above and below the Earth's surface. A watershed is made up of everything that occurs between the ridgeline, where the flow of water is initiated, to the river mouth, where it flows into the ocean, and includes both surface and groundwater. When we understand that the flow of water over and through an ecosystem connects all species and landscapes, we begin to see and take account of the whole system. When we begin to see the whole system, we are more able to design sustainable solutions and understand the impact and long-term consequences of these solutions. Changes in quality and quantity of water, for example, determine which and how many of each species can sustainably live in each watershed — humans, animals, and plants alike.

A watershed management approach synthesizes community-based watershed literacy, planning, and action. It draws on influences such as: 1) landscape/watershed features, 2) their physical and ecological functions, 3) the consequences of alterations to these natural, physical and ecological functions, and 4) the policy framework that enables certain interventions or solutions and precludes others. The better we understand the watershed as a connected system, and understand the relationships between our actions and the watershed we live in, the more we are able to manage for water reliability and quality for all aspects of the watershed.

1. Understand natural systems: Integrated thinking and science-based solutions

A connected approach to water and food supply management links agriculture, species conservation, and water management as integral components of a connected system. It shifts the workings of human systems — in this case, water and food supply systems — within the context of ecosystems. Based on this understanding, we prioritize projects that align with and leverage the processes and infrastructure of the natural environment.

A connectivity approach requires that we understand natural systems better. Existing science and traditional ecological knowledge about the structure and function of natural systems provides a strong foundation for the development of innovative approaches to land use. However, new science is needed that focuses on the nodes of connection between human systems and ecosystems, and integrates those discoveries into land use and water management. A science-based understanding of connectivity is necessary to more effectively engage our human systems within the natural environment, develop whole-systems goals, and design and manage human systems to reach those goals.

Much of the currently available data are inconsistent and challenging to access and interpret. As a result, public policy and regulatory decisions are often made with inadequate or misleading information. Improved data access, greater transparency in data sources, and more collaborative interpretation and planning will facilitate a science-based approach to the connectivity of our food and water supply management decisions.

2. Recognize that water, farmland, and habitat are finite resources that depend on each other

As we develop our understanding of the interdependence between water, farmland, habitat, and urban development, we must bring our management decisions for each of these into alignment. Rather than see them as competing land uses, the connectivity approach provides us with a framework to integrate our finite resources into our management practices in order to simultaneously produce food, steward our water and natural resources, and support healthy populations of humans and wildlife.

3. Emphasize connected-benefit projects

Prioritize public investments that generate connected benefits across urban, agricultural, and environmental domains, effectively shifting our resources to address the needs and goals of the whole system rather than one segment of it.

4. Recognize that food is water

We need to shift our collective perspective to recognize that food is water. The way we think about and manage our water supply and quality impacts a wide range of ecosystems outcomes, including our ability to sustain soil health for food production and water availability for all human and ecosystem needs.

Waterfowl in rice field. Photo courtesy of California Rice Commission

5. Focus on long-term goals versus short-term fixes

Institutional planning is generally based on human life cycles, which are relatively short compared to the much longer life cycles found in natural ecosystems. Human systems are designed to respond to immediate needs and emergencies, though often at the cost of a much-needed focus on long-term goals.

In the past decade, California's government has started to change the way it manages natural resources. Government policy is shifting away from its historical focus on siloed resource management and toward a more proactive and holistic approach of integrated resource management. We would like to see this approach include planning for a vision that more closely aligns with the longer life cycles of nature (akin to the Native American principle that actions be sustainable for seven generations) and emphasis on the guiding principle of connected thinking.

6. Avoid unintended negative consequences of past and emerging approaches

Connected thinking and management is needed in response to the unintended consequences and costs resulting from both past and current practices. In order to better anticipate the long-term consequences of today's approaches and solutions, we must prioritize scientific exploration of the connectivity of human systems and ecosystems, and make informed government policies. We believe that if human systems can better mirror the systems of the natural world, we can minimize unintended, negative consequences and achieve greater, more diverse, and sustained benefits with the same or fewer resources.

CASE SUMMARY

Kings River Basin Project

Groundwater overdraft is a primary issue facing the Kings River Basin. Over the past 40 years, groundwater levels have dropped significantly, from 40 feet in the Fresno area to 150 feet in Raisin City. Overdraft is a result of water demand exceeding available surface and groundwater supplies as they are currently developed and managed. The consequences include declining water levels, increased pumping costs, land subsidence, migration of poor-quality water, impact to economic development opportunities, and conflict among users.

Historically, management of water resources in the Kings River Basin had been limited to uncoordinated operations by overlying local water agencies and individual users. This exacerbated the problem of groundwater overdraft and constrained the scope of potential solutions, as each water supplier only managed within its district boundaries and with its individual resources.

In 2001, four water agencies in the Basin formed a Basin Advisory Panel with the purpose of working together to manage existing water supplies and develop new supplies. In 2004, the Basin Advisory Panel solicited wider stakeholder participation and formed the Upper Kings Basin Water Forum (Water Forum). The Water Forum's purpose was to increase communication and collaboration to create regional solutions for water resources management. In response to the state's Integrated Regional Water Management program (IRWM), the Water Forum grew into the Upper Kings Basin Integrated Water Management Authority in 2009, now known as the Kings Basin Water Authority (KBWA). The KBWA includes nearly 60 public, private, and nongovernmental organizations, and has supported critical collaborations that have resulted in a number of very successful regional water solutions that generate connected benefits. The full case assessment can be accessed at aginnovations.org/roundtables/crwfs/action/#Connectivity.

Relevant Principles:

CONNECTED THINKING

- Understand natural systems: Integrated thinking and science-based solutions
- Recognize that water, farmland, and habitat are finite resources that depend on each other
- Focus on long-term goals versus short-term fixes

INSTITUTIONAL LINKAGES

- Move beyond institutional goals and entrenchment

INSTITUTIONAL LINKAGES

Institutional linkages help us to build bridges across institutional siloes, linking institutional infrastructures, legal processes, information sources, regions, interests, and stakeholder groups. While some progress has been made toward increasing cross-institutional and stakeholder collaboration, this collaboration is needed system wide. Increasing institutional linkages is one of the most critical shifts we need to take. This shift is best supported through strategic initiatives that align the goals of single institutions with the goals of the whole system, while establishing common leadership and management practices and collaboration processes across these institutions. This requires political will, bottom-up and top-down planning, overcoming bureaucratic inertia, and new and evolving policies.

1. Move beyond institutional goals and entrenchment

Historically, institutions at the local, state, and federal level have been designed to fulfill specific resource management functions. Within those institutions, employees have specific roles with specific deliverables that contribute to the institution's mission. We find that this structure inhibits achievement of whole-systems goals that lie beyond the direct missions of individual institutions. Whole-systems goals can only be achieved when cross-institutional collaboration and integration become a high priority, occur at all levels, and are intentionally designed, funded, and implemented. This requires investing in institutional infrastructure redesign and professional development to enable employees to engage collaboratively. Institutional collaborations can be built by engaging in much needed intra- and cross-institutional learning. Existing examples of such learning include coordinated permit efforts,[7] interagency collaboration on groundwater and nitrate issues and dairy digesters,[8] and the California Biodiversity Council.[9]

A recent resolution by the California Biodiversity Council, *Strengthening Agency Alignment for Natural Resource Conservation*, advocates similarly for improving institutional linkages:

> "A growing body of scientific research demonstrates the need to move beyond existing efforts focused on the conservation of individual sites, species, and resources. The Council now recognizes the need to work in ways that transcend individual agencies' ownerships, missions, and authorities. This work will involve agencies working together in nontraditional ways that lead to strong alignment of conservation goals, plans, policies, and regulations across ownerships and jurisdictions."

2. Address conflicting policies and regulations

Both regulatory and nonregulatory state and federal agencies make natural resource management policies and regulations, which at times, conflict with or are duplicative of those made by other departments or agencies. This can result in 'turf' issues among agencies and frustration for those implementing the policies or regulations. Many agencies have begun to recognize these issues, and are taking leadership to proactively address them. Institutions that are guided by whole-systems goals and are regionally linked across stakeholder groups, are far more likely to avoid conflicting policies and regulations.

The IRWM process we used in the Kings Basin forced a diverse group of stakeholders and institutions out of their silos. They examined their common interests and opportunities for taking coordinated actions. As a result of connecting stakeholders in this way, we identified unified and measurable objectives to address some of the most pressing water resource issues in the region.

—DAVID ORTH, General Manager, Kings River Conservation District

Finding solutions to complex challenges requires that stakeholders with diverse interests work together to fashion connected, integrated responses. The guiding principles in this report will help steer decision makers through collaboration to develop these new responses. The members of CRWFS welcome those who use these principles to give us feedback on how to make the principles even more useful.

—FRANCES SPIVY-WEBER, Vice Chair, California State Water Resources Control Board

3. Manage political and economic drivers

Political and economic decisions should factor in the needs of the natural system. One way to achieve this is to modify existing regulations to more equitably distribute water to achieve connected benefits for human systems and ecosystems, rather than prioritizing benefits to single crops or regions. A way to incorporate the value of ecosystems into our political and economic frameworks is through the valuation of ecosystem services.[10]

4. Shift from 'one-size-fits-all' solutions to collaborative, regionally-appropriate, whole-systems strategies

The connectivity approach invites the development of long-term, statewide strategies and guidelines, as well as local and regional approaches and initiatives. Whole-systems goals should establish a general direction and allow flexibility in implementation.

5. Assess and manage unintended consequences

Unintended consequences stem largely from single institutions setting policies, regulations, and guidelines in isolation from other institutions. A more recent focus on interagency coordination has alleviated this to some degree. Continued and improved linkages between institutions and related disciplines are needed to assess potential consequences of new solutions and minimize negative repercussions. This includes cross-institutional and cross-disciplinary transparency and alignment with whole-systems goals.

6. Design and implement approaches to manage the transition from existing to new practices

A long-term transitional management plan is required to make the shift from existing management practices to implementing a more connected approach. These plans need to be designed and managed with cross-institutional input and buy-in as well as tools, such as executive orders or legislative mandates, to reinforce them. A transitional plan forecasts challenges and proactively seeks to resolve them.

CASE SUMMARY

The Central Valley Habitat Exchange

The Central Valley Habitat Exchange (CVHE) is a new initiative being developed to more completely valuate a range of environmental benefits provided by agricultural lands through restoration activities and/or changing management, and to promote the reintegration of habitat into California's working landscapes. Taking advantage of the emerging market of habitat credits, CVHE will facilitate a sustainable stream of investment in California's working landscapes by promoting, monitoring, and assisting in the exchange of habitat credits.

A habitat credit is a measure of the ability of a parcel of land to support a particular species or natural community. Habitat credits offer willing landowners the potential to gain another revenue source and to realize financial benefits from providing high quality habitat that contributes to sustaining our natural resources. Credits also provide a means for those managing natural resources to recognize and value working agricultural lands as opportunities to more effectively improve the resource base. The CVHE initiative highlights a significant opportunity for aligning human systems with ecosystems, particularly in the way that it links institutions and management bodies to improve stewardship of land and natural resources in California. The full case assessment can be accessed at aginnovations.org/roundtables/crwfs/action/#Connectivity.

Relevant Principles:

INSTITUTIONAL LINKAGES

- Move beyond institutional goals and entrenchment
- Manage political and economic drivers
- Design and implement approaches to manage the transition from existing to new practices

OWOW Pillar meeting. Photo courtesy of Santa Ana Watershed Project Authority.

CASE SUMMARY

Santa Ana Watershed Integrated Regional Water Management

The Santa Ana Watershed Integrated Regional Water Management (IRWM) Plan is known by stakeholders as the One Water One Watershed (OWOW) Plan. Begun in 2007, the plan's mission is to create opportunities for collaboration to find sustainable watershed-wide solutions among diverse stakeholders from throughout the watershed. It provides a blueprint for water resources management over 30 years, identifying the need to address four major threats: climate change, Colorado River drought conditions, Sacramento-San Joaquin Delta vulnerability, and population growth and development. The process to develop the plan identified three broad areas where action is needed: the development of a water ethic that values water differently; a more collaborative approach to water management; and the construction of sustainable water infrastructure.

The fundamental concept for the planning process was to pull parties together in every aspect of the water arena – those who provide water, those who use it, and those who manage it – in a way that has never been done before, and reaches beyond the interests of any one agency. This approach marked a major shift from planning efforts preceding IRWM by greatly expanding the number and type of agencies and organizations involved in the process. The inclusive, collaborative, and bottom-up management approach will help the Santa Ana region shift toward project planning and implementation practices that look for connected benefits that improve the health of the overall watershed in a way that would not have been possible before. The full case assessment can be accessed at aginnovations.org/roundtables/crwfs/action/#Connectivity.

Relevant Principles:

INSTITUTIONAL LINKAGES

- Move beyond institutional goals and entrenchment
- Address conflicting policies and regulations
- Shift from 'one-size-fits-all' solutions to collaborative, regionally-appropriate, whole-systems strategies
- Design and implement approaches to manage the transition from existing to new practices

PUBLIC AND STAKEHOLDER ENGAGEMENT

- Public action from the ground up
- Communicate with the public
- Increase awareness and effectiveness of educational programs

PUBLIC AND STAKEHOLDER ENGAGEMENT

The overall success of the connectivity approach depends on the public's support. Our efforts must effectively connect the public to the critical issues we all care about — water and food supply sustainability here in California. We define the public as anyone who consumes water – in other words, 'us' rather than 'them.' Many water users are also voters, whose role in influencing initiatives and related funding is important to the process. Ultimately, we all face the same water-related challenges, and their consequences.

Our goal is to effect a shift in perspective from the consumer mind-set to one that is participatory and empowers the individual user to help steward our water resources. To support this shift, we need to increase water resource literacy, provide better access to accurate information, and raise awareness of our individual contributions to California's water resource issues. Opportunities to engage in decision-making processes designed for public participation are also a key factor.

1. Participate versus consume

Accountability increases when people see themselves as an integral part of a larger system. Thinking of ourselves as consumers inherently separates us from the systems and processes that generate the services and products upon which we depend. When we see ourselves as participants in a connected system, we are more aware of both our positive and negative impacts to the system and how it affects our own lives. Initiatives that encourage recycling or allow us to calculate our water and ecological footprints help make these connections and shift the consumer mindset to one of participation.

There is a need to stimulate greater connectivity between the public and the natural environment. This includes a) increasing the public's understanding of water resource issues, b) raising awareness of the fact that food production requires a large amount of water, and c) drawing the public's attention to successful local projects in which they can get involved.

2. Public action from the ground up

Good government embraces bottom-up, grassroots initiatives that generate creative, collaborative, cross-institutional approaches and solutions. Illustrating how collaboration works inspires others to get involved and conveys that there are actions we can take to help address local and regional issues. As more people understand the challenges and participate in solutions, it instills a sense of ownership, which, in turn, generates collective responsibility of action.

3. Communicate with the public

We need to become better at telling the story about food and water in California, taking into account the perspectives, needs, and values of the public. This includes relating these topics to our personal and family lives, our health, jobs and wealth, our businesses and overall economic welfare, as well as the health of the environment. Shifting the language from 'them' to 'us' helps shift the perspective.

4. Increase awareness and effectiveness of educational programs

A number of educational programs on water and food supply are currently available.[11] However, existing educational programs often fail to reach the public due to a range of reasons including a lack of connection to real-life scenarios, limited hands-on learning activities, and failure to effectively address language barriers. To increase awareness about our food and water supply issues, educational programs need to be more accessible to the public and more vividly demonstrate the circumstances and consequences of our water consumption at home and on the farm.

Community Water Dialogue tour. Photo courtesy of Santa Cruz Resource Conservation District.

CASE SUMMARY

Pajaro Valley Groundwater Overdraft

California's Central Coast is a unique agricultural region where most farms rely primarily on groundwater. Because of their proximity to the ocean, coastal communities face the unique challenge of seawater intrusion into coastal freshwater aquifers. Declining groundwater levels (due to overdraft) and sea level rise have compounded the problem, and the average landward movement of seawater is now 200 feet per year. Because saline groundwater supplies are unsuitable for irrigation, coastal water suppliers are very interested in finding alternate freshwater sources not only to supplement supplies, but also for groundwater recharge. Higher groundwater levels slow the penetration of saltwater into the aquifer, and sustain the aquifer's use into the future.

In 2009, locally-based berry producer, Driscoll's, began the Pajaro Valley Community Water Dialogues, which involved a wide array of stakeholders, including landowners, farmers, farm organizations, environmentalists, government agencies, the water agency, university researchers, and the real estate industry. It was a forum to create connections among stakeholders and develop practical solutions to groundwater overdraft in a public venue. The Dialogues have increased awareness of several on-going water conservation efforts including increased irrigation efficiency, rotational fallowing, and a pilot program on performance-based conservation incentives. Trainings in irrigation scheduling, including use of evapo-transpiration data and understanding measurements of distribution uniformity, which are critical for optimizing irrigation efficiency, were also coordinated as a result of the Dialogues. The Dialogues were so successful that the local water management agency adopted the resulting solutions in their own plan. The full case assessment can be accessed at aginnovations.org/roundtables/crwfs/action/#Connectivity.

Relevant Principles:

CONNECTED THINKING

- Understand natural systems: Integrated thinking and science-based solutions
- Emphasize connected-benefit projects

PUBLIC AND STAKEHOLDER ENGAGEMENT

- Public action from the ground up
- Communicate with the public
- Increase awareness and effectiveness of educational programs

CONCLUSION

As more and more of us begin to apply the connectivity approach to the water challenges currently facing California — record drought, groundwater contamination and overdraft, environmental degradation, aging infrastructure, a growing population, competing water needs, and climate change — we will develop longer-term and more systemic solutions to California's water quality and supply reliability issues.

> *Every deliberate alteration to the landscape begins with a human proposal to take some action on a specific parcel of the globe. "Connectivity" provides a framework to better understand the impacts of those decisions. Most analytical frameworks focus on the impacts of a single-purpose action and fail to account for how this action impacts the overall system. When it comes to water we must consider all future actions using an approach that is system-wide such as the connectivity approach that we are proposing.*
>
> —SARGE GREEN, Coordinator of Integrated Resource Water Management

As conveyed through the cases summarized in this report, efforts are already underway throughout the state to develop connected-benefit solutions through connected thinking, improving institutional linkages, and engaging the public. More detailed accounts of each case are available in *Applying the Connectivity Approach: Water and Food Supply Projects in California that Connect, Link, and Engage*, available at aginnovations.org/roundtables/crwfs/action/#Connectivity. We hope that you will be inspired to take similar action toward applying the connectivity principles to water management issues you are working with and increasing shared ownership of these issues in the public realm.

The California Roundtable on Water and Food Supply will continue to refine and apply the concept of connectivity as we engage new topics, and we invite you to join us[12] to further explore the applicability of the connectivity approach and guiding principles to make our water and food supplies more reliable and resilient.

ENDNOTES

1. http://aginnovations.org/images/uploads/CRWFS_Water_Stewardship_Recs_electronic.pdf
2. http://aginnovations.org/images/uploads/CRWFS_Storage_to_Retention.pdf
3. First used for agriculture, the stream flows of the Owens and Mono Basins were exported via aqueduct to Southern California's urban populations in 1913. The history and decision-making process are described at http://californiaagriculture.ucanr.edu/landingpage.cfm?article=ca.v049n06p15&fulltext=yes
4. Environmental laws passed in the 1960s and 1970s included the National Environmental Policy Act (NEPA), the Clean Water Act and California's Porter-Cologne Act, the Clean Air Act, the Wilderness Act, the Wild and Scenic Rivers Act, and the Endangered Species Act.
5. http://aginnovations.org/images/uploads/CRWFS_Storage_to_Retention.pdf
6. http://aginnovations.org/regulations/reg_resources/#Permit%20Coordination
7. http://aginnovations.org/regulations/reg_resources/state_water_board_roundtables/ and http://aginnovations.org/regulations/reg_resources/california_federal_dairy_digester_working_group/
8. http://biodiversity.ca.gov/
9. The Yolo Bypass is a 60,000-plus acre flood control channel for the Sacramento River and several of its major tributaries.
10. http://aginnovations.org/images/uploads/CRAEESGuidelinesWeb.pdf
11. Examples of existing educational programs are the Community Alliance with Family Farmers Farm to School Program (http://caff.org/programs/farm-2-school/) and school garden programs (http://www.lifelab.org/for-educators/workshops/collaborative-workshops/csgt/)
12. The California Roundtable on Water and Food Supply can be accessed through Ag Innovations Network at http://aginnovations.org.

The California Roundtable on Water and Food Supply is a project of Ag Innovations Network, a nonprofit organization dedicated to helping stakeholders solve systemic issues through effective collaboration.

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Cover Photo: Dave Feliz, CA Department of Fish & Wildlife