

Water Quality, Quantity and Security Initiative Strategic Plan

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Introduction

Water—essential to all life—can only be understood in the context of larger societal concerns such as food safety, climate change, land use, agricultural and ecosystem sustainability, global population growth, and urbanization. Reflecting its significance, water is an integral component of major governmental acts such as the federal Endangered Species Act, National Environmental Policy Act, Clean Water Act, and the state’s Porter-Cologne Water Quality Control Act. In California, water is the life blood of the state’s economy; its availability and quality is critical for the state’s agricultural, urban, and environmental systems now and in perpetuity.

Background

The *ANR Strategic Vision* (2009) addressed anticipated themes and issues for California in the year 2025, including agriculture and food production, demographics and infrastructure, health

and nutrition, human development, and natural resources. It concluded that integrated strategic initiatives could best address these overlapping challenges facing the state. Five multidisciplinary, integrated strategic initiatives have been established that utilize the ANR network, infrastructure, and expertise to provide solutions for California. These initiatives are Endemic and Invasive Pests and Diseases; Healthy Families and Communities; Sustainable Food Systems; Sustainable Natural Ecosystem; and Water Quality, Quantity, and Security.

According to the *Strategic Vision*, several issues regarding California's water are paramount:

- The supply of water will be limited for all users.
- Competition for water will intensify among agricultural, urban, and environmental users, with water being transferred from agriculture to the latter two groups.
- Short- and long-term climate trends will exacerbate the problems associated with water availability.
- Degradation of water quality will become more important as a major public issue.
- Legal and regulatory decisions will have significant impacts on water use and quality among all sectors.

Initiative Goal

The overall goal of the Water Initiative is to define, prioritize, and implement ANR actions that effectively and efficiently help California address these issues and challenges using a five-year planning horizon. The Water Initiative strategic plan identifies key areas of inquiry to reach this goal and guides ANR in allocating resources to meet California's water resource needs. These key areas of inquiry are based on consistency with the *Strategic Vision*, current expertise within the ANR network that integrates research and extension, ability to attract or leverage additional non-ANR funding, and a high potential to support science-based decisions involving public policy or behavioral change.

In addition to the key areas of inquiry, the Water Initiative strategic plan has three overarching program criteria:

- Increase system understanding and characterization of water quality and quantity conditions;
- Develop and implement management practices to achieve water quality and quantity objectives; and
- Facilitate integrative research and extension program delivery.

Combined, the areas of inquiry and program criteria provide the Water Initiative's framework for organizing and supporting UC ANR efforts to reach Water Initiative strategic plan.

The Water Quality, Quantity, and Security Initiative's subject matter and key issues clearly cut across all of the other ANR strategic initiatives. In addition, its scope reaches many other areas outlined in the *Strategic Vision*. The breadth of the scope and the depth of its linkage with other strategic initiatives pose challenges and opportunities that are unique to this initiative. This strategic plan outlines preferred research and extension activities, some specific and more easily achievable and others more general and requiring long-term efforts. For example, the Water

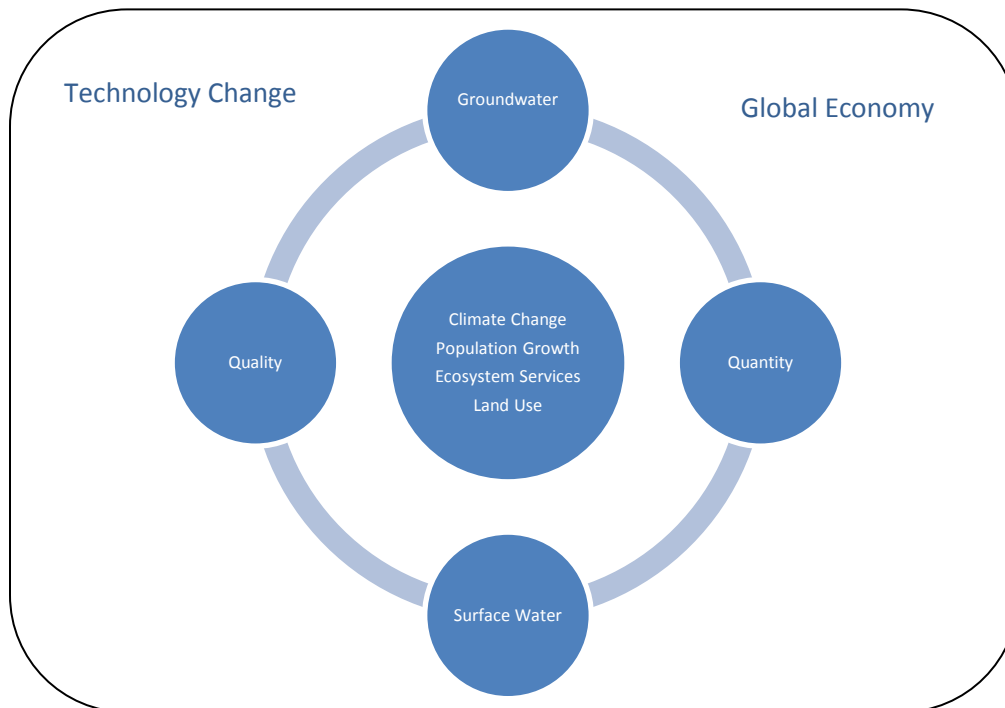
Initiative's efforts concerning climate change focus on the "local" (field, farm, county) footprint, developing targeted research and extension projects to contribute to the broader issue as a whole.

Areas of Research and Extension

The Water Strategic Initiative has targeted four key areas of inquiry for preferred research and extension projects; in which to engage in policy and decision making; and for defining the broader scope within which the Initiative's deliverables, expected outcomes, and/or impacts are provided:

1. Surface Water Quantity
2. Groundwater Quantity
3. Surface Water Quality
4. Groundwater Quality

Interactions between surface water and groundwater and between water quality and quantity present needs and opportunities for research, extension, and education in all of the above key areas of inquiry. In addition, there are many broad issues that cut across these four key areas including climate change, water balances and re-use, urban and rural land use planning, agricultural production systems, and wildlife ecosystems. Research and extension activities focused in the above key areas will also address these types of cross-cutting issues.



1. Surface Water Quantity

California's surface water resources are critical to the health of the environment and to the state's economy. More than 90 percent of California's surface water is generated or flows through its forest and rangeland watersheds. The surface water system is a complex network made up of waters in vernal pools; wetlands; lakes, including man-made reservoirs; streams; rivers; and conveyance canals. In combination, they provide water storage, flow, and delivery for municipal, industrial, agricultural, environmental, and recreational uses.

In an average year, approximately 50 to 60 percent of California's water is undeveloped while the remaining 40 to 50 percent is developed or "dedicated" to environmental, municipal, industrial, and agricultural uses. While the state's dedicated water supplies receive the most attention, ANR provides programs and personnel that address important aspects of the state's total water supply, both developed and undeveloped (e.g., water use and environmental services in forests and other naturally vegetated lands). ANR's efforts include research, outreach, and education to address issues critical to the availability and reliability of California's surface waters.

Preferred areas for research and extension

Topics common to agricultural, forest and rangeland, and urban land uses:

- Hydrology and ecosystem function; total flows, peak flows, and summer baseline flows all impact surface water uses and the natural environment.
 - Impacts of climate change on surface water hydrology
- Interaction between surface water and groundwater; surface water can be the recharge source for groundwater, so changes in surface water use or hydrology will impact groundwater resources. Alternatively, groundwater use has impacts on surface water, especially on summer and fall in-stream flows of undeveloped (undammed) streams
 - Conjunctive management of surface water and groundwater
- Water transfers and marketing of surface waters and groundwater
- Socioeconomic aspects of water management systems
- Water re-use

Topics specific to forest and rangeland watersheds:

- Climate resiliency in the face of recurring droughts and floods
- Storage and timing of use for livestock watering

Topics specific to production agriculture:

- Water right trading through winter storm runoff storage
- Agricultural irrigation water management
 - Irrigation scheduling
 - Irrigation system operation and management

Topics specific to urban agriculture:

- Urban water use efficiency with emphasis on landscape irrigation water management

Policy issues addressed

- Water supply reliability under climate change
- Water supply reliability in light of changing environmental regulations
 - Endangered species listings of fish and operation of Delta water pump facilities

- Utilizing facets of conjunctive water management (including water measurement, groundwater and ecosystem monitoring, water transfers, water markets, and water rights)
- Allocation of limited water supplies among competing users

Deliverables

- Improved understanding of and guidelines on allocation of surface water supplies to meet the needs of competing users.
- Improved knowledge of and recommendations on how allocation and management of surface water sources impact groundwater supplies.
- Improved assessment of groundwater use and alternatives on in-stream flows in critical periods.
- Improved understanding of the impacts of water transfers and marketing for public policy governing surface water transfers.
- Tools for agricultural water users to improve their water management.
- Management techniques for urban water users to improve their water use efficiency.

Expected outcomes and impacts

- Improved efficiency and more effective surface water allocation policies to accommodate competing water demands and changing hydrologic conditions.
- Effective tools for improved management of groundwater recharge in the allocation of surface water supplies.
- Improved management and optimization of groundwater use in groundwater-dependent ecosystems, including in-stream flow.
- Science-based information that leads to acceptable policies and methodologies to implement water transfers as part of conjunctive water management.
- Improved management of on-farm and urban uses of surface water from irrigation supplies. This includes improvements in the extension of information to water users.

2. Groundwater Quantity

California has allocated water for in-stream flows, irrigated agriculture, livestock agriculture, urban use, managed wetlands, wild and scenic rivers, and required Delta outflow. A combination of surface water, groundwater, re-used water, and recycled water provided the supply to meet these demands.

On average, 30 percent of the state’s annual irrigation and urban water supply is from groundwater. During droughts, groundwater may provide as much as 60 percent or more of this supply. About 85 percent of Californians, more than 30 million people, rely on groundwater for some of their drinking water supply. Many California communities in agricultural areas and practically all rural residences rely entirely on groundwater for drinking water. Agriculture’s dependency on groundwater for irrigation depends on both location and annual precipitation. Statewide, it is estimated that, on average, about 2 million more acre-feet of groundwater is extracted annually than is replenished.

Groundwater is California’s hidden resource, a water supply with localized hydrologic and geologic features that are not fully or easily understood. Similarly, the extent and nature of

groundwater use is complex and localized. The California Department of Water Resources has defined 431 groundwater basins statewide and further divided these into 515 distinct groundwater systems underlying about 40 percent of the state's surface area. California policy and institutional structure recognize the localized nature of this vital groundwater resource and promote local or regional efforts to monitor, comprehend, and manage it.

Preferred areas of research and extension

Topics common to agricultural, forest and rangeland, and urban land uses:

- Improve understanding of basin-scale water balances, particularly groundwater percolation, empirical measurements of water use, and return flows
 - Assess potential changes in management of groundwater and surface water systems
 - Project the effect of future growth and land use changes on groundwater resources
- Assess climate change's impact on groundwater basins
 - Account for changes in groundwater demand and recharge
 - Assess need for changes in groundwater management and surface water management under climate change scenarios
 - Evaluate merits of potential management responses to climate change scenarios
- Improve understanding of surface water and groundwater interactions in relation to the environment
 - Develop groundwater management assessment and implementation tools for improved management of groundwater-dependent ecosystems
- Improve understanding of impact of saltwater intrusion
- Develop new groundwater banking alternatives, particularly in agricultural regions
- Education/outreach on conjunctive management of groundwater and surface water

Topics specific to forest and rangeland watersheds:

- Well development and management for rural residential uses
- Contribution of subsurface and ground water to instream flows

Topics specific to production agriculture:

- Evaluate cropping patterns and related changes in irrigation practices on groundwater demand
- Evaluate role of irrigation efficiency in managing groundwater
 - Assess unintended impacts of more effective irrigation systems on groundwater and surface water balances
 - Assess opportunities to modernize water district infrastructure and aid groundwater management

Topics specific to urban environments:

- Evaluate impacts of changing urban landscapes on groundwater supply and demand
- Assess potential impacts of urban water re-use and watershed management on groundwater supply and demand

Policy issues addressed

- Groundwater's role in securing water supply reliability in California
 - Consideration of climate change scenarios
- Institutional and infrastructural improvements to foster local and regional groundwater management today and in future
 - Conjunctive management and integrated regional water management approaches

Deliverables

- New basin-specific knowledge and information that aids in implementing local or regional groundwater management.
- Improved science-based tools and guidelines to aid in the development of policies and methodologies that support local or regional groundwater management.
- Third-party, objective educational programs for the broader public on methods of groundwater management and conjunctive water management.

Expected outcomes and impacts

- Improved understanding among a broader base of water users about the role of groundwater in meeting the local, regional, and statewide annual water needs.
- More reliable and flexible water supplies by reducing conflict and enhancing transparency and collaboration among stakeholders to achieve local or regional groundwater management goals.
- Advances in the implementation of local or regional groundwater management.
- Adaptation and expansion of local and regional groundwater management to broader conjunctive water management or integrated regional water management.

3. Surface Water Quality

Population increases, urbanization, and climate change are placing unprecedented stresses on natural resources such as freshwater. This challenge is exacerbated in the state of California, with its predominantly arid and semi-arid lands. For example, growing populations, especially in coastal regions of the state, have increased degradation of surface water resources through contaminants from urban landscapes.

In addition, climate changes will further strain the availability of high-quality water resources in many areas of the state, requiring greater dependence on lower-quality recycled and/or reclaimed water for both food production and urban landscape irrigation.

Over the last two decades, government regulatory agencies, environmental nonprofit organizations, and public and private research institutions have invested considerable effort into improving the quality of California's surface waters. Even with this intense focus, the majority of California's streams, rivers, lakes, and estuaries continue to be impaired by excess nutrients (nitrate and/or phosphate), inorganic (e.g., selenium) or organic (e.g., pesticides) contaminants, and a variety of microbial pathogens (e.g., salmonella, giardia) and bacterial indicators (e.g., fecal coliforms). The potential impact of "emerging contaminants" such as pharmaceuticals and personal care products (PPCPs) is only beginning to be recognized.

Preferred areas of research and extension

Topics common to agricultural, forest and rangeland, and urban land uses:

- Characterization of constituents of concern in runoff (nutrients, pesticides, pathogens, sediments, temperature) including loading estimates for improved Total Maximum Daily Load (TMDL) allocations.
- Impact of current and alternative forest and rangeland management methods on movement of contaminants in surface runoff.

- Impact of current and alternative irrigation methods on movement of contaminants in surface runoff.
- Mitigation strategies to minimize movement of contaminants in surface runoff, including both structural and non-structural management practices.
- Management of recycled water runoff contaminants, including emerging contaminants, pathogens, salts, and nutrients into surface waters.
- Minimizing introduction of pesticides into surface runoff through the use of integrated pest management practices.

Topics specific to forest and rangeland watersheds:

- Improved management practices to mitigate sediment and nutrient delivery and temperature modification to surface waters.
- Improved management practices for livestock to mitigate surface water contamination from non-point source fecal pollution.

Topics specific to production agriculture:

- Early pollutant detection methods to improve production agriculture's ability to quickly respond to surface runoff contamination and possible food safety issues.
- Improved management practices for concentrated animal feeding operations (CAFOs) and their accumulated manure to minimize discharge of surface runoff containing nutrients, pathogens, and emerging contaminants such as antibiotics.

Topics specific to urban environments:

- Assess and develop urban management practices that lessen water quality degradation of surface water resources.

Policy issues addressed

- More accurate development and evaluation of TMDLs through robust field data collection and analysis and improved modeling to determine pollutant load allocations.
- Improved conservation practice effectiveness through development and evaluation
- Improved implementation of contaminant mitigation strategies through economic feasibility studies.

Deliverables

- Irrigation management strategies to minimize surface runoff carrying potential pollutants from agricultural production and urban landscapes.
- Rapid detection and economic decision-support tools to better control contaminants, particularly pathogens, in surface waters.
- Effective and economical structural (i.e., physical) and non-structural (i.e., management) mitigation strategies to protect surface waters in agricultural and urban environments.

Expected outcomes and impacts

- Widespread adoption of science-based mitigation strategies by agriculture and urban communities.
- Reductions in pollutant loadings in streams from human activities in agriculture and urban environments.

- Increased protection of the quality of existing surface waters in order to maximize the benefits and availability of freshwater resources for the growing population in California.

4. Groundwater Quality

The quality of California's water resources has been a major concern for the last half century. Public attention to this slow but insidious problem peaks periodically when faced with significant groundwater quality problems often associated with drinking water in urban areas. For the past 30 years, industrial and urban land uses have been broadly monitored and regulated. Prevention, detection, assessment, and remediation of industrial groundwater contamination from, for example, industrial waste seepage, solvents, petroleum product storage tank leakage, and poor landfill construction, as well as groundwater contamination from mining sites have been a major focus of regulatory agencies.

Also receiving attention are agricultural impacts on groundwater quality. Some examples include the selenium contamination in drainage water from San Joaquin Valley drainage 30 years ago or the periodic concern about the loss of irrigated land from perched, high-saline groundwater.

Studies conclude that the net salt accumulation in the San Joaquin Valley total approximately one-half million tons per year in the form of dissolved salts in both shallow and deep groundwater. Salt imports by infiltration into the valleys are governed by rainfall, surface water, and groundwater pumping; whereas salt exports are from drainage, bottom flux towards deep groundwater, and lateral flows to the San Joaquin River. Already, significant areas of irrigated land, in excess of 100,000 acres, have been removed from production due to encroaching sub-surface salinity. Studies project this will continue unless substantial changes in irrigation policy and practice are adopted.

Nitrate is California's most ubiquitous groundwater contaminant. Nitrate is a natural part of the nitrogen cycle in the environment, and nitrogen is essential to global food security, but too much nitrate can affect human health. Intensive agriculture and human activities have increased the occurrence of nitrate in the environment. Nitrogen contamination of groundwater and its effect on drinking water, public health, and other uses has been a concern for many decades, but only over the past five years has California legislatively moved to regulate agricultural sources of groundwater quality degradation (primarily nutrients and salts) under its four-decade-old Porter-Cologne Water Quality Control Act.

Preferred areas for research and extension

Topics common to agricultural and urban land uses:

- Characterization of materials of concern in groundwater recharge from irrigated land uses (nutrients, pesticides, pathogens, sediments, emerging contaminants).
- Impact of current and alternative irrigation delivery methods on movement of contaminants in recharge.
- Mitigation strategies to minimize movement of contaminants in recharge, including both structural and non-structural management practices.
- Management of recycled water contaminants in urban and agricultural irrigated lands recharge, including emerging contaminants, pathogens, salts, and nutrients into surface waters.

- Minimizing leaching of pesticides through the use of integrated pest management practices.

Topics specific to production agriculture:

- Effective monitoring methods to assess nitrate and salt leaching to groundwater that improve production agriculture's ability to respond to potential groundwater contamination.
- Improved management practices for confined animal farming operations (CAFOs) and their accumulated manure to minimize leaching of salts, nutrients, pathogens, and emerging contaminants such as antibiotics.

Topics specific to urban environments:

- Assess and develop urban landscape management practices that reduce leaching of salts, nutrients, pesticides, and emerging contaminants into groundwater.

Policy issues addressed

- Policies that address the salinity problem by its sources are needed.
 - Proportional contribution from municipal, commercial, and industrial sources will increase significantly during the next 25 years.
 - Salinity contribution from crop agriculture is expected to decrease, due to several factors. First, the improvement in irrigation efficiency and management will reduce the rate of deeper pollution and salinity transport to groundwater. Second, a slight decrease in irrigated acres will occur.
 - Salinity from animal production is projected to decrease, given that the enforcement of nutrient disposal from CAFOs improves and technical improvements in waste disposal continue.
- Policy addressing nitrate groundwater contamination is needed in four areas:
 - drinking water actions for affected areas,
 - reducing sources of nitrate contamination to groundwater,
 - monitoring and assessment, and
 - revenues to help support local and state solutions.
- Support of various stakeholders in the development and implementation of regulatory programs:
 - The agricultural regulatory orders by the Central Coast Regional Water Board,
 - three major agricultural regulatory programs by the Central Valley Regional Water Board (dairy general order, irrigated lands regulatory program, and salt and nutrient basin plan amendment), and
 - similar actions by other regional water boards under the sunset of nonpoint source discharge waivers and the State Water Board's 2009 Recycled Water policy.

Deliverables

- Since water is the main factor by which contaminants are transferred to the groundwater, changes in irrigation use, efficiency, and drainage disposal are critical, including
 - improved irrigation management; and
 - development, assessment, and demonstration of alternative clean recharge technologies in agricultural landscapes to support groundwater banking.
- Development of effective direct and indirect groundwater loading monitoring approaches from agricultural and urban landscapes.

- Modeling and assessment methods to understand long-term and short-term impacts of management practices on water quality in drinking water wells and irrigation wells.
- Improved management methods for groundwater resources in support of improving and protecting groundwater quality, including well construction, management, and abandonment.
- In addition to technical improvements, incentive structures for optimal use of this common property resource must be considered such as “cap and trade” or, for example, nitrate taxes.
- The importance of animal agriculture in the Central Valley to the nitrate problem cannot be overemphasized. There are significant potential technologies that not only reduce the impact of animal waste but utilize it for energy. Extension research efforts should focus on these areas.

Expected outcomes and impacts

- Widespread adoption of science-based mitigation strategies by agriculture and urban communities.
- Reductions in pollutant leaching to groundwater due to agricultural land uses and in urban environments.
- Increased protection of the quality of existing groundwater to maximize the benefits and availability of freshwater resources for California’s growing population and environment.
- Significant advances in technology, information dissemination by extension, and incentives to change management actions both in crop and animal agriculture.

UC ANR Resources

Role

As California’s land-grant institution, UC ANR’s role is to create and apply science in the search for solutions for California’s water and other problems. We also have a responsibility to educate and train the next generation of citizens and professionals, which will enable us to continue to address California’s water issues. We accomplish these goals through the continuum of the Agricultural Experiment Station (AES) researchers and Cooperative Extension (CE) specialists and advisors.

Personnel

ANR has AES researchers and CE specialists on the Berkeley, Davis, and Riverside campuses and CE specialists and advisors in the counties and at our research and extension centers. In addition, ANR program representatives and other staff provide key support. Personnel work on a variety of urban, rural, and agricultural water issues.

Resources

ANR support for the Water Initiative comes from many sources. The ANR Competitive Grants Program devotes a portion of its call to water resources. In addition, ANR academics have access to the research and extension centers, the statewide programs (California Institute for Water Resources; Master Gardener Program; Youth, Families and Communities Program; Integrated Pest Management Program; Sustainable Agriculture Research and Education Program; and

Agricultural Issues Center), and the other strategic initiatives. There are also several relevant Hatch and Smith-Lever multi-state projects concerning water.

Program and Interagency Coordination

- Coordination with Department of Water Resources' Water Plan Update 2013 and 2018
 - Coordination and collaboration with the Department of Food and Agriculture
 - Coordination with Association of California Water Agencies (ACWA)
 - Coordination and engagement with stakeholder processes within the regional water boards and State Water Board, including engagement in implementation of TMDL regulations, Dairy Program's General Order for Existing Milk Cow Dairies, Irrigated Lands Regulatory Program and Agricultural Regulatory Program, and Salt and Nutrient Management Plans' Basin Plan Amendments
 - Collaborations with the U.S. Geological Survey
 - Collaborations with the National Laboratories
 - Coordination and joint program of groundwater educational/extension programs with the Groundwater Resources Association of California program
 - Engagement in and support of local and/or regional groundwater management plans, urban water management plans, and integrated regional water management planning efforts
 - Collaborations with the Water Education Foundation
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Program Components

Approach

Solving California's water problems will require increased collaboration and integration within the scientific community. Interdisciplinary teams—with increased participation from behavioral and policy scientists—are necessary to solve the scientific and social aspects simultaneously.

Although the five existing strategic initiatives have independent panels and leaders, there are clearly areas of inquiry within each that cut across areas of inquiry in other initiatives. The issue areas of the Water Initiative are critical to all initiatives. Research supported through the initiatives must consider connections of specific projects with other initiatives and make the necessary linkages to lead to more robust outcomes with higher potential for significant policy or behavioral impacts. The strategic initiative leaders collectively support this approach.

Internal Funding Opportunities

While there are multiple, important areas of ANR research and extension under way, internal funding opportunities will focus on the primary areas of inquiry within the five strategic initiatives. Key criteria include

- Funding for new activities in research, education, and/or extension; particularly efforts that need initial support to leverage outside funding such as initial data gathering, grant planning, matching funds, stakeholder group meetings to prioritize needs, and integrated projects initiation.
- Funding activities that synthesize large data sets and existing knowledge with the goal of supporting science-based management decisions, policy-relevant impacts, or effective

science education programs directed at the general public or an important stakeholder group. The result could include commentaries or synthesis or white papers, which provide unbiased, policy-relevant information to legislators and governmental agencies on issues critical to California.

- Funding to expand extension activities in existing research grants or new research proposals to achieve broader statewide impacts in one area of inquiry. This can include recommendations for temporary or term appointments in outreach or extension activities.
- Synthesis and expansion of outreach and extension activities across other program areas.

Leveraging Outside Funding

It is critical that ANR funding be used strategically to leverage additional outside support through private, non-profit, state, or federal sources. The primary goal of ANR funding should be to enhance the research, extension, and education programs of proposals that address critical problems within the *ANR Strategic Vision* and to which ANR can contribute in unique ways. This is particularly important in areas where leadership and expertise exist within all phases of the continuum to integrate research, management, and extension. There are a number of programs whose emphases can align with those of the initiatives.

Possible Funding Sources for Water Initiative

Federal

- USDA National Institute of Food and Agriculture
 - Specialty Crops Initiative
 - Agriculture and Food Research Initiative
 - Section 406 Water Quality Program
- USDA National Wildlife Research Center
- USDA Natural Resources Conservation Service
- U.S. Agency for International Development /World Bank
- U.S. Coast Guard/Dept. of Defense (modest funding)
- U.S. Fish and Wildlife Service
- U.S. Geological Survey
- U.S. Bureau of Reclamation
- U.S. Army Corps of Engineers
- U.S. Forest Service
- U.S. Department of Energy (interested in CO₂)
- National Science Foundation
- Environmental Protection Agency
- National Oceanic and Atmospheric Organization
 - National Marine Fisheries Service
 - Sea Grant
- Earmarks and leveraging through state and federal legislators

State

- California Natural Resources Agency
 - California Department of Water Resources
 - California Department of Conservation
 - Bay Delta Conservation Plan

- Delta Stewardship Council
- California State Water Resources Control Board
- California Ocean Protection Council
- California Department of Food and Agriculture
- California Department of Forestry
- California Department of Fish and Game
- California Environmental Protection Agency

Other

- Commodity boards and industry organizations
- California Ocean Science Trust
- California Farm Bureau Federation’s Agriculture in the Classroom

Recommendations for New Academic Positions

Understanding the complexity of the state’s surface and groundwater issues as well as solving problems to benefit all Californians requires diverse, adaptable, well-trained, and dedicated academics. Within ANR, the need for Agriculture Experiment Station researchers and Cooperative Extension specialists and advisors in core areas critical to environmental sciences, agriculture, education, and youth has not been matched by recent hiring of academic personnel. Given the age demographics of the current academic workforce and the projected rate of retirements in the next several years, it is expected that many new hires will be needed to maintain ANR’s excellence in core programs and to address critical issues outlined in the *Strategic Vision*.

Recommendations for hiring new Cooperative Extension specialists and advisors will be made through several sources, including campus colleges, county directors, program teams, and workgroups. The strategic initiatives will also provide an avenue for filling critical needs within the context of the *ANR Strategic Vision*. These positions can be recommended by members of the initiative panels with expertise in the various disciplines or identified by proposals seeking support within the areas of inquiry.

Outreach and Communications

The long-term success of the initiatives, as well as ANR, depends upon a strong campus-county continuum and an effective outreach effort. In addition, campus and county-based Cooperative Extension programs throughout the state have a long tradition of effective collaboration with a wide array of stakeholders and clientele groups who often provide resources and help identify research priorities. Historically, ANR has effectively extended important and relevant information to appropriate audiences through traditional methods such as meetings, workshops, field or short courses, symposia, demonstrations, and a variety of print publications. ANR has also effectively reached out to the ethnically, racially, and culturally diverse demographic groups in California. In the future, a larger diversity of people and stakeholder groups, including policy or decision-makers, needs to be actively engaged with ANR activities, and a broader audience must be targeted to better reflect the diversity of California’s population. This can be achieved through multiple communication venues, including emerging technologies such as web or software-based sources, social and traditional media, and other innovative electronic media (i.e., films, videos, youtube.com educational clips, iPhone apps for accessing website information, website interactive tools).

ANR Communication Services offers many resources that enable our division to learn and use new methods of media outreach in addition to our traditional forms of communication. These new and emerging resources, and the corresponding training or support staff, should be increasingly available to ANR academics and staff to expand our ability to reach a wider and more diverse audience.

Interaction with Other Programs and Agencies

A fundamental criterion for the success of the initiatives beyond the five-year planning phase is the ultimate impact on public policy or behavioral change and how these efforts contribute to solving the key problems in California that they address. This can only be achieved through high-quality research coupled with strong and effective outreach efforts directed to those who either influence policy or have the ability to alter or modify their management practices or behaviors.

While it is important to use information and structures in other states as examples on which to build, California has many unique ecological, economic, and social issues that must be incorporated into policies and management. ANR should work closely with state and federal agencies to define the topic areas in which we have resources and expertise, identify those areas where knowledge and techniques are lacking, and balance and improve the links between basic and applied research needs. ANR leaders need to work closely with state agencies to direct funding towards those needs and pursue research and outreach through focused funding.

The priority issues identified in the *ANR Strategic Vision* are socially, agriculturally, ecologically, and environmentally complex and require integrated approaches that ANR academics are well equipped to handle. Although ANR programs are now divided between the strategic initiatives, collaboration between programs and stakeholders will be necessary for our future success. Water Initiative priorities are intrinsically linked to those in other initiatives, offering numerous collaborative opportunities to effectively address the complex issues facing Californians.

Program Teams, Workgroups, and Conferences

ANR recently initiated program teams that connect groups of people with related topic areas. The program teams are responsible for program planning, identifying emerging issues, planning collective research and extension activities and products, determining extramural funding opportunities, and recommending key positions. ANR workgroups have been, and are expected to continue to be, integral in organizing academics around specific research topics, many of which are essential to the success of the initiatives. Workgroups provide internal communication and networking, in-service training, identification of key emerging issues, and research and extension program planning. Other activities of the program teams and workgroups include communication and networking, providing subject matter for in-service training, and reporting and discussing individual or collaborative research findings. Although time may be limited to accomplish all of these objectives, program teams and workgroups are encouraged to use available communication technologies, including interactive, web-based meetings and video conferencing when additional in-person meetings are not practical or economically feasible.

References

- Atwill, Edward R., M.L. Partyka, R.F. Bond, Xunde Li, C. Xia, and B. Karle. 2012. Introduction to Waterborne Pathogens in Agricultural Watersheds. USDA NRCS Nutrient Management Technical Note Number 9. 84 pgs.
- Agricultural Water Stewardship. 2011. Recommendations to optimize outcomes for specialty crop growers and the public in California. California Roundtable on Water and Food Supply. <http://aginnovations.org/roundtables/crwfs/>.
- Bulletin 118. 2003. California's groundwater. California Department of Water Resources. <http://www.water.ca.gov/groundwater/bulletin118/bulletin118update2003.cfm>.
- California Water Plan. 2009. California Department of Water Resources. <http://www.waterplan.water.ca.gov/cwpu2009/index.cfm>.
- Harter, T. et al. 2012. Addressing nitrate in California's drinking water. Report to the State Legislature. Watershed Science Center, University of California, Davis.
- Howitt R. E. et al. 2009. The economic impacts of Central Valley salinity. Final report to the State Water Resources Control Board, Contract 05-417-150-0. University of California, Davis.
- Orlob, G. T. 1991. San Joaquin salt balance: Future prospects and possible solutions. In A. Dinar and D. Zilberman, eds., *The economics and management of water and drainage in agriculture*. Boston: Kluwer. 143–167.
- Roche, L.M., L. Kroemschroder, E. R. Atwill, R.A. Dahlgren, and K.W. Tate. 2013. Water quality conditions associated with cattle grazing and recreation on national forest lands. *PLOS ONE*. 8(6): e68127
- Schoups, G. 2004. Regional-scale hydrologic modeling of subsurface water flow and reactive salt transport in the western San Joaquin Valley, California. University of California, Davis, PhD. dissertation.
- Schoups, G., et al. 2005. Sustainability of irrigated agriculture in the San Joaquin Valley, California. *Proceedings of the National Academy of Sciences* 102(43): 15352–6.
- Van Genuchten, M. T., and G. J. Hoffman. 1984. Analysis of crop salt tolerance data. In I. Shainberg and J. Shalhevet, eds., *Soil salinity under irrigation*. Berlin: Springer Verlag. 258–271.